SYLLABUS

MASTER OF SCIENCE

ZOOLOGY

JODHPUR NATIONAL UNIVERSITY

JODHPUR

M.Sc. ZOOLOGY

Previous

Paper I	**Biosystematics, Taxonomy, Structure and Function of Invertebrates.**
Paper II	**Biological chemistry and General Physiology**
Paper III	**Molecular Biology, Biotechnology and Techniques in Biology**
Paper IV	**Quantitative Biology, Genetics and Evolution.**

Final

Paper V	**Biology of Chordates and Developmental Biology.**
Paper VI	**Ecology and Ethology**
Paper VII	**Cell Biology**
Paper VIII	**Environmental Biology**
Paper IX	**Industry Based Environmental Studies**

PREVIOUS

PAPER I BIOSYSTEMATICS, TAXONOMY, STRUCTURE AND FUNCTION OF INVERTEBRATES

Unit I

Principles of Animal Taxonomy :

1. Introduction to the science of taxonomy; rules of nomenclature.
2. Principles of classification : theories of biological classification & their history; the species category; the polytypic species; population systematics, intraspecific categories.
3. Methods of classification : taxonomic collection & the processes of identification, taxonomic characters; types of variations (qualitative and quantitative) within a single population, methods of arriving at taxonomic decisions on species level; preparation and use of taxonomic keys.
4. Trends in biosystematics - concepts of different conventional and newer aspects.

(a) Chemo taxonomy
(b) Cyto taxonomy
(c) Molecular taxonomy
(d) Elementary idea about sound based identification and classification.

5. Molecular perspective on the conservation of diversity. Diversity and ecosystem process: theory; achievements and future directions.
6. Evaluation of bio diversity indices.

(a) Shannon – Weinner index, dominance index.
(b) Similarity and dissimilarity index.
(c) Association index

Unit II

Structure and function of Invertebrates :

1. A study of the classification of Invertebrates, with distinguishing features & examples of various subdivisions.

2. Locomotory mechanisms:

(a) Amoeboid movements: ultrastructure of cilia and flagella; ciliary and flagellar movements; molecular and physiological mechanisms involved in the three kinds of movements.
(b) Myonemes and muscle fibres in invertebrate structure and their involvement in locomotion action.
(c) Locomotion in relation to hydrostatics, coelom, metamerism, arthropodization.
(d) An outline of flight mechanism in insects.

3. Feeding mechanisms:

(a) Amoeboid feeding.
(b) Ciliary feeding.
(c) Filter feeding.
(d) Parasitic mode of feeding.
(e) Feeding mechanisms in insects and echinoderms.
4. Respiration:
(a) Respiration in lower invertebrates (Protozoans to helminthes):
(b) Gills and Lophophores.
(c) Gills and lungs in Mollusca.
(d) Gills, trachea and lung like structures in Arthropods.
(e) Physiology of respiratory pigments in invertebrates.
6. Excretion: a study of structural and functional organization of excretory systems in various invertebrate groups and a survey of various excretory products met within them.
7. Osmoregulation and ionic regulation : a survey of principal mechanisms in fresh water, marine and terrestrial forms.
8. Structural and functional organization of nervous systems and receptors:
(a) Plan of nervous systems in the Coelenterates, Platyhelminths, Annelids, Arthropods, Molluscs and Echinoderms; structural and functional complexities of brain and ganglionic structures.
(b) Receptors: Structural and functional organization of the mechanoreceptors, chemoreceptors and photoreceptors.
9. Endocrine system : A survey of endocrinal structures and their hormones; role of neurosecretions and hormones in developmental events of insects and crustaceans.
10. Reproduction :
(a) Reproduction in Protozoa
(b) Reproduction in Porifera
(c) Reproduction in Metazoa : Sexual reproduction; Parthenogenesis.
(d) Reproduction in Metazoa : Asexual reproduction in Coelenterata and Polychaeta.
(e) Larval forms and their significance.

