

Dr. Bhimrao Ambedkar Government College Sriganganagar

FACULTY OF SCIENCE

M. Sc. ZOOLOGY

Programme Outcomes:

- The programme also works across related majors within the M.Sc zoology.
- Distinguish between the Structure, Function, Behaviour and evolution of different animals.
- Master of Science majors of conservation biology and ecology, giving you an in-depth knowledge of those most closely related programmes.
- Apply the wide range of subject based skills to various fields that provide a base for future career in disciplines such as Health Sciences, Agriculture, Environmental Management, Biotechnology , Publishing ,Teaching and Research.
- Perform, Assess and implement practical techniques and procedure to solve biological problems and analyse and quantify data collected during any related project.
- Understand the applications of Biological techniques to various fields of life science.
- When you graduate with a Master of Zoology you will have learned how to work at a high level of academic achievement.
- Work to deadlines under pressure and communicate effectively.

Program Specific Outcomes :

- Understand Nature, environment natural resources and their conservation, Classification & Behaviour of different animals, Human genetics, Cytology and Evolution.
- Apply the wide range of subject based skills to various fields that provide a base for future career in disciplines such as Health Sciences, Agriculture, Environmental Management, Biotechnology, Publishing ,Teaching and Research.
- Distinguish between the Structure, Function, Behaviour and evolution of different animals.
- Perform, Assess and implement practical techniques and procedure to solve biological problems of animals and analyse and quantify data collected during any project.
- Understand the applications of Biological techniques used into various fields of biology.

M.Sc. ZOOLOGY

M.Sc.Previous

Paper I – Taxonomy, Phylogeny, Structure and Function in Invertebrates

Paper II – Biological Chemistry, Immunology and Physiology

Paper III- Molecular Biology, Cytogenetics and techniques in Biology

Paper IV- Evolution, Statistical Methods and Computer Application in Biology

Practical- Based on Paper I to IV in two days

PAPER I: TAXONOMY, PHYLOGENY, STRUCTURE AND FUNCTION IN INVERTEBRATES

3 hours duration

Max marks 75

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. A study of the classification of Invertebrates with distinguishing features and examples of various subdivisions.
2. Introduction to the science of taxonomy, rules of nomenclature.
3. Principles of classification: Theories of biological classification and their history; the species category; the polytypic species; population systematics; intraspecific categories.
4. Methods of classification: taxonomic collection and the processes of identification, taxonomic characters: types of variations (qualitative and quantitative) within a single population, methods of arriving at taxonomic divisions on species level; preparation and use of taxonomic keys.
5. Cytotaxonomy: Importance of cytology and genetics in taxonomy,

UNIT-II

1. Criteria for phylogenetic interrelationship between Invertebrate phyla
2. Origin of Multicellularity(Protozoa, parazoa and metazoan)
3. Origin of radiata (Coelenterata and Ctenophora)
4. Origin of Bilateria from radiata(Importance of Planula larva and Ctenophores)
5. Phylogenetic significance of Rhynchocoela
6. Interrelationship of the Pseudocoelomate groups with special reference to Rotifera, Gastrotricha, Kinorhynca, nematomorpha and Entoprocta.
7. Affinities and evolutionary significance of the unsegmented lesser protostome phyla(Priapulida, Echiuroidea and Sipunculoidea. Echiurida and Sipunculida).
8. Phylogenetic relationship between the coelomate phyla(Annelida, Onychophora, Arthropoda and Mollusca).
9. Affinities and evolutionary significance of the Lophophorate coelomate phyla (Brachiopoda, Phoronida and Ectoprocta).
10. Affinities of the invertebrate deuterostome phyla(Chaetognatha, Echinodermata, Pogonophora and Hemichordata)

UNIT-III

1. Locomotion in Invertebrate

(a) Amoeboid movements: Ultrastructure of cilia and flagella: Ciliary and flagellar movements; molecular and physiological mechanisms involved in the three kinds of movements

(b) Myotomes and muscle fibers in invertebrate structure and their involvement in locomotory action.

© Locomotion in relation to hydrostatics. Coelome, metamerism, arthropodization

(d) An outline of flight mechanism in insects.

2. Filter feeding in higher invertebrates; Feeding mechanisms in insects and echinoderms.

3. Respiration

(a) Respiration in lower invertebrates (Protozoans to Helminthes)

(b) respiration In higher invertebrates (Trachea, Gills, Lungs and Lophophores)

(c) Physiology of respiratory pigments in invertebrates

4. Excretion: Study of structural and functional organization of excretory systems in various invertebrate groups and a survey of various excretory products met within them.

5. Osmoregulation and ionic regulation: Survey of principal mechanisms in fresh water, marine and terrestrial invertebrate forms.

UNIT-IV

1. Structural and functional organization of nervous systems and receptor

(a) Plan of nervous systems in the Coelenterates, Platyhelminthes, Annelida, Arthropoda, Mollusca and Echinodermata. Structural and functional complexities of brain and ganglionic structures.

(b) Receptors: Structural and functional organization of the mechanoreceptors, chemoreceptors and photoreceptors.

2. Endocrine system: A survey of endocrinal structures and their hormones role of neurosecretions and hormones in developmental events of insects and crustaceans.

3. Reproduction

Asexual and sexual reproduction met within different invertebrate groups, Parthenogenesis. Larval forms met within different invertebrate group and their significance

UNIT-V

Parasitism: general consideration, Types of parasites, type of hosts, symbiosis and commensalism.

Protozoan parasites: Distribution, habit and habitat, structure life cycle and disease caused by selected pathogenic protozoan parasites of man. *Entamoeba histolytica*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax*.

Helminthes parasites: General characters, organization and larval forms of Platyhelminthes and nemathelminthes.

Distribution, habit and habitat, structure and life cycle of economically important helminth parasites of man and domesticated animals: *Echinococcus granulosus*, *Hymenolapsis nana*, *Schistosoma haematobium*, *Paragonimus westermani* and *Trichinella spiralis*.

Arthropod parasites of public health importance: Biology, disease transmitted, caused, prevention and control of bedbug, fleas, lice

Suggested reading material

- Avise, J.C. Molecular markers. Natural History and Evolution. Chapman and Hall. New York.
- Barnes, R.D. Invertebrate Zoology, 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. NewYork.
- Hyman L.H. The Invertebrates Vol.2. McGraw Hill Co. NewYork
- Hyman, L.H. The Invertebrate Vol.8. McGraw Hill Co. NewYork and London.
- Hyman, L.H. The Invertebrates Vol.I. Protozoa through Ctenophora. McGraw Hill Co. NewYork.
- Jagerstein, G. Evolution of Metazoa life cycle, Academic Press, Newyork and London
- Kato, M. The Biology of Biodiversity, Springer
- Mayer,E. Elements of taxonomy
- ParkerT.J. and Haswell, W.A. Text book of Zoology. Macmillan and Co. London.
- Read, C.P. Animal Parasitism. Prentice Hall Inc.NewJersy
- Russel Huntler,W.D. A biology of higher invertebrate. The Macmillan Co. Ltd.
- Sedgwick, A.A. Students text book of Zoology Vol I,II,II. Central Book depot. Allahabad.
- Simpson G.G. Principals of Animal taxonomy. Oxford IBH Publishing Company.
- Tikadar,B.K. Threatened Animals of India.ZSI Publication. Calcutta
- Wilson,E.O.Biodiversity. Academic Press. Washington
- Wilson, E.O. The diversity of life. W.W. Northem and Co.
- Meglitsch, Schram. Invertebrate Zoology. Oxford
- Kotpal, R.L. Invertebrate phylum series(Protozoa to Echinodermata)Rastogi publication.
- Chaterjee: Parasitology
- Chandler and Read, Introduction to Parasitology
- Noble and Noble: Parasitology
- Smith: Animal parasitology

PAPER II: BIOLOGICAL CHEMISTRY, IMMUNOLOGY AND PHYSIOLOGY

3 hours duration

Max marks 75

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UNIT-I

- 1. Chemistry of Carbohydrates:** definition, general properties, classification (Monosaccharides, Disaccharides, Polysaccharides) Sugar derivatives; Metabolism of carbohydrates
- 2. Chemistry of Lipids:** definition, general properties and classification, fatty acids: Simple and compound lipid, Steroids, metabolism of lipids, Biomedical importance of lipids.
- 3. Chemistry of proteins and Amino acids:** definition, general properties of amino acids and proteins, Metabolism of proteins, Biomedical importance of proteins and Vitamins
- 4. Chemistry of Nucleic Acids:** Definition, general properties, classification and importance of Nucleic acids.
- 5. Enzymes:** Chemistry of enzymes, Nomenclature, specificity and metabolism of enzymes, Competition and noncompetitive inhibition, Allosteric inhibition.
- 6. Inborn errors of metabolism**

UNIT-II

Introduction and historical background of immunology, Antigens, Antibody, antibody structure and diversity, MHC, mechanism of immune response. HLA class I, II, II molecules, Humeral and cell mediated immunity, Hypersensitivity reaction: type I, II, III and IV. Primary and secondary immune deficiency disease, CID, AIDS, vaccination/Immunization. Active and passive immunization, novel approach for various vaccines, process of vaccination, prokaryote parasite (Viral and bacterial). Eukaryotic parasite (Fungal, protozoa, trematodes, cestodes, nematodes and arthropod disease).

UNIT-III

Physiology of Digestion, respiration and Circulation

Mechanism of secretion and action of all types of digestive juices met within the mammalian digestive pathway, Physiological mechanisms involved in the absorption of the end products of digestion, digestive glands and process of digestion, digestive disorders.

