FYUG NZO SYLLABUS (NEP 2020)
DEPARTMENT OF ZOOLOGY, SCHOOL OF SCIENCES, NSOU

DSC (Major) Papers offered by the Zoology Department

5CC-ZO-01: PRACTICAL (4 Credit/100 Marks)
Animal Diversity – Non-chordates and Chordates

Study of Specimens with Reasoning:

1. Protista – *Amoeba, Euglena, Plasmodium, Paramecium*
2. Metazoa without coelom – *Sycon, Hyalonema or Euplectella, Obelia, Physalia,* Jellyfish, Sea Anemone, *Taenia,* Male and female *Ascaris*
3. Annelida – *Aphrodite, Nereis, Earthworm, Hirudinaria*
4. Arthropoda – *Palaemon, Scylla, Carcinoscorpius, Penaeus, Scolopendra,* Millipede, *Periplaneta, Apis* (any four)
5. Mollusca – *Chiton, Dentalium, Pila, Lamellidens, Loligo, Sepia, Octopus* (any four)
6. Echinodermata – Starfish, *Ophiura, Echinus, Cucumaria* and *Antedon* (any three)
7. Protochordata – *Balanoglossus*, *Branchiostoma*, *Herdmania*, *Petromyzon, Ammocoetes larva* (any three)
8. Fish – *Sphyrna, Pristis, Torpedo*, *Scoliodon, Labeo*, *Exocoetus*, *Anguilla, Echenis* (any four)
9. Amphibia – *Teniolosa, Ureotyphlus*, *Salamander*, *Bufo*, *Hyla, Rhacophorus* (any four)
10. Reptilia – Turtle, *Calotes*, *Chamaeleon, Draco, Vipera*, *Naja, Crocodylus, Gavialis* (any four)
11. Birds – Any three common birds from different orders available in concerned college laboratory or surroundings
12. Mammals – *Sorex*, Mega or Microchiroptera, Squirrel and any two common mammals of different orders around you.

Supportive Techniques to Study Animal Diversity

13. Study of different techniques for animal preservation
14. Key for Identification of poisonousand non-poisonous snakes
15. Study of different scales present in animal body
16. Study of Molluscan shell (Conchology)

5CC-ZO-02: THEORY (4 Credit/100 Marks)
Animal Diversity – Non-chordates and Chordates

1. Basic concepts of five kingdom classification – domains of life, General characteristics of Protista, Parazoa and Metazoa.
2. Subkingdom Protozoa – General characteristics and Classification up to class.
3. Phylum Porifera – General characteristics and Classification up to class.
4. Phylum Cnidaria – General characteristics and Classification up to class.
5. Concept of body axis and symmetry, coelom, pseudocoelom and segmentation.
6. Types of Helminths and Nematodes – General characteristics and Classification up to class.
7. Phylum Annelida – General characteristics and Classification up to class.
8. Phylum Arthropoda – General characteristics and Classification up to class.
9. Phylum Mollusca – General characteristics and Classification up to class.
10. Phylum Echinodermata – General characteristics and Classification up to class.
11. Origin of Chordates and Vertebrates, Protochordates – General characteristics and Classification up to class.
12. Emergence of Agnatha (jawless vertebrate) and Gnathostomata (vertebrate with jaw).
13. Pisces – General characteristics and Classification up to order.
14. Amphibia – General characteristics and Classification up to order.
15. Reptilia – General characteristics and Classification up to order.
16. Aves – General characteristics and Classification up to order.
17. Mammalia – General characteristics and Classification up to order.