Unit III

Origin and interrelationship between invertebrate phyla :

1. Criteria for phylogenetic interrelationships between Invertebrate phyla.
2. Origin of Parazoa, Mesozoa and Metazoa.
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 Pesudocoelomate groups, with special reference

to Rotifera, Gastrotricha, Kinorhynca, Nematomorpha and Entoprocta.
7. Affinities and evolutionary significance of the unsegmented lesser protostome phyla (Priapulida, Echinrodea and Sipunculoidea, Echiurida and Sipunculida).
8. Phylogenetic relationship between the coelomate phyla (Annelida, Onychophora, Arhropoda 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).

Suggested Reading Material (All latest editions)

1. E.J.W.Barrington, Invertebrate Structure and Function, ELBS.
2. M. Kato. The Biology of Biodiversity, Springer.
3. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
4. E.O. Wilson, Biodiversity, Academic Press, Washington.
5. G. G. Simpson. Principle of animal taxonomy; Oxford IBH Publishing Company.

PAPER II BIOLOGICAL CHEMISTRY AND GENERAL PHYSIOLOGY

Unit I

Biological Chemistry :

1. Basic chemical concepts : A study of the chemical bonds and functional groups.
2. Biocatalysis : Classification and nomenclature of the enzymes; nature of enzymes, enzyme specificity; factors affecting enzyme activity; enzymatic and non-enzyamtic catalysis; coenzymes and their functions.
3. Energy considerations : Biological oxidation & reduction. Fundamental reactions of biological oxidation; redox potential and electron transfer system enzymes and prosthetic groups.
4. Organic constituents in living systems.

I. Carbohydrates

A. Definition, general properties, classification; configuration of carbohydrates:

B. Structure and importance of :

(a) Monosaccharides :

Trioses : Glyceraldehyde; dihydroxyacetone.

Tetroses : Erythrose; erythrulose.

Pentoses : Ribose; (Ribulose); Xylulose.

Hexoses : Glucose, Fructose, Galactose
(b) Disaccharides : Lactose, maltose, sucrose.
(c) Polysaccharides : Cellulose, starch, glycogen, pectin, chitin mucopolysaccharides.

Sugar Derivatives :

(i) Deoxy Sugars : Deoxyribose.
(ii) Amino Sugars : Glucosamine; neuraminic acid
(iii) Sugar acids : Glyceric acid, uronic acids & galactouronic acids, ascorbic acid.
(iv) Sugar alcohols : Glycerol, mesoinositol.
(v) Phosphoric ester of : Triose Phosphate, Pentose Phosphate, sugars Hexose Phosphate.

C. Metabolism :

(a) Catabolism of glycogen, glucose & fructose, details of glycolysis & Krebs cycle; Cori cycle.
(b) Phosphogluconate pathways (Pentose Phosphate Pathway).
(c) Synthesis of glycogen; glycogenesis and glyconeogenesis.

II. Proteins :

(a) Definition, general properties; classification and importance of amino acids & proteins; nucleoproteins.
(b) Structural formulae of the amino-acids.
(c) Structure of proteins; primary, secondary, tertiary and quarternary. Domain structure (Basic knowledge of the determination of aminoacid sequence as exemplified by a tripeptide).
(d) Metabolism :
(i) Amino acid degradation : Deamination reactions : oxidative and non oxidative deamination reaction; Trans-amination & transdeamination; decarboxylation; Ornithine cycle of urea formation; fate of carbon skeleton of the amino acids (metabolism of individual amino-acids excluded)
(ii) Synthesis of the non-essential amino-acids and protein.

Unit II

III. Lipids :

(a) Definition, general properties & classification.
(b) Fatty acids : Structure properties, types and importance, with special reference to essential fatty acids.
(c) Structure and importance of :
(i) Simple lipids : Fats, waxes.
(ii) Compound lipids : Phospholipids; glycolipids; aminolipids; Sulpholipids.
(iii) Fat soluble vitamins A, D, E and K.
(iv) Steroids : Cholesterol; bile acids, steroid hormones.
(v) Lipoproteins

IV. Inborn errors of metabolism.

General Physiology :

V. Physiology of the nervous system :

(a) Nerve impulse : Biophysics, biochemistry and molecular physiology of genesis, conduction and transmission across synaptic junctions.

(b) Synapse physiology and integration of information; coding in the neural information processing. Neuro transmitters.

(c) Reflex action : Various types of central peripheral reflexes in mammalian nervous systems.

VI. Physiology of the receptor system :

(a) General mechanism involved in stimulus transduction at receptor sites.