Chemistry of respiration with particular reference to mammals, respiratory path, respirator pigments, ventilation, modified forms of respiration, respiratory disorders.

Blood, Physiology of blood clotting, heart, transport mechanism, nervous regulation of heart function in man, conductile and contractile mechanism of heart, cardiac cycle in man, ECG, regulatory mechanism of heart, circulatory disorders(hypertension, Hypotension, Anaemia, Myocardial infarction etc.)

UNIT-IV

Physiology of Excretion, Muscle tissue and Nervous tissue.

Various nitrogenous waste products, Kidney, Architecture of nephron, role of kidney in osmoregulation, mechanism and regulation of urine formation, disorders of excretion.

Morphology and functional architecture of the contractile apparatus in muscle tissue; Study of the biophysical and biochemical events underling contraction and relaxation process. Muscular disorders.

Biochemistry and molecular physiology of genesis, conduction of nerve impulse and transmission across synaptic junctions, neurotransmitters, reflex action.

UNIT-V

1. Physiology of the receptor system: general mechanism involved in stimulus transduction at receptor sites: Functional architecture and stimulus processing in eye, ear and olfactory epithelium.

2. **Endocrine physiology:** Cellular mechanisms of hormone action in target tissues (Hormone receptors, membrane receptors, nuclear receptors, G protein), Hypothalamic control of pituitary activity and phenomenon of neurosecretion; genesis types and general functions of hormones of various endocrine glands (Hypophysis, adrenal, thyroid, parathyroid, testis, and ovary, Islets of Langerhans).

3. **Reproduction:** Endocrinological control of the testicular, ovarian and uterine functions, physiological aspects of implantation and parturition and lactation. Reproductive abnormalities (Gonorrhoea, Syphilis, genital herpes, prostrate problems, vaginitis, Uterine tumors, menstrual complications).

Suggested reading material

- Alberts et al. molecular Biology of the cell, Garland
- Barrington, E.J.W. General and comparative endocrinology. Oxford Clarendon Press.
- Bentley, P.J. Comparative Animal endocrinology, CUP.
- Gorbman et al. Comparative endocrinology. John Wiley and sons.
- Hadley, Endocrinology, Prentice Hall
- Hoar' general and comparative physiology, Prentice hall
- Lodish et al. Molecular cell Biology, Freeman
- Martin, C.R. Endocrine physiology, OUP.
- Nielson, S. Animal physiology, CUP
- Prosser and Brown. Comparative animal physiology. Sathish book enterprises.
- Williams, R.H. text book of endocrinology. WB Saunders.
- Gyton, S Human physiology
- Ganongs. Review of medical physiology. Lange medical
- Vander shermann, Human Physiology. McGraw Hill
- Chatterjee, C.C. Human Physiology, Vol. I and II.
- Mathews et al. Biochemistry. Pearson education.
- Jain, J.L. Biochemistry. S, chand. New Delhi
- Voet and Voet. Biochemistry, Wiley eastern
- Lehninger, Biochemistry. CBS
- Rama Rao. A text book of biochemistry. UBSPD.
- Armstrong, F.B. biochemistry. Oxford.
- Soni, K.C. Animal physiology, CBC. Jaipur
- Stryer, L. Biochemistry. Freeman
- Marieb. Human anatomy and physiology, Pearson education.
- Sembulungam. K. Medical physiology, Jaypee.

PAPER III: MOLECULAR BIOLOGY, CYTOGENETICS AND TECHNIQUES

3 hours duration

Max marks 75

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questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. History and Scope of Molecular Biology

2. **Detailed structure of DNA and RNA**, B-DNA, Z-DNA, Topological structure of DNA, t-RNA, micro RNA

3. **DNA Replication**: Process and difference between Prokaryotic and Eukaryotic DNA replication. DNA and RNA polymerase, Structure and function. Accessory proteins involved in DNA replication, regulation of replication.

4. **Protein Synthesis**: Mechanism of transcription in prokaryote and Eukaryotes. Role of sigma and Rho factor in transcription, Split gene, processing of Hn-RNA (capping, tailing and splicing) Translation (Initiation complex, elongation and termination) Post and cotranslational modification

5. **Gene regulation in prokaryote and Eukaryote**- Lac operon, tryo operon of E.Coli, Enhancer and silencer, Non coding gene.

UNIT-II

1. **Molecular recombination and repair of DNA**- Holliday junction, rec A and other recombinase, Mobile genetic element (transposon). Integrons, retroposons, DNA repair (direct repair, nucleotide excision repair NER, base excision repair BER, Mismatch repair MMR).

2. **Cell cycle**. Cancer and Apoptosis (cell death), mitosis promoting factors MPF, Anaphase promoting factors APF, CDKs and cyclins, p53, onchogenes (SIS and RAS), tumour suppressor gene (TS)

3. **Genetic engineering recombinant technology**, restriction endonuclease, gene transfer techniques, Transgenic organism, genetic engineering and its application, gene therapy, cloning of animals.

4. **mapping and identifying a disease gene**, genetic mapping of locus (DNA markers-RFLP, microsatellite, SNP), genetic mapping of complex trait.

UNIT-III

1. **Human karyotype**- Banding techniques, Human genome, Human chromosome and genetic map, chromosomal mapping, human pedigree analysis)

2. **Somatic cell genetics**-cell fusion, heterokaryon

3. **Imprinting of genes**

4. **Molecular cytogenetics**- FISH, GISH, DNA finger printing, PD-Loop techniques, chromosomal painting, PCR, DNA chip and microarrays.

5. **Genome organization**- C value paradox, prokaryotic genome, viral genome and eukaryotic genome.

6. **Somatic cell genetics**- Cell fusion and hybrids agents and mechanism of fusion; Heterokaryon-selecting hybrids and chromosome segregation.

UNIT-IV

1. **Biosensors**

2. **Immunological techniques based on Ag-Ab interactions**, ELISA, radioimmunoassay (RIA)

3. **Separation techniques and radioisotope and mass techniques in Biology:** electrophoresis, centrifugation, MRI,
4. Cryo-techniques, for microscopy, Freeze dying

UNIT-V

1.DNA sequencing and genome libraries: preparation of template DNA, Automated DNA sequencing, DNA sequence storage and analysis.

2. Animal and Human genomics: C. elegans, Drosophila genome, Mouse genome, Human genome, genome of other animals.

3. Molecular evolution: Concept of neutral evolution, molecular divergence and molecular clock, molecular tools in phylogeny, classification and identification, proteins and nucleotide sequence analysis; origin of genes and proteins, gene duplication and divergence.

4. Genetic evidences for modern human origins-Tracing human history through mitochondrial DNA. The Neanderthal genome , another archaic huminin genome.

Suggested reading material

- **Atherly, A.G., J.R.Girton and J.F.McDonald.** The Science of genetics. Saunders College Publishing, Harcourt Brace College, NY.
- Alberts, B., D.Bray, J.Lewis, M.Raff, K.Roberts and J.D.Watson:** Molecular biology of the Cell, Garland Publishing Inc. New York.
- Braun, Robert:** Introduction to Instrumental analysis, McGraw Hill International edition.
- Brooker, R.J.** Genetics: Analysis and Principles. Benjamin/Cummings, Longman Inc.
- Brown, T.A(Ed):** Molecular Biology Lab Fax, Bios Scientific Publishers Ltd., Oxford.
- Dabre, P.D.,** Introduction to Practical Molecular Biology, John Wiley and Sons Ltd., New York.
- Darnell, J.H.Lodish and D. Baltimore:** Molecular Cell Biology Scientific American Book, Inc.,USA.
- Fairbanks, D.J. and W.R.Anderson.**Genetics- The Continuity of Life. Brooks/Cole Publishing Company ITP,NY,Toronto.
- Gardner, E.J., M.J.Simmons and D.P.Snustad.** Principles of Genetics. John Wiley and Sons.Inc.NY.
- Griffiths, A.J.F., J.H. Miller,D.T.Suzuki,R.C.Lewontin and M.W.Gelbari.** An introduction to genetic analysis. W,H.Freeman and Company, New York.
- John R.W. Masters Ed.** Animal cell culture- A practical approach, IRL Press.
- Lewin, B.** Genes.VIII to XII volume . OUP, Newyork
- Meyers, R.A.** Molecualr biology and Biotechnology. A comprehensive desk reference,(Ed), VCH Publishers, Inc., New York.
- Sambrook, J., E.F.Fritsch and T. Maniatis:** Molecular cloning: a laboratory manual, Cold Spring harbor Laboratory Press, New York.
- Snustad, D.P. and M.J.Simmons.** Principles of genetics. John Wiley and Sons.Inc. NY.
- Watson,J.D., N.H.Hopkins, J.W.Roberts, J.A. Steitz and A.M.Weiner.** Molecular biology of gene, The Benjamin/Cummings Pub.Co.,Inc., California.

Wilson, K and K.H. Goulding: A biologist guide to principles and techniques of practical biochemistry. ELBS Edn.

Karp, G. Cell and Molecular biology, Wiley eastern.

Menninger. Cell structure and function. Saunder College publishing.

Primrose. Principles of gene manipulation and genomics. Blackwell

Gupta, P.K. cell and Molecular Biology. Rastogi publication.

Rana, SVS. Biotechniques. Rastogi publications.