6CC-ZO-03: PRACTICAL (4 Credit/100 Marks)
Ecology

Aquatic Ecology

1. Study of zonation/stratification of pond or lake ecosystem
2. Study of temperature and turbidity/penetration of light in pond or lake
3. Determination of pH in water and soil sample
4. Estimation of free CO_2 in water sample
5. Estimation of Dissolved Oxygen content (Winkler's method) in water sample
6. Estimation of Primary productivity by light & dark bottle method

Sampling method and Community Analysis

7. Transact methods – Point and Line
8. Quadrat method – preparation of nested quadrat, estimation of effective quadrat size, sampling method by quadrat
9. Pitfall trapping method and light trapping method in practice
10. Community analysis by diversity and abundance estimation
11. Sorenson's Similarity & Shannon-Weiner diversity indices
12. Calculation of Diversity Indices in real-time

Biodiversity and Evolution

13. Short-report on a visit to Zoological Garden/Wild-life sanctuary/ National Park/Fossil Park or any wilderness (individual activity), OR, Short-report on local biodiversity of the surrounding of the learner's residence on any two major taxa of animals (individual activity)
14. Study of homology and analogy from suitable specimens and pictures [virtual mode can be applied]
15. Darwin's Finches with diagrams/ cut outs of beaks of different species [virtual mode can be applied]

6CC-ZO-04: PRACTICAL (4 Credit/100 Marks)
Histology, Osteology and Developmental Biology

Histology

1. Demonstration of paraffin block preparation of tissue.
2. Demonstration of microtome sectioning of tissue.
3. Stretching of tissue section and fixing on glass slide.
4. Haematoxylin and Eosin staining of mammalian tissue sections.
5. Study of permanent slides of mammalian endocrine glands – pituitary, thyroid, pancreas, adrenal, testes and ovary.
6. Study of permanent slides of mammalian organs – duodenum, intestine, liver, lung, kidney.

Osteology

7. Method of preparation of animal skeleton.
8. Study of Skulls of amphibia, reptile (Calotes), bird (fowl) and mammal (rat/guineapig and dog). [for amphibia and reptile photograph or virtual mode can be applied]
9. Axial and appendicular skeletal system of fowl and white rat.
10. Carapace and plastron of turtle [virtual mode can be applied]

Developmental Biology

11. Study of Life-history stages of Mosquito.
12. Study of life history stages of Tode/Frog.
13. Study of Frog sperm and ova through permanent slides or photo-micrographs.
14. Study of developmental stages of chick embryo – whole mount permanent slides of 24hrs, 48hrs and 72 hrs embryo.

6CC-ZO-05: THEORY (4 Credit/100 Marks)
Ecology and Biodiversity

1. Ecology – Definition and general concepts; Levels of organization and Ecology
2. Study of Physio-chemical Factors and the concept of Limiting Factors.
3. Population and its attributes – Density, Natality, Mortality, Fecundity, Life Table, Age and sex ratio.
4. Survivorship curve, their patterns and implications in population structure.
5. Population growth curve – exponential and logistic and their importance in population structure.
6. 'r' and 'k' selection strategies.
7. Population regulation – density dependence and independence.
8. Community characteristics, species richness, dominance, diversity and abundance.
9. Community stratification, Ecotone and Edge effect.
10. Ecological niche concept, resource partitioning, Gause's principle.
11. Lotka-Volterra equation and its significance in community formation.
12. Ecological succession, Community stability and resilience.
13. Food Chain – grazing and detritus, linear and Y shaped, Food-web.
14. Energy flow in ecosystem, ecological pyramid and ecological efficiency.
15. Biodiversity and its types; Climatic zonation and biodiversity.
16. Major biodiversity areas of the World and India, Biodiversity hotspots, IUCN and Red Data-book.
17. Wildlife conservation strategies (*in situ* and *ex situ*); important laws of wild-life conservation in India.
18. Project Tiger and Elephant.

6CC-ZO-06: THEORY (4 Credit/100 Marks)
Cell and Developmental Biology

Cell Biology

1. Cell: General structure and function, Concept of Eukaryotic cell evolution.
2. Plasma membrane structure and function; Transport across membrane, active, passive, facilitated transport.
3. Mitochondria – structure and function, Mitochondrial respiratory chain.
4. Golgi apparatus: structure and function; GERL system and its significance.
5. Cytoskeleton – structure and function; Microtubules, microfilaments and intermediate filaments.
6. Structure of nucleus, nuclear envelop, nuclear pore complex, nucleolus.
7. Cell junction; Tight junction, Gap junction, Desmosome.
8. Cell Division: Mitosis and meiosis, Cell cycle and its regulation.
9. General concept of cellular differentiation, maturation and lineage specificity, symmetric and asymmetric cell division.