(b) Functional architecture and stimulus processing in retina, organ of Corti and olfactory epithelium.

VII. Stress physiology :

(a) Basic concept of environmental stress and strain; concept of elastic and plastic strain; stress resistance, stress avoidance and stress tolerance.

(b) Adaptation, acclimation and acclimatization

(c) Concept of homeostasis

(d) Physiological response to oxygen deficient stress

(e) Physiological response to body exercise

(f) Meditation, Yoga and their effects.

VIII. Thermoregulation and cold tolerance :

(a) Basic principles of metabolism

(b) Heat balance and exchange

(c) Endotherms vs Ectotherms

(d) Counter-current heat exchangers

(e) Torpor, hibernation and aestivation

(f) Adaptations to very cold environments

Unit III

General Physiology :

1. Physiology of muscle tissue :

(a) Morpho-functional architecture of the contractile apparatus in muscle tissue.

(b) A detailed study of the biophysical and biochemical events underlying contraction & relaxation process.

(c) Physiological properties of cardiac, skeletal and visceral muscles.

(d) Nerve innervation, denervation and muscle function.

2. Excretion :

Biophysics, architecture, biochemistry and physiology of various functions performed by the vertebrate nephron; origin and formulation of nitrogenous excretory products; physiological relationship between habitat and excretion mechanisms. Role of kidney in osmoregulation.

3. Ionic and osmotic balance :

(a) Osmoregulation vs osmoconforming

(b) Osmoregulation in aquatic and terrestrial environments
(c) Kidney function and diversity
(d) Other osmoregulatory organs
(e) Nitrogenous waste excretion

4. Respiration :

(a) Factors modifying oxygen consumption in animals.
(b) Acclimatization to low oxygen tension; toxicity of high oxygen tension.
(c) Chemistry of respiration, with particular reference to mammals.
(d) Buffer systems of blood and the acid-base balance.

5. Nutrition, digestion and absorption :

(a) Nutritive types in animal kingdom.
(b) Role of vitamins and minerals in nutrition. Deficiency diseases.
(c) Composition, molecular machanism of secretion & action of all types of digestive juices met within the mammalian digestive pathway; hormonal and nervous regulation of secretion of digestive juices.
(d) Physiological mechanisms involved in the absorption of the end products of digestion.

6. Blood and circulation of body fluids :

(a) Physiology of RBC and the mechanism of transport of gases of blood: Physiology of leukocyte function; antibody production, Antiinflammatory activities, phagocytosis, physiological basis and clinical significance of blood groups; biochemistry and physiology of blood clotting.
(b) Types of heart and transport mechanisms.
(c) General comparative study of cardiac cycle in animals with particular reference to man.
(d) Homeostasis and nervous regulation of heart function in vertebrates: Conductile and contractile mechanisms in the heart.

7. Endocrine Physiology :

Cellular mechanisms of hormone action in target tissues; 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).

8. Reproduction :

Physiological events accompanying fertilization process, Endocrinological control of the testicular, ovarian and uterine functions, capacitation, physiological aspects of implantation and parturition.

Suggested Reading Material

1. Eckert, R. Animal Physiology : Mechanisms and Adaptation. W.H. Freeman and Company, New York.
2. Hochachka, P.W. and Somero, G.N. Biochemical Adaptation. Princeton, New Jersey.
3. Hoar, W.S. General and comparative Animal Physiology, Prentice Hall of Inadian.

4. Schiemdt Nielsen. Animal Physiology : Adaptation and Environment. Cambridge.
5. Strand, F.L. Physiology : A Regulatory Systems Approach. Macmillan Publishing Co., New York.