Soni, K.C. Modern cell biology

Soni, K.C. Biotechnology volume I to V

Wilson and Walker. Principles and techniques of Biochemistry and Molecular biology. Cambridge University press.

**PAPER IV: EVOLUTION, STATISTICAL METHODS AND COMPUTER
APPLICATION IN BIOLOGY**

3 hours duration

Max marks 75

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UNIT-I

1. Theories of evolutionary thought:

(a) Greek thought to Lamarck

(b) Darwin and theory of evolution

© the period after Darwin

2. Genetic basis of Evolution: genetic and quantitative aspects of evolution; population as a unit of evolution; gene frequency; gene pool; evolution, the result of change in gene frequency; genetic equilibrium and Hardy Weinberg Law; Mutation pressure; selection pressure; effects of population size; random and non-random reproduction; genetic drift (Sewall-Wright effect)

UNIT-II

1. Variation: Somatic and germinal variations, chromosomal variations; gene mutations, rate, direction and nature of mutations, natural and induced mutations, mutagens.

2. Isolation and its role in species formation

(i) Speciation; definition of species, sub-species and races; speciation a gradual or a sudden process. Allopatric and sympatric speciation.

(ii) Isolating mechanisms; geographical, ecological, physiological, biochemical, anatomical, developmental, behavioral, psychological and social.

(iii) Effects of Isolation: restriction of random dispersal and random mating; character displacement; reduction of fertility

(iv) Failure of isolating mechanism, gene flow, migration, Heterosis

UNIT-III

1. Adaptational diversity and nature of adaptations; adaptive radiations and occupation of new environments and niches; mimicry and coloration.

2. Ecology and evolution

3. natural selection, critical evaluation of the concepts of struggle for existence and survival of the fittest; the modern concept of natural selection's adaptation and differential reproduction; Nedarwinism and Neolamarckism.

4. Characteristics of evolution: Extinction, replacement, irreversibility of specialization etc.

UNIT-IV

1. Objective and significance; important terms and symbols; graphs (bar diagrams, histograms, frequency polygon, line diagrams, pie diagram)

2. Frequency distribution and centering constants (Mean Median and Mode)

3. Measures of variation (Standard deviation, variance, standard error of the mean)

4. Rates and ratios.

5. Sampling variation of proportions. Significance of difference in proportions (t-test)

6. Chi-square test.

7. Correlation and regression.

UNIT-V

1. Analysis of variance (ANOVA)

2. Probability distributions: Binomial, Poisson and Normal

3. Mathematical Modeling

(a) Types of models- statistical, empirical, mechanistic, stochastic

(b) Properties of models-generality, precision, realism

© building a model planning (Conceptualisation), implementation, evaluation, sensitivity analysis).

(d) Detailed treatment of selected specific models from different areas of Biology (examples)

i. Cycling of nutrients in an ecosystem/eutrophication model.

ii. Optimal clutch size in birds

iii. Morphogenesis

iv. Genetic drift

4. Computer application in zoological study; software used in biomedical sciences (Image analysis, system automation).

Suggested reading material

- Ball, Marion J.: What is a computer?, Houghton Mifflin Company, Boston, Massachusetts, 1972
- Batschelet, E. Introduction to mathematics for life scientists. SpringerVerlag, Berlin.
- Brightman' Richard W. and Jeffrey M Dimsdale: Using microcomputer, Galgotia Publication Pvt. Ltd., 1987
- Desmonde, William H: Computers and their uses, Prentice Hall, Inc., Englewood Cliffs; New Jersey, 1964
- Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press. '
- Dobzhansky, Th., FJ. Ayala GL Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi. '

- Futuyama, D.J. *Evolutionary Biology*, Sinauer Associates, INC Publishers, Dunderland.
- Green, R.H. *Sampling design and statistical methods for environmental biologists*. John Wiley & Sons, New York.
- Gupta, Amar and Hoo-min D Toong: *Insight into personal computers*, IEEE Press, 1985
- Hartl, D.L. *A Primer of Population Genetics*. Sinauer Associates, Inc, Massachusetts.
- Jha, A. P. *Genes and Evolution*. John Publication, New Delhi.
- Jorgensen, S.E. *Fundamentals of ecological modeling*. Elsevier, New York.
- Kemeny, John G.: *Man and the Computer*, Charles Scribner's Sons, New York, 1972
- King, M. *Species Evolution-The role of chromosomal change*. The Cambridge University Press, Cambridge.
- Lendren, D. *Modelling in behavioral ecology*. Chapman & Hal, London, .UK.
- Merrel, D.J. *Evolution and Genetics*. Holt, Rinchart and Winston, Inc.
- Murray, J.D. *Mathematical biology*: Springer-Verlag, Berlin.
- Pielou, E. C. *The interpretation of ecological data: A primer on classification and ordination*.
- Rajaiaman D and Rajaraman V: *Computer Primer*, Prentice Hall, India, 1986
- Rossi, Claude J.De: *Computer- Tools for Today*, Childrens Press, Chicago, Illinois, 1972
- Smith, J.M. *Evolutionary Genetics*. Oxford University Press, New York.
- Snedecor, G.W and W.G. Cochran. *Statistical methods*. Affiliated East'West Press, New Delhi (Indian ed.).
- Sokal, R.R. and F.J. Rohlf. *Biometry*. Freeman, San Francisco.
- Strikberger, M.W. *Evolution*. Jones and Bartett Publishers, Boston London.
- Swartzman, G.L, and S.P O. Kaluzny. *Ecological simulation primer*. Macmillan, New York.

Practical Work Based on Paper I to IV
(Total No. of laboratory hrs. 480)

1 Invertebrates:

Identification, classification & study distinguishing features of important Representatives from various groups (Protozoa to Hemichordata).

2. Study of permanent prepared slides (From protozoa to Hemichordata)

3. Anatomy:

(i) Reproductive, excretory, nervous & circulatory systems of an annelids (earthworm and leech).

(ii) Nervous system and general anatomy of Patella, Lamellidens, Mytilus, Sepia, Loligo, Octopus and Aplysia.

(iii) General Anatomy, Reproductive and Nervous Systems of Cockroach, Grasshopper Crab and Prawn.

(iv) Study of sections of the arm of a starfish; water vascular system of starfish; general anatomy of a holothurian; Aristotle's lantern of a sea-urchin: complete as well as disarticulated arrangement of the parts of Aristotle's lantern.

4. Permanent Preparation and Their Study :

(i) Preparation of cultures of Amoeba, Paramecium and Euglena; Study of these protozoans using vital dyes.

(ii) Permanent preparations and study of Amoeba, Paramecium and Euglena from cultures, Vorticella from the pond water; flagellates' from the gut of white ant and housefly, Trypanosomes in the blood of house rat, lifecycle stages of Monocystis from the seminal vesicle of earthworm.

(iii) Collection and study of live Hydra, its fixation and permanent preparation.

(iv) Collection, fixation & permanent preparations of trematodes; cestodes & nematodes found in sheep and pig in the stool of infected persons.

(v) Permanent preparation of various parts of dissection carried out of the animals mentioned in para-3 Anatomy section and study of the structures.

(vi) Permanent preparations of different materials to be provided for study,

5. Biological Chemistry:

i. Identification of Protein, carbohydrates and lipid in various tissues.

ii. Identification of different kinds of mono, di and polysaccharides in biological and chemical materials.

iii. Quantitative estimation of the following by spectrophotometer and semi auto analyser methods in various tissues,

(a) Carbohydrates: glycogen and glucose.

(b) Proteins: total proteins.

(c) Lipid: Phospholipids and cholesterol.

(d) Nucleic acids: DNA and RNA.

(e) Enzymes: acid and alkaline phosphatase.

iv. Paper chromatography and thin layer chromatography:- uni-dimensional chromatography, using amino acids from purified samples and biological materials.

v. Paper electrophoresis and Gel (SDS page and Agarose) electrophoresis; Determination of serum protein through paper and gel (SDS and Agarose electrophoresis)

vi. Study of digestive enzymes in different parts of the alimentary canal (including salivary glands of the cockroach).

6. Physiology:

i. Demonstration of the use and operation of oscilloscope for recording neuro-electric activity and electro-cardiogram.

ii. Kymographic recording of muscle twitch, summation of twitches, tonic contractions, tetanus, fatigue and staircase phenomenon from the sciatic nerve muscle preparation of rat.

iii. Kymographic recording of the rat heart beat & the study of the effect of electrical stimulation, various ligatures, drugs, etc.

iv. Study of spinal and convulsive reflexes in rat.

v. Photometric determination of haemoglobin in blood sample.

vi. Demonstration of the following in blood: clotting time, erythrocyte sedimentation rate, haemolysis and crenation.

vii. Determination of blood urea value.

viii. Enzyme activity of LDH and SDH.

7. Cell Biology:

- i. Squash & smear preparations of testis of cockroach and grasshopper, Acetocarmine & Fuelgen staining of these preparations.
- ii. Study of mitosis in onion root tip and mammalian bone marrow cells.
- iii. Study of giant chromosomes in the salivary gland of Chironomus larva and Drosophila.
- iv. Vital and supra-vital staining (with neutral red and Janus Green B) of cells of the testis of an insect or mammal to study the mitochondria.
- v. Preparation of multi-polar nerve cell from the spinal cord of a mammal.
- vi. Chromosome counts in cells of the testis of an insect or mammal or cells of the bone marrow of a mammal.
- vii. Study of prepared microscopic slides, including those showing various cell types, mitosis, meiosis and giant Chromosomes.
- viii. Preparation and staining of bar bodies.
- ix. RNA and DNA estimation.