Developmental Biology

10. Early embryonic development – Gametogenesis, Spermatogenesis, Oogenesis; Egg and egg membrane.
11. Fertilization event, acrosome reaction, activation and block of polyspermy.
12. Cleavage planes and patterns, types of blastula, Fate map construction.
13. Gastrulation and early development of frog and chick embryo, Germ layers and their fate.
14. Embryonic induction and organizers – introductory concept of mechanism at cellular level.
15. Extraembryonic membrane – general concept; Chick extraembryonic membrane.
16. Placenta: Types and function with examples.
17. Post-embryonic development; Metamorphosis and its regulation in insects and amphibia.
18. Implication of Developmental Biology – Teratogenesis; *in vitro* fertilization (IVF); Use of stem cells; Amniocentesis.

6CC-ZO-07: THEORY (4 Credit/100 Marks)
Animal System and Function

1. Protista System Biology; Locomotion of *Amoeba* and *Paramoecium*; Reproduction of Asexual and Sexual modes in protista.
2. Organization of canal system in Porifera and its function.
3. Polymorphism in Cnidaria; Biology of Coral reef formation.
4. Osmoregulatory system in Protista and Evolution of excretory system in Helminth, Annelida and Arthropoda.
5. Locomotory organs and Systems in Invertebrates – Parapodia, Setae and Water-vascular-system.
6. Nervous system and Cephalization in Mollusca, Torsion and detorsion.
7. Larval forms of invertebrates including protochordates and their evolutionary relationships.
8. Affinity of Limulus and Ectoprocta (Bryozoa).
9. Physiology of Osmoregulation and Ventilation in fish.
10. Metamorphosis of Amphibia – Neoteny and Paedomorphosis.
11. Special organs in snake -Jacobson's organ, Poison apparatus and biting mechanism.
12. Evolution of Tetrapoda skull and its divergence.
13. Bird migration – types, cues and mechanism of migration. Perching mechanism of birds
14. Echolocation and Sonar systems in Bats and Whales.
15. Affinity of Sphenodon, Archaeopteryx and Prototheria.
16. Comparative anatomy of circulatory system and heart in vertebrates.
17. Comparative anatomy of Excretory system and Kidney in Vertebrates.
18. Comparative anatomy of Brain in Vertebrates.
19. Comparative anatomy of stomach in tetrapods

7CC-ZO-08: PRACTICAL (4 Credit/100 Marks)
Parasitology, Cell Biology and Biochemistry

Parasitology

1. Study of life stages of *Entamoeba histolytica*, *Leishmania donovani* and *Plasmodium sp*. (in permanent slides)
2. Study of life stages of *Taenia solium*, *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* (through preserved specimen/ permanent slides / microphotographs).
3. Study of *Pediculus humanus* capitis and corporis, *Ctenocephalides spp.* and *Cimex lectularius* through permanent slides/photographs.
4. Study of nematode/cestode parasites from the intestines of poultry bird.
5. Identification of different mosquito vectors.

Cell Biology

6. Demonstration of different types of microscopes and different types of microscopic preparation of biological samples, stains and fixatives.
7. Study of mitosis from bone marrow of goat/ Onion root tip.
8. Study of various stages of meiosis from *grasshopper* testis.
9. Study of polytene chromosome from chironomid larvae (demonstration, microphotograph, virtual method can be applied)

Biochemistry

10. Qualitative tests to identify carbohydrates (Glucose, Fructose, Sucrose, Lactose and starch).
11. Qualitative tests to identify proteins.
12. Estimation of total protein in given solutions by Lowry's method.
13. Studies of enzyme activity from human saliva under optimum conditions.
14. Effect of pH, temperature and inhibit or sontheaction of salivary amylase.