PAPER III : MOLECULAR BIOLOGY, BIOTECHNOLOGY AND TECHNIQUES IN BIOLOGY

Unit I

Molecular Biology :

1. Nucleic Acids : General account.
2. DNA replication
(a) Prokaryotic and eukaryotic DNA replication.
(b) Mechanics of DNA replication.
(c) Enzymes and accessory proteins involved in DNA replication.
3. Transcription
(a) Prokaryotic transcription.
(b) Eukaryotic transcription.
(c) RNA polymerases.
(d) General and specific transcription factors.
(e) Regulatory elements and mechanisms of transcription regulation.
(f) Transcriptional and post-transcriptional gene
3. Post-transcriptional modifications in RNA
(a) 5'-Cap formation
(b) Transcription termination
(c) 3'-end processing and polyadenylation
(d) Splicing, Editing
(e) Nuclear export of mRNA
(f) mRNA stability
4. Translation
(a) Genetic code
(b) Prokaryotic and eukaryotic translation
(c) The translational machinery
(d) Mechanisms of initiation, elongation and termination
(e) Regulation of translation
(f) Co-and post-translational modifications of proteins

Unit II

Biotechnology :

1. Recombination and repair
(a) Holiday junction, gene targeting, gene disruption

(b) FLP/FRT and Crelox recombination
(c) RecA and other recombinases
(d) DNA repair mechanisms
2. Molecular mapping of genome and elementary knowledge of Bioinformatics
(a) Genetic and physical maps
(b) Physical mapping and map-based cloning
(c) Southern and flourescence in situ hybridization for genome analysis
(d) Molecular markers in genome analysis : RFLP, RAPD and AFLP analysis
(e) Application of RFLP in forensic, disease prognosis, genetic counselling pedigree and varietal analysis, animal trafficking and poaching; germplasm maintenance and taxonomy.
(f) DNA sequencing, sequencing methods, sequence submission, sequence alignment, sequence alignment tools, sequence homologies, DNA fingerprinting.
3. Transgenic animals and knock-outs
(a) Production
(b) Applications
(c) Embryonic stem cells
(d) Care and breeding of experimental animals including bioethics
4. Assisted reproduction technologies
(a) Embryo sexing and cloning
(b) Screening for genetic disorders
(c) ICSI, GIFT
(d) Cloning of animals by nuclear transfer
5. Assay
(a) Definition and criteria of reliability
(b) Chemical assays
(c) Biological assays-*in vivo* and *in vitro* assays
6. Principles and uses of analytical instruments-Balances, pH meter, colorimeter, spectrophotometer, flame photometer, ultracentrifuge, densitometic scanner, spectrofluorometer. chemiluminometers, radioactivity counters, differential scanning calorimeter. ESR and NMR spectrometers.
7. Microscopy – Principle of light transmission scanning, electron, phasecontrast. Fluorescence, electron cryo and confocal, scanning electron microscopes. Microphotography. Image analysers and their applications

Unit III

Techniques in Biology :

1. Microbiological techniques
(a) Media preparation and sterilization
(b) Inoculation and growth monitoring
(c) Use of fermentors
(d) Biochemical mutants and their use
(e) Microbial assays

2. Cell culture techniques
(a) Design and functioning of tissue culture laboratory.
(b) Cell proliferation measurements
(c) Cell viability testing
(d) Culture media preparation and cell harvesting methods
3. Cryotechniques
(a) Cryopreservation for microscopy
(b) Cryotechniques for microscopy
(c) Freeze-drying for physiologically active substances
4. Separation techniques in biology
(a) Molecular separations by chromatography, electrophoresis, precipitation etc.
(b) Organelle separation by centrifugation etc.
(c) Cell separation by flowcytometry, density gradient centrifugation, unit gravity centrifugation, affinity adsorption, anchorage based techniques etc.
5. Principles and techniques of nucleic acid hybridization and Cot curves; Sequencing of proteins and nucleic acids; Southern, Northern and South-Western blotting techniques; Polymerase chain reaction, Methods for measuring nucleic acid and protein interactions.
6. Principles and applications of tracer techniques in biology; Radiation dosimetry; Radioactive isotopes and half life of isotopes; Effect of radiation on biological system; Autoradiography; Cerenkov radiation; Liquid scintillation spectrometry.

Suggested Reading Material

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts. J.A. Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., Calfornia.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA.
4. Molecular Biology of the Cell, B. Alberts, d.d Bray, J.Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing inc., New York.
5. Gene VI, Benjamin Lewin, Oxford University Press, U.K.
6. Molecular Biology and Biotechnology, A comprehensive desk reference, R.A. Meyers (ED.), VCH Publishers, Inc., New York.
7. Molecular Cloning : A Laboratory Manual, J. Sambrook, E.F. Fristsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
8. Animal Cell Culture – A practical approach, Ed. John R.W. Masters, IRL Press.
9. Introduction to Instrumental analysis, Robert Braun, McGraw Hill International Editions.
10. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.H. Goulding, ELBS Edu.