8: Genetics:

- i. Culture and identification of male and female Drosophila.
- ii. Identification of wild and mutant forms of Drosophila.
- iii. Monohybrid & Dihybrid inheritance in Drosophila.
- iv. Simple problems based on Mendelism to be done by the students.
- v. identification of blood groups in man.
- vi. Demonstration of sex chromatin.
- vii. Problems based on gene interaction to be done by the students.

9. Statistical Methods in Biology:

- i Preparation of frequency tables and graphs.
- ii. Calculation of standard deviation, variance and standard error of the mean.
- iii. Calculation of probability & significance between mean using t -test.
- iv. Calculation of significance using Chi-square test.
- v. Plotting the slope of a line on a graph, calculations of the slope of a line, coefficient and regression. Students shall have to maintain a complete record of the work done.
- vi. Preparation of histogram, bar diagram and Line graph using computer.

Note: Use Of animals for dissection and practical work is subject to the conditions that these are not banned under the wildlife protection act.

M.Sc.Previous
PRACTICAL EXAMINATION SCHEME

BOARD FIRST: DAY FIRST	DURATION 5 HRS	
1.Exercise in Biological Chemistry		08
2.Exercise in Cell biology		08
3.Exercise in Taxonomy		06
4.Exercise in Statistical Methods		09
5.Spots 1-7		14
6. Seminar/Field/Tour report		10
7. Viva-voce		10
8. Class record		10
Grand Total		75 Marks

BOARD SECOND: DAY SECOND	DURATION 5 HRS	
1. Dissection		12
2. Slide preparation		06
3. Spots 1-7		14
3. Exercise in Physiology		13
4. Exercise in genetics		10
5. Viva Voce		10
6. Class record		10
Grand Total		75 Marks

M.SC. (FINAL) ZOOLOGY
PAPER V: CHORDATA & DEVELOPMENTAL BIOLOGY OF CHORDATES

Total No. of lectures hours 80

Marks 75

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. Origin and outline classification of the chordates.
2. Interrelationships of Hemichordata, Urochordata and Cephalochordata and their relations with other Deuterostomes.
3. Life histories of sessile and pelagic tunicates and ascidian, Pyrosoma, Salpa, Doliolum and Oikopleura
4. Origin, evolution and adaptive radiation of vertebrates.
 - (a) Geological time scale and fossils
 - (b) Origin, evolution and general characters of Agnatha (Ostracoderms and Cyclostomes).
 - (c) The early gnathostome (Placodermi)
 - (d) A general account of the elasmobranchi, Holocephali, Dipnoi, Crossopterygi
 - (e) Adaptive radiation in bony fishes.

UNIT-II

1. Origin, evolution and adaptive radiation of Amphibia
2. Origin and evolution of reptiles: the concept of land Seymouria and related forms: Cotylosauria, basic skull types and outline classification of reptiles.
3. Dinosaurs, types and evolutionary significance
4. Living reptiles- a brief account of Rhynchocephalia. Chelonia, Crocodilia and Squamata
5. Origin and evolution of birds
6. Origin of flight: flight adaptations
7. Origins of mammals: Primitive mammals (Prototheria and Metatheria)
8. A general survey of the main radiations in eutherian mammals (excluding detailed reference to individual order)
9. Evolution of man: relationship of man with other Primates: fossil record of Man's ancestry.

UNIT-III

1. Theories of Development. Preformation and Epigenesis
2. Oogenesis
 - (a) Growth of oocyte and Vitellogenesis
 - (b) Organization of egg cytoplasm; role of the egg cortex:
 - (c) Morphogenetic determination in egg cytoplasm. I
3. Fertilization; significance of fertilization for development and the essence of activation of

the egg.

4. Early embryonic development:

- (a) Patterns of cleavage, blastulation & gastrulation in chordates (Tunicates to mammals).
- (b) Fate maps.
- (c) Morphogenetic movements.
- (d) Mechanics and significance of gastrulation. .

5. Causal basis of development: Primary embryonic induction:

- (a) Concepts of potencies; prospective fates; Progressive determination, Totipotency and Nuclear transfer experiment.
- (b) Induction of the primitive nervous system (Spemann's primary organizer).
- (c) Nature & regionally specific properties of inductor.
- (d) Competence.
- (e) Abnormal (heterogeneous) inductors.
- (f) Chemistry & mechanism of action inducing substances.

UNIT-IV

1. Cell differentiation and differential activity

2. Organogenesis:

- (a) Morphogenetic processes in epithelia and mesenchyme in organ formation.
- (b) Morphogenesis- of the brain; neural crest cells and their derivatives.
- (c) Development of the eye, heart & alimentary canal and its accessory organs.

3. Maternal contribution in early embryonic development

4. Genetic regulation of early embryonic development (Drosophila development as a model).

UNIT-V

1. Embryonic adaptations:

- (a) Evolution of the cleidoic egg and its structural and physiological adaptations.
- (b) Development & physiology of the extra- embryonic membranes in amniotes. .
- (c) Evolution of viviparity.
- (d) Development, types and physiology of the mammalian placenta.

2. Metamorphosis in Amphibia

- (a) Structural & Physiological changes during metamorphosis.
- (b) Endocrine control of metamorphosis.

3. Regeneration:

- (a) Types of regeneration, physiological, reparative and compensatory hypertrophy regenerative ability in chordates. .

- (b) Morphological and histological process in amphibian limb regeneration.

© Wolffian regeneration

- (d) Origin of cells of regeneration, de-differentiation, re-differentiation, pattern formation during amphibian limb regeneration, reasons for the absence of limb regenerative ability in mammals. Methods for induction of regenerations.

PAPER VI: ANIMAL ECOLOGY AND ETHOLOGY

Total No. of lectures hours 80

Marks 75

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two

questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. Concepts of modern ecology.
2. Limiting factors: Liebig's law of minimum, Shelford's law of tolerance; combined concept of limiting factors, conditions of existence as regulatory factors.
3. Analysis of Environment
 - (a) The general environment.
 - (b) Role of Physical factors: temperature, light water; atmospheric gases, the media, substratum, climatology.
 - (c) Brief review of important physical factors as limiting factor.
 - (d) Nutrients and environment.

UNIT-II

1. Organization at the population level:
 - (a) General properties of population.
 - (b) Population growth form and forces shaping the population growth.
 - (c) Measurement of Population. Simple numerical problems on measurement of population to be done. .
 - (d) Animal aggregation and social life.
2. Organization at the community level:
 - (a) Biotic community concept.
 - (b) Community structure and concept of community dominance.
 - (c) Ecotone and concept of "edge effect".
 - (d) Pattern in communities: Stratification, zonation, activity, food web, reproductive and social structure.
 - (e) Community versus the continuum.
 - (f) Evolution of Communities; Palaeoecology; Community structures in past ages.
3. Ecological regulations:
 - (a) Succession in community: Basic types of succession, convergence and divergence in succession; modifications in succession; concept of climax, mono-climax versus poly-climax theory; barriers and ecesis in succession; Biome.
 - (b). Fluctuations within Community; irruptive cycle, fluctuation, causes of fluctuation cycles.

UNIT-III

1. Environment and animals:
 - a. Nature and constituents of ecosystem.
 - b. Fundamental, operation of ecosystem
 - c. Flow of matter and energy in ecosystem
 - d. Homeostasis in the ecosystem
 - e. Cycling of chemical elements in ecosystem.
 - f. Concept of productivity: Productivity of land and water, measurement of productivity.

2. Organization and dynamics of ecological communities :The habitat approach: A detailed knowledge of extent, Zonation, environment biota, adaptations and communities of fresh water, marine, terrestrial and estuarine ecosystems.
- 3.The ecological outlook: Space ecology, nuclear radiation, human population explosion, resources and applied human ecology.

UNIT-IV

1. Introduction of animal behaviour
2. Orientation
 - (a) Classification of various types of taxes and kineses.
 - (b)Flight muscle in Locust
3. Methods of studying behaviour: Brain lesions; electrical stimulation, drug administration. Effect of toxins, drugs and alcohol on human behaviour and addiction.
4. Types of behaviour and their regulation:
 - (i) Components of feeding behaviour, hunger drive, directional movement, avoidance, eating, carrying and hoarding
 - (ii)Factors influencing choice of food
 - (iii) Nervous regulation of food and energy intake
 - (a) Motivated behaviour, Drive, satiation and neuro-physiological control
 - (b) Feeding behaviour
 - (c) Learning: Habituation conditioned reflex: trial and error, latent learning, learning and discrimination, imprinting, neural mechanism of learning.
 - (d) Instinctive behaviour; concept, phyletic descent and physiology
 - (e) Hormones and behaviour, Mammalian nervous system with special reference to the involvement of hypothalamus in the regulation of behavioural patterns

UNIT-V.

1. Social behaviour in Primates
 - (a) Primate societies
 - (b) Social signals, olfactory, tactile, visual, vocal
 - (c)Status: Dominance and hierarchy territorial behaviour courtship and mating aggression.
2. Behaviour of domestic and zoo animals
3. Behaviour in birds: Behaviour of Streptopelia (ring dove) homing and migration
4. Reproductive behaviour in fish(Stickle back or any other fish)
5. Social behaviour in insects: Communication; concealment behaviour. The role of pheromones (A general account)
6. Behavioural genetics: Single gene effect, multiple gene effect, behavioural variation in an individual, genetics and human behaviour

PRACTICAL WORK BASED ON PAPER V AND VI

Total no of lect. Hours: 240

1. Chordates

- (a) **Taxonomy:** Study of museum specimens or representative, animals from all chordate groups (protochordates to mammals).
- (b) **Anatomy (Models, Charts, Computer simulation):**
 - (i) General anatomy and neural gland of Herdmania.
 - (ii) Afferent and efferent arteries, cranial nerves of any commercial fish.
 - (iii) Study of fish anatomy through serial section of fry and fingerling stages.