7CC-ZO-09: Practical (4 Credit/100 Marks)
Biostatistics and Bioinformatics

Biostatistics

1. Diagrammatic presentation & summarizing biological data by Histogram & Pie Diagram
2. Analysis of central tendency in biological data set.
3. Application of Chi Square Test in biological data sets.
4. Application of Student 't' Test in biological data sets.
5. Analysis of the linear relationship between a pair of variables using Correlation
6. Analysis of biological data using SPSS software.

Bioinformatics

7. Introduction to UNIX operating system
8. Introduction to Windows operating systems
9. Graphical representation of basic biological data using MS Excel.
10. Introduction to NCBI database
11. Introduction to RCSB PDB database
12. Sequence retrieval using BLAST
13. Sequence alignment using Bioinformatics tools
14. Secondary structure prediction of Protein using GOR and PSIPRED tools.

7CC-ZO-10: THEORY (4 Credit/100 Marks)
Evolution and Taxonomy

Evolution

1. Evolutionary concept: Lamarckism, Darwinism and Neo-synthesis.
2. Sources of variations, heritable variations and their role in evolution.
3. H-W Equilibrium and its implication in population variation and evolution; Evolutionary forces disordering HWE.
4. Natural selection and its evidences.
5. Genetic drift, founder's effect, genetic bottleneck.
6. Role of adaptations in evolution of animals – explanation with examples.
7. Evidences of Evolution – Fossil records, Transitional forms, Evolution of horse.
8. Origin of life; Chemogeny and Biogeny, RNA world, Evolution of Eukaryotes; Geological time-scale.
9. Concept of Microevolution and Macroevolution.
10. Origin and evolution of modern man; Primate vs Hominid characteristics, Evolution from *Australopithecus* to *Homo sapience*.

Taxonomy

11. Basic concept of Taxonomy and systematics; Taxonomic types and hierarchy.
12. Codes and rules of Zoological Nomenclature; Principle of priority, synonym and Homonym.
13. Biological and Evolutionary species concept; Speciation; Isolation mechanism and modes.
14. Numerical Taxonomy.
15. Molecular Taxonomy.
16. Phylogeny; Cladistics and Cladogram.

7CC-ZO-11: THEORY (4 Credit/100 Marks)
Genetics and Molecular Biology

Genetics

1. Principals of inheritance, Mendelian genetics, Allele concept, multiple alleles, lethal allele.
2. Concept of dominance and epistasis, Pleiotropy, Sex-linked, Sex-influenced and Sex-limited inheritance.
3. Linkage and crossing over – cytological basis and molecular mechanism.
4. Recombination model, recombination frequency and linkage intensity.
5. General concept of chromosome mapping, Interference and Coincidence.
6. Chromosomal aberration types, Mutation and its molecular basis, mutation effects.

7. Chromosomal mechanism of sex determination in *Drosophila* and Man.
8. General concept of polygenic inheritance with examples; Demonstration of mechanism with simple numerical.

Molecular Biology

9. General concept of replication, Components of replication machinery, General model of replication.
10. Comparative study of replication in circular and linear ds-DNA, Replication in telomere.
11. General concept of transcription: Mechanism of transcription in prokaryotes, Transcription regulatory sequences and proteins.
12. Introductory idea of transcription in eukaryotes, Transcription factors and regulatory sequences.
13. Concept of intron, exon, splicing mechanism and production of functional mRNA.
14. Gene regulation in prokaryotes; Transcriptional regulation – *lac* and *trp* Operon.
15. Genetic code, Degeneracy and Wobble Hypothesis.
16. Mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly, amino-acyl t-RNA synthetase.
17. Proteins involved in initiation, elongation and termination of polypeptide chain in prokaryotes.