PAPER IV – QUANTITATIVE BIOLOGY, GENETICS AND EVOLUTION

Unit I

Quantitative Biology :

1. Computer applications in zoological studies
(a) Fundamentals of computers
(b) History and generations of computers
(c) Computer peripherals and architecture
(d) Elementary idea about operating system (Window versions) and MS Office
(e) Software used in Biomedical Sciences (Image analysis, sound analysis, system automation and GIS).
2. Statistics.
(a) Principles and practice of statistical methods in biological research, samples and populations.
(b) Graphical and tabular presentation of data.
(c) Basic statistics-average.
(d) Statistics of dispersion, coefficient of variation.
(e) Standard error; Confidence limits.
(f) Probability distributions (binomial, poisson and normal).
(g) Tests of statistical significance.
(h) Simple correlation and regression.
(i) Analysis of variance.

Unit II

Advanced Genetics :

1. Mutation and mutagenic agents:
(a) Classification of mutations, translocation, inversion deletion, duplication, replication and gene mutation.
(b) Molecular basis of mutation.
(c) Mutagenic agents.
2. Multiple alleles: ABO, Rh and MN types of blood groups & their genetics
3. Cytoplasmic inheritance and maternal effects:
4. Evolution of sex chromosomes.
5. Human heredity: Important human characters & their inheritance; principles of eugenics, genetic councelling, genetic disorders (Turner's syndrome, Klinefelter's syndrome, Down's syndrome), sequencing human genome.
6. Bacterial genetics: Bacterial mutation, conjugation & transduction. Lysogenic and lytic cycle in bacteriophage, Plasmid.
7. Regulation of gene expression in prokaryotes and eukaryotes (Oparin concept), DNA finger printing.
8. Principles, methods and application of Genetic engineering, Recombinant DNA Technology; in situ hybridization.

Unit III

Evolution :

1. Concepts of evolution and theories of organic evolution with an emphasis on Darwinsim.
2. Neo-Darwinism
2.1 Hardy-Weinberg law of genetic equilibrium
2.2 A detailed account of destabilizing forces :-
(a) Natural selection
(b) Mutation
(c) Genetic drift
(d) Migration
(e) Meiotic drive
3. Quantifying genetic variability
(a) Genetic structure of natural populations
(b) Phenotypic variation
(c) Models explanining changes in genetic structure of populations
(d) Factors affecting human disease frequency
4. Molecular population genetics
(a) Patterns of change in nucleotide and amino acid sequences
(b) Ecological significance of molecular variations
(c) Emergence of Non-Darwinism-Neutral hypothesis
5. Genetics of quantitative traits in populations
(a) Analysis of quantitative traits
(b) Quantitative traits and natural selection
(c) Estimation or heritability
(d) Genotype-environment interactions
(e) Inbreeding depression and heterosis
(f) Molecular analysis of quantitative traits
(g) Phenotypic plasticity
6. Genetics of speciation
(a) Phylogenetic and biological concept of species
(b) Patterns and mechanisms of reproductive isolation
(c) Models of speciation (Allopatric, sympatric, parapatric)
7. Molecular Evolution
(a) Gene Evolution
(b) Evolution of gene families, Molecular drive
(c) Assessment of molecular variation
8. Origin of higher categories
(a) Phylogenetic gradualism and punctuated equilibrium
(b) Major trends in the origin of higher categories
(c) Micro and Macro-evolution
9. Molecular phylogenetic
(a) How to construct phylogenetic trees ?

(b) Phylogenetic inference-Distance methods, parsimony methods, maximum likelihood method.
(c) Immunological techniques
(d) Amino acid sequences and phylogeny
(e) Nucleic acid phylogeny-DNA-DNA hybridizations, Restriction enzyme sites, Nucleotide sequence comparisons and homologies
(f) Molecular clocks

Suggested Reading Material

1. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
2. Dbzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surject Publication, Delhi.
3. Futuyama, D.J. Evolutinary Biology, Suinuaer Assciates, INC Publishers, Dunderland.
4. Hartl, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
5. Jha, A.P. Genes and Evolution. John Publication, New Delhi.