- (iv) Limb musculature, cranial nerves and eye muscles and their innervations in frog
- (v) General anatomy, major blood vessels and cranial nerves of any nonpoisonous snake.
- (vi) Study of differences between poisonous and non-poisonous snakes.
- (vii) Flight muscles, perching mechanism, air sacs and anatomy of the neck region in the pigeon.
- (viii) Reproductive system and anatomy of the neck region in rat.
- (ix) General anatomy, digestive, respiratory and urinogenital systems in chick

(c) **Osteology:** Comparative study of the axial and appendicular skeleton from fish to mammals, with particular reference the important skull types in reptiles' birds and mammals.

Alizarins and Victoria-blue preparation of the skeleton of any vertebrate, dried and articulated preparation of the skeleton of any vertebrate.

(d) **Permanent Preparations:** Spicules and pharyngeal wall of Herdmania, velum and pharyngeal wall of Amphioxus. Whole mounts of pelagic tunicates, ampulla's of Lorenzini in a skate or ray; Different types of scales, ear ossicles of rat or any other mammal.

(e) **Histology:** A detailed study of the histology of all mammalian tissues and organs through prepared slides to be made available .

2. Development Biology:

(a) Study of development of frog or toad through:

- (i) Formalin preserved or living material (egg, spawn, embryo, larvae and metamorphic stages).
- (ii) Permanent microscopic slide of sections through representative regions of successive embryonic and larval stages

(b) Study of development of chick through

- (i) Permanent whole mounts of successive embryonic stages and
- (ii) Permanent microscopic slides of sections through representative regions of successive embryonic stages (Special emphasis should be laid on organogenesis and morphogenesis)
- (c) Removal of chick embryos 18, 21, 24, 33, 72 and 92 hours from the egg and their study and identification in the living state.
- (d) Study of (i) formalin preserved fetuses with placenta and (ii) histology of placenta of any mammal.

3. Ecology:

(a) Measurement of climatic factors (atmospheric, water, temperature and relative humidity)

(b) Measurement of water, soil pH, edaphic factors of soil, preparation of soil extract, determination of humidity in microhabitat. pH, Alkalinity of water; pH, dissolve oxygen, free carbondioxide, chloride, salinity, temporary and permanent hardness of water, velocity of current.

(c) Measurement of population density, Numerical problems of population determination to be done

(d) A field study of any one of the following habitat to be assigned to an individual or to a group of students.

(e) Mode of life and types of beak and feet in birds.

4. Ethology:

(a) Study of the process of learning in rat with the help of animal Maize, analysis of the

results of simple experiments.

(b) Study of the shock and avoidance behaviour in rat including extinction and relearning; analysis of the result of these experiments

© Imprinting in precocial birds

(d) Chemical communication in the earthworm

(e) Study of the food preferences and feeding behaviour of an insect pest.

(f) Study of the phototactic response in *Tribolium*/Housefly

(g) Study of habituation in chicks.

5. Zoological tour

Tour is compulsory for all the candidates to observe and study Vertebrate fauna in natural habitat.

(Note - use of animals for dissection/practical work is subject to the conditions that these are not banned under the Wild Life Protection Act and UGC guidelines.)

SPECIAL PAPERS

3HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

PAPER VII (A): CELL BIOLOGY

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. Concept of cell theory and historical development in cell biology

2. **Cell types:** detailed structure of the structure of the different types of cells

(i) Nerve cell (ii) Muscle cell (iii) Gland cell (iv) Blood cell

3. **Membrane structure and function:** various models of Plasma Membrane, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes

UNIT-II

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

UNIT-III

1. **Cell division and cell cycle:** Types of cell divisions and their regulation, control of cell cycle

2. Physiological study of mitotic and meiotic divisions with special reference to the mechanism of chromosome movement and organization of the spindle apparatus, mitotic poisons and their actions, Gametogenesis, Physiology of union of the gametes

UNIT-IV

1. **Chromosomes:** Structural, chemical and functional organization of the different types of chromosomes (giant chromosomes, supernumerary chromosomes), Chromosomal aberration
2. **Gene organization:** Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons

UNIT-V

1. **Host parasite interaction:** Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells
2. **Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth

PAPER VIII(A): CELL BIOLOGY

3HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. **Cell and tissue culture:**
 - (a) Behaviour of cells in culture
 - (b) Primary and established cell lines; kinetics of cell growth
 - (c) Natural and defined media for culture
 - (d) Importance of cell and tissue culture
2. Primary tissue explantation technique, organ culture
3. Basic concept of cloning; methods and utility.

UNIT-II

1. **Chemical basis of "fixation" and "staining" and a discussion on the following techniques:**
 - (a) Freeze substitution
 - (b) Freeze drying
 - (c) Fresh and fixed frozen sections
 - (d) PAS, Metachromasia, Feulgen, lipid and protein staining techniques
 - (e) Centrifugation and ultra-centrifugation

- (f) Single two dimensional & column chromatography
- (g) Intra-vital and supra-vital staining
- (h) Paper, gel and disc electrophoreses

2. Role and mechanism of action of the following enzymes at the cellular level:

- (a) ATPase
- (b) Succinic dehydrogenase
- (c) Acid and alkaline phosphatases
- (d) Hyaluronidase

UNIT-III

Elementary concept of the principle & theory of microscopy as exemplified by the following:

- (a) Phase contrast microscopy
- (b) Interference microscopy
- (c) Polarizing microscopy
- (d) Fluorescence microscopy
- (e) Electron microscopy
- (f) Ultra violet microscopy

UNIT-IV

Innate and adaptive immune system: Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines

UNIT-V

1. A general account of the effect of ionizing radiation at the cellular level
2. Elementary ideas of the origin of following diseases:
 - (a) Glycogen storage disease
 - (b) AIDS
3. Cellular aspects of the process of ageing
4. Molecular Maps of Animal Genomes: Molecular markers; Mapping population and Computer softwares, Genetic maps, cytogenetic maps, physical maps, integrated genomic maps, linkage disequilibrium (LD), Maps of the future, Sequencing of Genomes.

PRACTICAL WORK BASED ON PAPER VII(A) AND VIII (B)

CELL BIOLOGY

1. Handling and operation of following apparatus and equipments:
 - (a) Phase Contrast Microscope
 - (b) Electrophoretic, Chromatographic and electrophysiological equipments
2. Microtomy - Wax, fresh, frozen and fixed frozen sections
3. Study of stained preparations of mitochondria and golgi bodies under the light microscope
4. Study of germ cells; smear preparation of spermatozoa from vas deferens (vital

- staining) and permanent preparation of a single ovum
5. Biochemical estimations of the following in various tissues:
 - (a) Lipids: Cholesterol
 - (b) Carbohydrates: Glycogen
 - (c) Proteins
 - (d) Amino acids: chromatographic and electrophoretic separation
 - (e) Ascorbic acid
 6. Study of unfixed materials: Unstained and live animal tissues by phase contrast microscopy
 7. Histo-cytochemistry:
 - (a) Methyl green-pyronin -method
 - (b) Feulgen staining
 - (c) Periodic acid schiff method
 - (d) Alcian blue/ Bromophenol blue method
 8. Histo,cytochemical staining of Enzymes in animal tissue:
Staining of alkaline and acid phosphates, total proteins, Glucose 6 Phosphatase
 9. Preparation of Karyotype in animal tissue
 10. Field visit to Centres of research for knowledge of different instruments, artificial insemination etc. and preparing field report
- Note: Use of animal for dissection and practical work is subject to the conditions that these are not banned under the Wildlife (Protection) Act, 1972.**

PAPER VII(B): ENVIRONMENTAL BIOLOGY

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. Concepts and Scope Environmental Biology, Earth, man and environment.
2. The earth systems and Biosphere: Conservation of matter in various geospheres- lithosphere, hydrosphere, atmosphere and biosphere. Climates of India.
3. Impact of environment at cellular lever: Cellular interaction with environment with special reference to pH, light, temperature and salinity.

UNIT-II

Environmental Physiology: Ecophysiological adaptations with special reference to desert, high attitudes lotic, marine environment, Hibernation and aestivations. Poikilo-therms and Homeotherms. Response to temperature and pressure. Thermal properties of water and survival limits. Acclimatization.

UNIT-III

A detailed study of different ecosystems: Study will include abiotic and abiotic components and their interrelationships, productivity and adaptations of animals.

(A) Terrestrial ecosystems:

(i) Grasslands, including grazing lands.

(ii) Forests: Characteristics of alpine, temperate and tropical forests. Stratification. High altitude with special reference to Himalayan Ecology.

(iii) Deserts: Types and ecological attributes of desert biota.

UNIT-IV

1. Taiga: Extent and ecological peculiarities.

2. Tundra: Extent and ecological peculiarities.

3. Aquatic Ecosystems :

(i) Fresh water: Lakes including salt lakes, ponds streams, springs, rivers and marshes.

(ii) Marine ecosystem: Zonation, fauna.

(iii) Estuarine: Ecological peculiarities, adaptations including impact on fauna.