7CC-ZO-12: THEORY (4 Credit/100 Marks)
Basic Biochemistry and Metabolism

1. Biological macromolecules: Structure, types and biological importance: Carbohydrate, Protein, Lipid, Nucleic acids and Vitamins.
2. Laws of thermodynamics and its relevance to biological systems.
3. High-energy phosphate bonds and its role in energy capture and transfer.
4. Enzymes: Nomenclature and classification.
5. Specificity of enzyme action; Cofactors; Isozymes.
6. Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalysed reactions.
7. Derivation of Michaelis-Menten equation, Concept of K_m and V_{max}, Lineweaver-Burk plot; Multi-substrate reactions.
8. Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.
9. Catabolism *vs* Anabolism, Stages of catabolism.
10. Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters, ATP as "Energy Currency of cell"
11. Carbohydrate metabolism: Glycogenesis; Glycogenolysis; Gluconeogenesis; Glycolysis.
12. Citric acid cycle.
13. Pentose phosphate pathway.
14. β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atom.
15. Biosynthesis of palmitic acid; Ketogenesis.
16. Catabolism of amino acids: Transamination, Deamination, Urea cycle.

7CC-ZO-13: THEORY (4 Credit/100 Marks)
Biostatistics and Bioinformatics

Biostatistics

1. Introduction to Biostatics: Basics of biostatistics & relevance in analyzing biological data.
2. Variables and Sampling: Basic idea on variables, frequency distribution and sampling techniques.
3. Central Tendency: Mean, median and mode of biological data set.
4. Measurement of Variation: Variance, range, quartile deviation. Standard deviation and standard error - problems and application.

5. Statistical Interference: Introduction to significance test; Null & Alternative hypothesis; Levels of significance.
6. Test of Significance: Chi Square Test & Student 't' test.
7. Correlation and Regression.

Bioinformatics

8. Introduction to Bioinformatics: Basic understanding of Bioinformatics; Branches of Bioinformatics; Aim and Scope of Bioinformatics.
9. Sequence and Format: Concept of nucleotide and Protein sequence; File formats used in bioinformatics.
10. Databases: Introduction to Biological Databases, Biological Database Retrieval System. NCBI databases.
11. Primary Biological Databases: Concept of nucleotide primary databases; Concept of protein primary databases.
12. Secondary & Specialized Biological Databases: Concept of nucleotide secondary databases; Concept of protein secondary databases. Idea of specialized biological databases.
13. Sequence Alignments: Introduction; Concept of Alignment; Multiple Sequence Alignment (MSA); MSA by CLUSTAL W.
14. Molecular Phylogeny: Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.
15. Applications of Bioinformatics.

7CC-ZO-14: THEORY (4 Credit/100 Marks)
Animal Physiology and Endocrinology

1. Structural organization and functions of gastrointestinal tract and associated glands.
2. Mechanical and chemical digestion of food; Absorptions of carbohydrates, proteins and lipids.
3. Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities.
4. Transport of oxygen and carbon dioxide in blood.
5. Cardiac physiology; Heart muscle; Rhythm and pace-making nodes, Regulation of pump and blood volume.
6. Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance.
7. Structure of neuron and its function; Structure and function of glial cells.
8. General brain anatomy and its functional zonation.
9. Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibres.
10. Histology of different types of muscle; Ultrastructure of skeletal muscle.
11. Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch.
12. Histology of testis and ovary; Physiology of male and female reproduction; Puberty.
13. Histology of endocrine glands - pituitary, thyroid, parathyroid, pancreas.
14. Classification of hormones; Regulation of their secretion; Mode of hormone action.
15. Hormones secreted by endocrine glands and their functions.

7CC-ZO-15: THEORY (4 Credit/100 Marks)
Economic Zoology and Public Health

Economic Zoology

1. Introduction to Economic Zoology.
2. Fisheries – Capture to culture system; Inland and coastal fisheries, EEZ.
3. Induce breeding and culture of IMC, Eco hatchery, semi-intensive and intensive fish farming.
4. Prawn and Shrimp Culture – Types and differences between prawn and shrimp, Shrimp farming in India; Diseases of Prawn and Shrimp.