FINAL

PAPER V – BIOLOGY OF CHORDATES AND DEVELOPMENTAL BIOLOGY

Unit I

Biology of Chordates :

1. Origin and outline classification of the 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.

a) Geological time scale and fossils
b) Origin, evolution and general characters of Agnatha (Ostracoderms and Cyclostomes).
c) The early gnathostome (Placoderms).
d) A general account of the Elasmobranchi, Holocephali, Dipnoi and Crossopterygi.
e) Adaptive radiation in bony fishes.

f) Origin and evolution and adaptive radiation of Amphibia.
g) Origin and evolution of reptiles; the conquest of land, Seymouria and related forms; Cotylosauria, basic skull types and outline classification of reptiles.
h) Dinosaurs types and evolutionary significance.
i) Living reptiles - a brief account of Rhynchocephalia, Chelonia, Crocodilia and Squamata.
j) Origin and evolution of birds.
k) Origin of flight; flight adaptations.
l) Origin of mammals
m) Primitive mammals (Prototheria & Metatheria)
n) A general survey of the main radiations in eutherian mammals, excluding detailed reference to individual orders.
o) Evolution of man; relationships of man with other Primates; fossil record of man's ancestry.

Unit II
Developmental Biology :
5. Theories of Development : Preformation and Epigenesis.
6. Spermatogenesis
7. Oogenesis:
(a) Growth of oocyte and vitellogenesis.
(b) Organization of egg cytoplasm; role of the egg cortex.
(c) Morphogenetic determination in egg cytoplasm;
8. Fertilization ; significance of fertilization for development and the essence of activation of the egg.
9. Early embryonic development :
(a) Patterns of cleavage, blastulation and gastrulation in chordates (tunicates to mammals).
(b) Fate maps.
(c) Morphogenetic movements.
(d) Mechanics and significance of gastrulation.
10. 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 fate
11. Body Axes
(a) Establishment of Body axes in mammals and birds
(b) Proximate tissue interactions
12. Causal basis of development : Primary embryonic induction:
(a) Concepts of potencies; prospective fates; progressive determination, totipotency and pleuripotency, nuclear transfer experiment.
(b) Induction of the primitive nervous system (Spemann's primary organizer).

(c) Nature and regionally specific properties of inductor.
(d) Competence.
(e) Abnormal (heterogeneous) inductors.
(f) Chemistry and mechanism of action inducing substances.
(g) Cell differentiation and differential activity
13. Early vertebrate development
(a) Neurulation and ectoderm
(b) Mesoderm and endoderm
14. Cell diversification in early animal embryo
(a) Xenopus blastomeres
(b) Morphogen gradients
(c) Embryonic stem cells.
(d) Renewal by stem cells-epidermis
(e) Skeletal muscle regeneration
(f) Connective tissue cell family
15. 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 and alimentary canal, accessory organs.
(d) Maternal contributions in early embryonic development.
(e) Genetic regulations of early embryo.

Unit III

Some Specific Aspects of Development :

16.. Embryonic adaptations :
(a) Evolution of the cleidoic egg and its structural and physiological adaptations.
(b) Development and physiology of the extra- embryonic membranes in amniotes.
(c) Evolution of viviparity.
(d) Development, types and physiology of the mammalian placenta.
17. Regeneration :
(a) Types of regeneration, physiological, reparative and compensatory hypertrophy, regenerative ability in chordates.
(b) Morphological and histological process in amphibian limb regeneration.
(c) Origin of cells of regenerations, differentiation, redifferentiation, pattern formation during amphibian limb regeneration, reasons for the absence of limb regenerative ability in mammals. Methods for induction of regenerations
18. Tetrapod limb development.
19. Homeobox concept in different phylogenetic groups
20. Hemopoietic stem cells
(a) Stem cell disorders
(b) Blood cells formation

(c) Bone marrow transplants
(d) Gene therapy
21. Metamorphosis
(e) Amphibian metamorphosis
(f) Insect metamorphosis

Suggested Reading Material

Alexander, R.M. The Chordata. Cambridge University Press, London.
Barrington, E.JW. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinbourgh.
Bourne, G.H. The structure and functions of nervous tissue. Academic Press. New York.
Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick and Jackson, London.
Eccles, J.C. The understanding of the brain. McGraw Hill Co., New York and London.