UNIT-V

1. Major biogeographic (zoogeographic and phytogeographic) regions of the world and India, extent, characteristics and species composition.

2. Development and evolution of ecosystems, causes and kinds of succession. Diversity and productivity in relation to stages of succession and development.

3. Urban, rural and other man made ecosystems their impact on flora and fauna, socio-ecological impacts of urbanization and industrialization.

PAPER VIII(B): ENVIRONMENTAL BIOLOGY

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

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UNIT-I

1. History of man and his cultural evolution in relation to impact on environment.

2. Management of Environment: Natural resources, their conservation and development:

(i) Agriculture and forestry including pest management.

(ii) Wild life resources.

UNIT-II

1. Mineral resources.

2. Aquaculture (Fresh and Marine)

3. Energy resources

4. River basin

5. Pollution: (Monitoring, sources, effect and control)

- (a) Water (b) Air (c) Land (d) Thermal (e) Noise (f) Radiation
6. Municipal water supply, sewage and its treatments

UNIT-III

1. Environmental health
 - (a) Urban health problem. Impact of urbanization stress, Health status and health problem.
 - (b) Rural health problem
 - (c) Occupational health
2. Environmental legislation in Indian perspective
 - (i) Wildlife Protection Act 1972
 - (ii) Environmental Protection Act 1986
 - (iii) Biological Diversity Act 2002
 - (iv) International Conventions and Treaties

UNIT-IV

1. Environmental toxicology: Natural and man made toxicants in the environment and their impact on animal life in different ecosystems; Safety measures; Disposal and management of different types of wastes
2. Current Environmental Issues: Green House Effect, Ozone layer depletion, Desertification, Soil erosion, Population explosion, Sustainable development

UNIT-V

1. Methodology for environmental analysis:
 - (a) Monitoring
 - (b) Analysis of physical and chemical factors.
 - (c) Statistical analysis
 - (d) Bioassay techniques.
2. Environmental Impact Assessment

PRACTICALS FOR ENVIRONMENTAL BIOLOGY

1. Water quality analysis (Physico- chemical parameters).
 - (a) Temperature
 - (b) pH
 - (c) Dissolved oxygen
 - (d) Acidity
 - (e) Hardness
 - (f) Alkalinity
 - (g) Chlorides.
 - (h) Sulphates
 - (i) Total dissolved solids
 - (j) BOD
 - (k) COD
2. Air quality monitoring for:
 - (a) Setttable matter
 - (b) Suspended particulate matter
3. Microscopic examination of water: Indicators of pollution, planktons, benthic and littoral fauna and flora.
4. Bioassays of polluted waters using fish or other aquatic organisms.
5. Statistical analysis: Grouping of data and preparation of frequency distribution. Histogram and frequency polygon; Calculating mean, median and mode for grouped and ungrouped data; Calculating standard deviation for grouped and ungrouped data; Fitting simple linear regression. Plotting scatter diagram and regression line; Computing correlation coefficient and testing its significance for grouped and ungrouped data.
6. Soil/ Sediment analysis
 - (a) EC
 - (b) pH
 - (c) Alkalinity
 - (d) Organic matter
 - (e) Texture
 - (f) Salinity

7. Spots:

a. Instruments/Equipment in environmental studies: viz., pH meter, Turbidimeter, Conductivity meter, Spectrophotometer, Flame photometer, Centrifuge, BOD incubator, COD Flux unit, Air, water and mud samplers, Min.-Max. thermometer, Dry-Wet bulb thermometer, Barometer, Wind wane, Rain gauge, GPS, etc.

b. Local flora- Terrestrial and aquatic

c. Local fauna- Terrestrial and aquatic

8. Sampling procedures and report on a case study.

9. Field trip to any of the following habitats:

(a) Forest: Wild life sanctuary (b) Fresh water habitat

(c) Marine habitat (d) Semi arid habitat

(Students are expected to give complete ecological report of the trip including ecosystem structures; indicators and estimation of environmental degradation, if any)

Note: Use of animal for dissection and practical work is subject to the conditions that these are not banned under the Wildlife Protection Act and UGC guidelines.

PAPER VII(C): ENTOMOLOGY

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

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UNIT-I

A general idea of fossil insects, evolution of insects; Insect classification (up to orders and suborders).

UNIT-II

Detailed classification of important and selected super families and families of the following orders of economic importance: Orthoptera, Isoptera, Homoptera, Hemiptera, Lepidoptera, Diptera, Coleoptera and Hymenoptera

UNIT-III

Insect morphology: Head, thorax, abdomen and their appendages
Integument

UNIT-IV

Functional organization of Muscular, digestive, circulatory, respiratory, excretory, reproductive, nervous and endocrine systems; sense organs, sound and light producing organs.

UNIT-V

Embryology: Structure of a typical insect egg, types of metamorphosis met within insects, development: embryonic and post embryonic, diapause.

PAPER VIII(C): ENTOMOLOGY

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

Definition of pest; Types of pest; General idea of damage caused by pests; Principal methods of pest control: Physical, Mechanical, Cultural, Use of Botanicals, Biological and Legal; The concept of IPM; A general idea of plant protection organization in India

UNIT-II

Chemical control: Insecticides: their chief types, modes of action and methods of application/ formulation; a general idea of appliances used in the application of insecticides and their safe handling. Development of resistance to chemicals

UNIT-III

A general knowledge of chemosterilants, attractants, repellants, pheromones, growth regulators and other compounds

Life history, damage caused and control of stored grain pests of cereals and pulses (including general idea of storage)

Life history, damage caused and control of 3 major pests of the main crops: wheat, paddy, maize, jowar, millet, sugarcane, cotton and oil seeds

UNIT-IV

Beneficial insects: Silkworm, honey bee and lac insect and industries related to them; Insects as vectors of diseases and their control– mosquitoes, house flies, sand flies, lice, fleas. Insect borne diseases of man – Typhus, yellow fever, dengue fever, encephalitis, plague, leishmaniasis.

UNIT-V

Ecology: effect of physical factors. Intra specific and inter-specific relations; dynamics of population; Life cycle of aphids, Phase theory of locust
Social life in Isoptera and Hymenoptera, caste determination in social insects;

ENTOMOLOGY PRACTICAL BASED ON PAPER IV AND V

1. Knowledge and use of equipment for the collection and preservation of insects, insect net, killing bottle, spreading board, insect box device for inflating larva, light trap, etc.
2. Collection and preservation .of insects and their different stages.
3. Collection of seasonal insects, nocturnal insects, aquatic insects, crop pests, stored grain pests and insects of medical and veterinary importance.
4. Identification of insects from various orders prescribed for study in the syllabus. .
5. Permanent preparations: wings, mouth parts, antennae, legs, spiracles, sting etc. of insects.
6. Collection and preservation of insects and their different stages.
7. Dissections of grasshopper, house cricket, bug, butterfly, housefly, honey bee, wasp, beetle to study important features of the digestive, circulatory, respiratory, excretory, nervous, reproductive and neuroendocrine systems.
8. Familiarity with techniques and appliances of applying insecticides, experiments for testing the insecticides.
9. Knowledge of rearing insects and of maintaining the insectary.
10. Exercise in ecology: Soil pH, water pH, free carbon dioxide; dissolved oxygen, chlorides, total alkalinity and total salinity.
11. A tour to visit important centers of entomological studies.
(Note : Use of animal for dissection and practical work is subject to the conditions that these are not banned under the Wildlife Protection Act and UGC guidelines.)

PAPER VII(D): FISH BIOLOGY

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. General account and phylogenetic significance of ostracoderms and placoderms.
2. Classification of fishes, with distinguishing characters of the principal subdivisions.
3. Origin and adaptive radiation of various groups.

UNIT-II

1. Geographical distribution
2. Body form and locomotion
3. Integument and exoskeleton

UNIT-III

1. Structure, modification and functions of fins
2. Theories of origin of median and paired fins
3. Endoskeleton
4. Musculature

UNIT-IV

1. Food & alimentary canal, physiology of digestion.
2. Blood vascular system and circulation of blood
3. Respiratory organs, physiology of respiration and regulation of breathing, air-breathing organs.
4. Structure, function and physiology of the swim bladder.
5. Weberian apparatus.

UNIT-V

1. Excretory organs and the physiology of excretion, Osmoregulation.
2. Nervous system and sense organs.
3. Endocrine glands, hormones & reproductive behaviour, gonads, reproduction development and hatching, viviparity

PAPER VIII(D): FISH BIOLOGY

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

NOTE: The question paper shall be divided into three sections: Section A (20 marks) shall comprise of 10 compulsory questions of 2 marks each and not more than two questions from each Unit (Answer in not more than 50 words). Section B (25 marks) shall comprise of two questions from each unit and candidate has to attempt five questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. A general survey of world fisheries, survey of principal fisheries of India (Fresh water, estuarine and marine).
2. Plankton in relation to fisheries.
3. The biology of Indian major carps, catfishes, Hilsa, sardine, mackerel, sharks, prawns and oysters.
4. Pisciculture and its importance, with special reference to India.

UNIT-II

1. A brief outline on the methods of fishing in fresh water of India.
2. Biochemical composition of fish; fish as food.
3. Bi-products of fishing industry, with special reference to India.
4. Ecological factors affecting the life of fishes; marine ecosystems.