5. Pearl Culture; Biology of original and artificial pearl formation; Pearl oyster farming and culture system.
6. Apiculture – Types of honey bees in India; Colony organization and commercial beekeeping technique; Artificial bee hive; Production of honey and biproducts.
7. Sericulture – Types of silk and silk insects; Life cycle of silkworm (Mulberry); Silk culture procedure (Mulberry); Status of silk industry in India.
8. Major crop pests (Rice, Jute, vegetable, stored grain) and their management.

Public Health

9. General concept of public health and community; Food and water source and hygiene; Communicable diseases.
10. Food and water borne infections; Bacterial and viral infections.
11. Parasitism – Parasitosis and Zoonoses: types with examples.
12. Parasitic Protists – Morphology, life cycle and pathogenicity of *P. vivax*, *E. histolytica* and *Leishmania sp*.
13. Helminths and parasitic diseases – *Taenia sp.* and *Fasciola sp.* Morphology, Life cycle, Parasitic adaptations and pathogenicity.
14. Nematode parasite morphology, Lifecycle, Parasitic adaptation and Pathogenicity of *Ascaris sp*. and *Wuchereria sp*.
15. Vectors and major vector borne diseases – mosquito, sand fly, house fly, human louse, ticks and mites.
16. World scenario of health and diseases; Role of WHO in maintaining human health.

8CC-ZO-16: THEORY (4 Credit/100 Marks)
Molecular Cell Biology

1. Eukaryotic cell membrane – membrane fluidity and movement – lipid raft and other membrane organization and their function
2. Mechanism of membrane biosynthesis and assembly, vesicle formation, exocytosis and endocytosis
3. Trafficking among different subcellular compartments-GERL system and functional significance
4. Cellular interaction with ECM and role of ECM in determining cell function
5. Basement membrane and cell adhesion molecules (CAM), Cellular interaction and communication mechanism with adjacent cells
6. Cytoskeleton – types of tubules, filaments and their functions, mechanism of cytoskeletal dynamicity; Cytoskeleton in cell shape determination and molecular migration within cells
7. Structure of nuclear membrane and nuclear pore complex (NPC)
8. Mechanism of nucleo-cytoplasmic communication, Importance of nucleo-cytoplasmic axis in determining cellular functions
9. Components of cell signaling – Types of membrane receptor families
10. Intracellular receptors and signaling molecules – Secondary messengers
11. Mechanism of signal transmission, inhibition and speed of response
12. G protein coupled receptor signaling – signaling mechanism of vision and smell
13. Receptor coupling and phosphorylation – mitogenic signalling and regulation
14. Divergence, convergence, amplification and crosstalk of cellular signalling

8CC-ZO-17: PRACTICAL (4 Credit/100 Marks)
Physiology, Immunology and Biotechnology

1. Blood film preparation and Leishman's staining,
2. Differential count of WBC.
3. Demonstration of: PCV, ESR.
4. Haemin crystal.

5. Recording of blood pressure and effects of posture and exercise on BP on human.
6. Measurement of BMR.
7. Isolation of peripheral blood mononuclear cells (PBMC) from rat.
8. Study of histological sections of lymph gland and spleen anatomy and cellular distribution in permanent slide.
9. Demonstration of isolation of genomic DNA from cell or tissue,
10. Colorimetric or spectrophotometric method (by diphenylamine reagent or other methods) of analysis of isolated DNA.
11. Demonstration of animal cell culture laboratory and instruments.
12. Preparation of sterile glass goods and basic reagents for primary / secondary cell culture.
13. Preparation of minimal growth media.
14. Demonstration of any types of animal cell culture (virtual method may be applied).