PAPER VI : ECOLOGY AND ETHOLOGY

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, molar forces, the substratum, climatology.
(c) Brief review of important physical factors as limiting factor.
(d) Nutrients and environment.
4. 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.
5. Organization at the community level :
(a) Biotic community concept.
(b) Community structure & concept of community dominance.
(c) Ecotone & concept of "edge effect".
(d) Pattern in communities : Stratification, zonation, activity, food web, reproductive and social.

(e) Community versus the continuum.
(f) Evolution of Communities; Palacology; Community structures in past ages.
6. Ecological regulations :
(a) Succession in community : Basic types of succession convergence & divergence in succession; modifications in succession; concept of climax, monoclimax versus polyclimax theory; barriers & ecesis in succession; Biome.
(b) Fluctuations within community; eruptive cycle, fluctuation; causes of fluctuation, cycles.
7. Environment and animals:

Unit II
(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.
8. 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 & estuarine areas.
9. The ecological outlook : Space ecology, nuclear radiation, population, resources & applied human ecology.
10. Ecosystem dynamics and management;
(a) Stability and complexity of ecosystems;
(b) Speciation and extinction;
(c) Environmental impact assessment;
(d) Principles of conservation; Conservation strategies;
(e) Prospects and Strategies for sustainable development.

Unit III
11. Introduction to Ethology. Ethology *as* a branch of biology and its significance
12. Types of behaviour and their regulation :
(a) Feeding behaviour :
(i) Components of feeding behaviour; hunger and drive; directional movement, avoidance, eating, carrying and hoarding.
(ii) Factors influencing choice of food.
(iii) Nervous regulation of food and energy intake.
(b) Learning : Habituation conditioned reflex; trial and error; latent learning; learning and discrimination imprinting; neural mechanism of learning.
(c) Instinctive behaviour; concept, phyletic descent and physiology.
(d) Motivated behaviour : Drive, satiation & its neurophysiological control.

(e) Social behaviour in primates :
(i) Social signals, olfactory, tactile, visual, vocal.
(ii) Status : dominance & hierarchy territorial behaviour courtship & mating aggression.
(iii) Primate societies.
(f) Behaviour in birds : Behaviour of *Streptopelia* (ring dove) homing and migration.
(g) Reproductive behaviour in fish (Stickle back or any other fish).
(h) Social behaviour in insects : Communications; concealment behaviour.
(i) The role of pheromones (a general account).
13. Orientation :
(a) Classification of various types of taxes &, kineses.
(b) Flight orientation in locust.
14. Methods of studying behaviour: Brain lesions, electrical stimulation, drug administration.
15. Behavioural genetics: Single gene effect; multiple gene effect; behavioural variation in an individual; genetics and human behaviour.
16. Behaviour of domestic and Zoo animals.
17. Hormones and behaviour. Mammalian nervous system with special reference to the involvement of hypothalamus in the regulation of behavioural patterns.

Suggested Reading Material

Begon, M., J.L. Harper and C.R Towusend. Ecology, individuals. Populations and communities. Blackwell Science, Oxibrd, U.K.
Cherrett, J.M. Ecological concepts. Blackwell Sci. Publi. Oxford. UK.
Elseth, B.D. and K.M. Bauiugartuer. Population biology. Van Nostrand Co., New York.
Jorgenseu, S.E. Fundamentals of ecological modeling. Elsevier, New York.
Krebs, C.J. Ecology. Harper & Row, New York.

PAPER VII : CELL BIOLOGY

Unit I

1. Concept of cell theory.
2. Cell types : Detailed structure of the different types of cells.
(i) Nerve cell (ii) Muscle cell (iii) Gland cell (iv) Blood cell.
3. Cell Membrane :
(a) Study of various models of the molecular structure of the cell membrane as suggested by Devson & Danielli, Robertson & Green : Other recent views on the subject.
(b) Molecular structure of the specialized modifications of the cell membrane (Cilia, flagella, myelin sheath etc.)