5. Fish and mankind.

UNIT-III

1. Age and growth determination in fishes
2. Population dynamics: Estimation of population number and mortality rates in fresh waters
3. Fecundity: eggs and life history of fish production with special reference to fresh water
4. Aquaria and their uses, setting up and maintenance of aquaria
5. Exotic fishes and their role in Indian fresh waters

UNIT-IV

1. Diseases of fishes (symptoms, etiology and treatment)
2. Problems of fresh water pollution in relation to fisheries with special reference to Rajasthan
3. Adaptations in Fishes: Deep Sea and Hill Streams
4. Courtship and parental care, a general study of fish behaviour

UNIT-V

1. Sound producing organs
2. Bioluminescence
3. Electric Organs
4. Poisons and Venoms: Poison Glands in Fishes
5. Migration and its causes

FISH BIOLOGY PRACTICAL BASED ON PAPER VII AND VIII

1. Dissection/demonstration:

Complete anatomy of a teleost, represented by Wallago: external features. general. viscera; including the urinogenital organs, jaw and lateral musculature, including the nerve supply, afferent and efferent branchial blood vessels, brain and cranial nerves; eye muscles and their innervation; membranous labyrinth, Weberian ossicles- swimbladder connection, dry and alizarin preparations of the skeleton and its study

2. Study of breathing organs in a fish of commercial use (*Channa* and *Heteropneustes* or any cat fish).
4. External features, cranial nerves and membranous labyrinth of any ray.
5. Permanent preparations and study of different scales.
6. Micro-technical procedures: Preparation and study of serial sections of a larval fish and representative tissues and organs of fish.
7. Collection of local fishes and their identification upto the species level; Study of the available museum specimens. Identification of fingerlings of Indian Major Carps.
8. Hydro-biological Studies:
(a) Analysis of water to determine the pH, free carbon dioxide; dissolved oxygen, chlorides,

calcium, total alkalinity and total salinity.

(b) Collection: estimation and analysis of plankton.

9. 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

(e) Active transport in tubule.

10. Field studies

(a) Periodical visits to a local fishing farm or fish centre to gain a first hand knowledge of its pisciculture practices and fisheries activities.

(b) A week's tour of an inland fisheries research station of Pisciculture centre. The suggested places for the tour are Udaipur;- Rana Pratap Sager Dam at Kota, Alwar, Bhartapur, Allahabad, Cuttack and Barrackpore

(c) A week's stay and work at an important marine Biological or fisheries centre in the country. The suggested places for this work are Veraval, Central Institute of Fisheries Education at Bombay and National Institute of Oceanographic Research at Goa.

Note: A record of the work done under Item 7 has to be compulsorily submitted by each candidate.

(Note: Use of animals for dissection/practical work is subject to the conditions that these are not banned under the wild life protection act and UGC guidelines.)

PAPER VII(E): ENDOCRINOLOGY (Deferred for the session)

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

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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, 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.

UNIT-II

(b) 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

(c) Parathyroid: General, developmental and comparative anatomy; biochemistry and physiology of the parathyroid hormone; effects of parathyroidectomy.

UNIT-III

(d) Pancreatic islets: General developmental and comparative anatomy; biochemistry and physiology of insulin and glucagon: effects of pancreatectomy.

(e) Adrenal: General development and comparative anatomy, chromaffin tissue; biochemistry and physiology of catecholamines: the sympathetico chromaffin complex steroideogenic tissue; structure and nomenclature of steroid hormones, effects of adrenalectomy.

(f) Pineal: general development and comparative anatomy, biochemistry and physiology, the pineal principles

UNIT-IV

1. Chemical messenger: Mechanism of hormone action.

2. Endocrine integration: Diffuse effects of hormones; neoplastic growth; migration in birds and fishes; bird plumage, hibernation; Osmoregulation; blood pressure regulation.

3. Vertebrate neuro-endocrinology: Ultra structure 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.

4. Invertebrate neuro-endocrinology : Anatomy and physiology of the endocrine and neuro endocrine systems of Annelida, Arthropoda and Mollusca.

PAPER VIII(E): ENDOCRINOLOGY (Deferred for the session)

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

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UNIT-I

1. Hormonal control of 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.

UNIT-II

1. The male reproductive system: Comparative anatomy and physiology of the mammalian and submammalian testis and sex accessory structures, semen and its biochemistry, testicular hormones and their functions.

2. The gonadal hypophyseal-hypothalamus relationship.

3. Breeding seasons in vertebrates, evolution of viviparity, induced spawning in fish and

frog.

UNIT-III

1. Endocrinology of fertilization, implantation, delayed implantation, parturition and lactation.
2. Placenta as an endocrine tissue foetoplacental unit.
3. Functional aspects of chemical, mechanical and surgical control of male fertility in laboratory mammals and the human.

UNIT-IV

1. Functional aspects of chemical, mechanical and surgical, control of female fertility in laboratory mammals and the human.
2. Pheromones: Control of fertility in insects.
3. Prostaglandins: Types chemistry, mechanism of action and their effects on mammalian reproduction.

UNIT-V

1. Hormonal imbalance and major endocrine disease:

- | | | | |
|---------------------|-------------------------|-----------------|-----|
| (a) Gigantism. | (b) Acromegaly. | (c) Dwarfism. | (d) |
| Addison's disease. | (e) Cushing's syndrome. | (f) Goiter. | |
| (g) Cryptorchidism. | (h) Hypogonadism | (i) Amenorrhea. | (j) |
| Diabetes mellitus. | (k) Tetany. | | |

ENDOCRINOLOGY PRACTICALS

1. Dissection and gross examination of various endocrine glands of representative vertebrates.
2. Micro-scopical study of various endocrine glands of representative vertebrates through micro-technical procedure.
3. Study of the estrous cycle in mouse or rat by the vagina smear technique.
4. Surgical procedures: castration, ovariectomy, adrenalectomy, thyroidectomy, and hypophysectomy'.
5. Bioassays for estimations, androgens and anti-estrogens, the Aschiem-Zondek pregnancy test
6. Biochemical estimations of cholesterol content in adrenal tissue glycogen in uterine tissue.
7. Sperm count.
8. Study of the sex chromatin.
9. Effect of epinephrine on chromatophores in fish.
10. Study of microscopic slides of endocrine and related structures,

PAPER VII (F) MOLECULAR DEVELOPMENT BIOLOGY **(Deferred for the session)**

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

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questions selecting one from each Unit, 5 marks for each question (Answer in not more than 200 words) and Section C (30 marks) shall comprise of five questions with not more than one question from each Unit and candidate has to answer any three, 10 marks for each question (Answer in not more than 500 words).

UNIT-I

1. History of embryology, theories of development, scope of developmental biology.
2. Reproductive cycle and breeding habits in vertebrates.
3. Ovulation and its control, induced breeding.
4. Organization of egg cytoplasm for development, egg cortex, origin of polarity and symmetry in egg.

UNIT-II

1. Fertilization: Biochemistry of fertilization. Molecular Embryology and Classical Theories of Fertilization, egg activation, Parthenogenesis: biology and viability of sperms and ova, sperm banks, artificial insemination, fertilization of mammalian ova in vitro, their cultivation and reimplantation and the significance of this technique.
2. Cleavage, role of nucleus, problem of DNA synthesis, DNA replication during cleavage; protein synt.\lesis during cleavage, energy requirements and production; biochemical changes and distribution of cytoplasmic substances during cleavage, chemical nature of the mitotic apparatus; characteristics of cleavage.

UNIT-III

1. Early embryonic development in selected non-chordates Coelenterate, Ctenophora. Platyhelminthes, Annelida. Mollusca, Echinodermata, Insecta and Chordata with particular reference to types of eggs, patterns of cleavage (radial, Bilateral, spiral, superficial, discoidal), blastulation, establishment of the germ layers and the basic body plan and molecular changes.
2. Morphogenetic cell movement; dissociation and re-aggregation of cells: Biochemical Interactions between me Nucleus and the Cytoplasm during Morphogenesis.
3. Fate maps; methods of their constructions and their utility; comparative topographical relationship of the presumptive areas in early embryos of amphioxus fishes, amphibians and birds.

UNIT-IV

1. Cells and tissue interactions in development:
 - (a) Prospective fate; potencies; determination; autonomous and dependent differentiation.
 - (b) primary embryonic induction': Induction and determination of the neural plate in chordates, nature and regionally specific properties of the primary inductor, methods of study and analysis of the phenomenon of Neural induction (transplantation; implantation; explantation, histochemical; immunological, radiobiological techniques etc.) heterogenous (abnormal) inductors; chemistry and properties and inducing substances; competence; mechanism and theories of induction; secondary and tertiary inductors, spemann's organizer.
 - (c) Progressive determination: gradual restriction of the development potencies of the germ layers of amphibian and chick embryos.
 - (d) Mosaic and regulative eggs- a problem of determination
 - (e) Trans determination in insect germinal discs
 - (f) Ectodermal- mesodermal interactions in the morphogenesis of limbs in vertebrates; the role of apical ridge.
 - (g) Inductive interactions in the morphogenesis and differentiation of the eye in vertebrates.

UNIT-V

1. Origin and development of nerve cells and nerve fibers; relationship between centre and periphery in nerve growth.
2. Computer analysis of cellular interaction.
3. Gradients: The concept Childs hypothesis: metabolic differences in embryonic cell, biochemical gradients in sea urchin eggs and their morphogenetic importance.
4. Morphogenetic fields: The concept, nature and temporal character of field, progressive determinations within a field
5. Development of pattern; Feather pattern in birds, wing pattern in insects.
6. Molecular basis of communication between cells and within the cells:
 - (a) Autocrine, paracrine and endocrine hormones and their action.
 - (b) Neurotransmitters and neuroendocrine action.
 - (c) Receptors- receptors, acceptors, and other cell surface markers pharmacological receptors, cholinergic receptors, steroid receptors, and cell membrane receptors of major histocompatibility complex. . '
 - (d) Adenyl cyclase system, Inositol- lipid (IP-DAG) path.

PAPER VIII (F) MOLECULAR DEVELOPMENT BIOLOGY **(Deferred for the session)**

3-HRS DURATION

MAX. MARKS 75

TOTAL NO OF LECTURE 80

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UNIT-I

1. Differentiation
 - (a) Definition: biochemical basis of differentiation; structural and biochemical changes during differentiation of muscle, cartilage, vertebrate pigment cells, lens and lens fibers, and epidermis
 - (b) Chemical control of differentiation, influence of animalizing and vegetalizing agents in sea urchin.
 - © Influence of hormones on differentiation of tissues and organs.
2. Developmental 'genetics':
 - (a) Role of nucleus and cytoplasm in development.
 - (b) Nuclear transplantation in Amphibians.
 - (c) Somatic cell hybridization.
 - (d) Differential gene function during development, chromosomal puffing; differential synthesis and utilization of various types of RNA during embryogenesis (sea urchins;

amphibians) changing patterns of protein synthesis during development (lactate dehydrogenases; haemoglobin; antigens and antibodies).

(e) Cell death in morphogenesis.

UNIT-II

1. Aging: Changes in cell structure and functions' during aging; possible mechanisms
2. Teratology: Types of anomalies; genetic effects (peilotropism; phenocopies; analization, inborn errors in metabolism: environmental effects, teratogenic agents (drug, nutritional deficiencies, infections, ionizing radiations etc.) general mechanism and mode of action of teratogenic agents: embryological considerations in teratology twinning

UNIT-III

1. Abnormal Growth

(a) Teratomas

(b) Malignancy, general characteristics and properties. of cancer cell including structural and metabolic alterations in those cells metaplasia, carcinogenic agents.

2. Regeneration in Hydra.

(a) Definition characteristics of regeneration and its comparison with ontogenetic development.'

(b) Distribution of regenerative ability in the animal kingdom.

(c) Regeneration in Hydra.

(d) Regeneration in Planaria.

(e) Appendage regeneration in arthropod and its relation with moultings and metamorphosis, heteromorphosis; autonomy)

(f) Regeneration in vertebrates with special emphasis of morphological study of this phenomenon on tail regeneration (Ammocoetes; anurans; urodelans; lizard limb regeneration (anurans; urodelans) and wolffian lens regeneration (urodelans).

(g) Source of cells for regeneration; dedifferentiation potencies and convertibility of dedifferentiated cells, the problem of reversibility, irreversibility of differentiated cells, modulation.

(h) Patterns of wound healing and regeneration.

(i) Role of nerves and hormones in regeneration., '

(j) Concept of positional information, patterns formations, during amphibian, limb regeneration. Retinoids in pattern formation. Roles' of genes in Regeneration. .

(k) Loss of ability of organ regeneration in vertebrates. Induction of regeneration in mammals. regenerative cases.

(l) Liver regeneration in mammals.

UNIT-IV

1. Methods preparation and utility of normal tables of embryonic and larval developmental stages

2. Embryonic Nutrition: Yolk utilization by embryos of invertebrates and vertebrates, foetal nutrition in mammals; placental physiology.

UNIT-V

1. Metamorphosis: Metamorphosis, and its hormonal control in Insects; morphological, physiological and biochemical changes during metamorphosis in Amphibians and its endocrine control.

2. Cell tissue and organ culture

(a) Basic requirements design of the laboratory.

- (b) Balanced salt solutions; pH control; use of antibiotics.
- (c) Culture media; natural and chemically defined
- (d) Methods of preparing cells, tissues and organs for culture *in vitro*.
- (e) A critical appreciation of some of the main methods of preparing cells, tissue and organ culture.
- (t) Contribution of cell. Tissue and organ culture studies in developmental biology, medicine etc.
- (g) Embryo culture techniques (New's ring technique Aurbach's embryo culture technique

PRACTICAL WORK BASED ON PAPER VII(F) AND VIII(F)

MOLECULAR DEVELOPMENTAL BIOLOGY

1. Collections handling and preservation of gametes: spiral cleavage in a snail.
 2. Cleavage in a frog/toad.
 3. Study of living embryos. of the chick after 3 to 12 days of incubation.
 4. Demonstration of cell death by vial staining.
 5. Study of tail tip chromosomes of amphibian larvae.
 6. Fluorochrome on the development of amphibians, Study of metamorphic stages of insect.
 - 7 Study of metamorphic stages of anuran and early embryonic development of frog.
 8. Regeneration studies on amphibian tadpole (tail or limb). Studies on the effects of retinoids on pattern formation during limb and tail regeneration
 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. Explant culture of embryos on agar.
 16. 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. Effect of development of *Drosophila*.
 17. Sound call analysis and application in identification of amphibian species.
 18. SDS-PAGE electrophoresis-to study change in profiles of soluble proteins during development.
 19. To study effects of known cytological markers such as actinomycin-D, Tunicamycin cyclohexamide etc. on development.
 20. Expression of segmental genes during *Drosophila* development.
 21. Aurbach's and New's ring culture techniques.
 22. Biochemical changes during development - protein, nucleic acid-semi auto analyser study.
 23. T3, T4, TSH profiles during amphibian metamorphosis and comparison with mammalian development.
 24. Identification of antibodies development using ELISA.
 - 25: Demonstration of endonuclease activity on DNA fragment.
- (Note: use of animals for dissection/practical work is subject to the conditions that these are not banned under the wild life protection act.

(Duration 5 h)

SCHEME OF PRACTICAL EXAMINATION AND DISTRIBUTION OF MARKS

Board First

(a) Chordate' major dissection/demonstration	08 Marks
(b) Permanent preparation	05 Marks
(c) Exercise in developmental biology	06 Marks
(c) Exercise in Ecology/ Ethology	06 Marks
(d) Identification and comments of spots (7)	14 Marks
(e) Microtomy	06 Marks
(f) Tour Report and Seminar	10 Marks
(g) Viva- voce	10 Marks
(h) Class Record	10 Marks
G. Total	75 Marks

Board Second (Special paper)

(a) Cell Biology

(a) Biochemical estimation	07 Marks
(b) Exercise histo-chemical or cyto-chemical techniques	07 Marks
(c) Light Microscopic Preparation of Mitochondria / Golgi bodies / spermatozoa/ single ovum	06 Marks
(d) Identification and comments on Spots (7)	14 Marks
(e) Microtomy	06 Marks
(f) Project /Field report (Hand written, not more than 100 pages)	20 Marks
(g) Viva- voce	08 Marks
(h) Class Record	07Marks
G. Total	75 Marks

(b) Entomology

(a) Dissection	07 Marks
(b) Permanent preparation	05 Marks
(c) Identification of 3 insects using taxonomic key	09 Marks
(d) Exercise in ecology	06 Marks
(e) Identification and comments on Spots (6)	12 Marks
(f) Project/Field report (Hand written, not more than 100 pages)	20 Marks
(t) Viva- voce	10 Marks
(g) Class Record	06 marks
G. Total	75 Marks

(c) Fish Biology

(a) Major Dissection/ demonstration	08 Marks
(b) Minor dissection/demonstration	04 Marks
(b) Permanent preparation	04 Marks
(c) Species identification using taxonomic key (2 fishes)	04 Marks
(c) Hydro-biological/biochemical/physiological exercise	05 Marks
(d) Project/Field report (Hand written, not more than 100 pages)	20 Marks
(e) Identification and comments on Spots (7)	14 Marks
(f) Viva-voce	08 Marks
(g) Class Record	08 marks

G. Total	75 Marks
(d) Environmental Biology	
(a) Water analysis	08 Marks
(b) Microscopic Examination of water/ sampling method	06 Marks
(c) Bioassay method/Statistical method	05 Marks
(d) Soil analysis	06 Marks
(e) Spotting (5)	10 Marks
(e) Field trip/ Project report	20 marks
(f) Viva- voce	10 Marks
(g) Class Record	10 marks
G. Total	75 Marks
(e) Endocrinology	
(a) Dissection or Surgical procedure	06 Marks
(b) Exercise on bioassay of hormone administration effects	06 Marks
(c) Quantitative estimation of glycogen/cholesterol/ ascorbic and/fructose in given endocrine tissue	06 Marks
(d) Exercise on sperm count /vaginal cycle/effect of Epinephrine on fish chromatophores	06 Marks
(e) Microtomy	06 Marks
(f) Identification and comments on Spots (5)	10 Marks
(h) Project/Field report (Handwritten, not more than 100 pages)	20Marks
(g) Viva- voce	08 Marks
(h) Class Record	07 Marks
G. Total	75 Marks
<u>(f) Molecular Developmental Biology</u>	
1. Exercise on living embryos/ Teratological experiments	06 Marks
2. Exercise on metamorphosis/ Regeneration	04 Marks
3. Exercise on cell death / chromosomes	06 Marks
4. Exercise on cleavage/explant culture	04 Marks
5. Microtomy	08 Marks
6. Identification.and.commentson spots (6)	12 Marks
7. Viva- voce	08 Marks
8. Field/ Project report	20 Marks
9. Class record	07 Marks
G.Total	75 Marks