(c) Concept of cell surface : Electro kinetic properties of cell surface, their role in intercellular inter-action in cell fusion, Cell aggregation etc.
(d) Properties & functions of the cell membrane, with special reference to permeability.
4. Cytoplasm :

Unit II
(a) Generalized structure & composition of the cytoplasm.
(b) Detailed discussion on the following cytoplasmic components with special reference to the biochemical and physiological aspects:
(i) Endoplasmic reticulum (ii) Ribosomes (iii) Golgi body (iv) Mitochondria (v) Lysosomes, Peroxisomes & other related particles
(vi) Centrosomes.
5. Nucleus :
(a). Structure & functions of the nuclear envelop.
(b). Structure and chemical organisation of the resting nucleus.
(c). Nucleus & Nucleolar extrusions.
(d). Chemistry and biosynthesis of nucleic acids.
6. Chromosomes :

Unit III
(a) Structural, chemical and functional organization of the different types of chromosomes (autosomes, giant chromosomes, sex chromosomes supernumerary chromosomes etc.).
(b) Chromosomal aberration.
(c) Variation & evolution of chromosome numbers.
7. Cell Division :
(a) Detailed structural, chemical & physiological study of mitotic & meiotic divisions, with special reference to the mechanism of chromosome movement & organization of the spindle apparatus.
(b) Mitotic poisons & their action.
(c) Polyploidy.
(d) Polysomy.
8. Gametogenesis :
(a). Cytological, cytochemical and endocrinological study on the developing male & female germ cells.
(b). Physiology of ovum & spermatozoan.
(c). Physiology of the union of gametes and the acrosome reaction.

PAPER VIII ENVIRONMENTAL BIOLOGY

Unit I

1. Systems analysis including models in environmental biology.
2. Impact of environment at cellular level : Cellular interaction with environment.
3. Environment Physiology : Basic metabolic rate and body size Metabolism and climatic adaptations : Hibernation and aestivation. Poikilotherms and Homeotherms. Asphyxic responses. Response to temperature and pressure. Haematological changes. Thermal properties of water and survival limits. Acclimatization.

Unit II

A detailed study of different ecosystems : Study will include biotic & a biotic components and their interrelationships, productivity & adaptations of animals.
4. Terrestrial ecosystems :
(i) Grasslands. including grazing lands
(ii). Forests : Characteristic of alpine, temperate & tropical forests. Stratification. High altitude with special reference to Himalayan Ecology.
(iii). Deserts: Types and ecological attributes of desert biota.
(iv) Taiga : Extent and ecological peculiarities.
(v) Tundra : Extent and ecological peculiarities.
5. Aquatic Ecosystems :
(i) Fresh water : Lakes including salt lakes, ponds streams, springs, rivers and marshes.
(ii) Marine ecosystem : Zonation, fauna.
(iii) Estuarine : Ecological peculiarities, adaptation including impact on fauna.
6. A general knowledge of Biogeography.

Unit III

7. Development & evolution of ecosystems, causes & kinds of succession. Diversity and productivity in relation to stages of succession and development.
8. Urban, rural and other man made ecosystems, their impact on animal life. Urbanization and industrialization. Socio-ecological impacts.

PAPER IX : INDUSTRY BASED ENVIRONMENTAL STUDIES

UNIT – 1

Environment – Definition – Scope – Structure and function of eco system's procedures, consumers and decomposers – energy flow in the ecosystem –

ecological succession – food chain, food web and ecological pyramids - concepts of sustainable development.

UNIT – 2

Natural resources: Renewable – air, water, soil, land and wildlife resources. Non- renewable – mineral, coal, oil and gas. Environmental problems related to the extraction and use of natural resources.

UNIT – 3

Biodiversity – Definition – values – consumption use, productive social, ethical, aesthetic and option values threats to biodiversity – Hotspots of bio diversity – conservation of bio-diversity: In-situ Ex-situ. Bio-wealth – national and global level.

UNIT – 4

Environmental pollution : Definition – causes, effects and mitigation measures – Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution – Nuclear hazards – solid wastes acid rain – climate change and global warming environmental laws and regulations in India – Earth summit.

UNIT – 5

Population and environment – Population explosion – Environment and human health – HIV / AIDS – Women and child welfare – Resettlement and Rehabilitation of people, role of information technology in environmental health – Environmental awareness.