8CC-ZO-18: THEORY (4 Credit/100 Marks)
Health Disease and Immunobiology

1. Evolution of Parasitic Association, Modifications and Adaptations
2. Zoonosis and Myiasis – occurrence and effects on human health
3. Vector born parasites and pathogens – Malaria and Kala-azar; Mechanism of *Plasmodium* antigenic variations
4. Helminth Parasites – mechanism of infection and consequences
5. Cell structure and function of Bacteria and Archaea, cell-wall types, surface structure and spore structure variations
6. Microbial association and human physiology – flora of skin, gut, respiratory and urinogenital tracts and their functional relevance
7. Pathogenicity of microbes in human association, harmful effects on human, mechanism of toxicity and damage
8. Viral structure and types or diversity, retroviruses, sub-viral entities – viroids, prions and their effect on human; Nature of viral infections and consequences on health
9. Mechanism, epidemiology and longitudinal effect of some viral infections on global population – HIV, Ebolla, SARS (including SARS-COV2) and MERS
10. General outline of immune system function against pathogens and parasitic infection
11. Process and mechanism of inflammation in infection and tissue damage
12. Paths and processes of leukocyte movement, assembly, activation, effector function and homeostasis (general account)
13. Humoral and cytotoxic effector functions – antigen-antibody reaction, complement activation and their interaction with phagocytosis, mechanism of cytotoxicity
14. Outline of immunity in – a) microbial infection, b) helminth infection and c) viral infection
15. Hypersensitivity – types, mechanisms and consequences
16. Vaccination – processes and approaches; Concept of Community Medicine

8CC-ZO-19: THEORY (4 Credit/100 Marks)
Biosystematics and Conservation Biology

1. Modern trends in biosystematics: Chemotaxonomy, Ecotaxomony, Behavioural taxonomy, Cytotaxonomy and Molecular taxonomy
2. Theories of biological classification, Kinds and Components of classification, Concept of lineage, Phyletic Lineages
3. ICZN operative principles and important rules of nomenclature
4. Evolutionary and Biological species concept and critics of the concepts
5. Origin of reproductive isolation, biological mechanism of genetic incompatibility, mechanism of speciation in Panmictic and Apomictic species
6. Taxonomic diversity within species – Concept of Variety, Subspecies and other infra-specific categories, hybrids – Critical analysis of species boundary and category

7. Molecular Phylogeny – use of Proteins, DNA and RNA
8. Concept of construction of rooted and un-rooted phylogenetic trees using bioinformatics tools and their interpretation
9. Use of phylogenetic trees in analyzing evolutionary trends, steps in phylogenetic analyses
10. Concept of small population paradigm and minimum viable population size, population viability analysis.
11. Habitat destruction and fragmentation effect in population size and survival in time scale
12. Anthropogenic interference in community and landscape ecology
13. Conservation area selection and Reserve designing, Conservation corridors, Edge influence
14. Conservation strategies – *ex situ*, *in situ* and other approaches, population conservation and conservation network
15. Wildlife Protection Act, 1972 and implications in India; Characteristics of different types of reserve forests.
16. Conservation projects in India – Bengal Tiger and Elephant, Indian One-horned Rhinoceros, Red Panda, Gangatic River Dolphin
17. Understanding succession as a natural process, Managing succession in agro-ecosystem, restoration and conservation
18. Restoration projects in India – forms, functions, participation and progress.

8CC-ZO-20: THEORY (4 Credit/100 Marks)
Molecular Biology and Biotechnology

1. Structural complexity of Eukaryotic Genome; Coding and noncoding, repetitive, regulatory DNA types
2. Genome structure of human gene families; Genome structure of model organisms – *E coli*, *C elegance*
3. Chromosomal protein modification – acetylation, methylation, phosphorylation and other modification effects in gene expression
4. Epigenetic modification for cellular identity and memory – DNA methylation, CG island, Genomic imprinting and inheritance pattern
5. Nucleosome structure modification during transcription; local and global chromatin structure modification
6. Eukaryotic transcription regulation – sequences and factors in modulation the production of primary transcript or hnRNA
7. Processing of eukaryotic mRNA from primary transcript, localization of mRNA and its stability control for gene expression
8. Synthesis and processing of eukaryotic ribosomal and transfer RNA
9. MicroRNAs – small regulatory RNAs and their regulation in gene expression, RNA silencing pathways
10. Overview of eukaryotic translation control and production of polypeptide chain
11. Post-translational modification in cellular compartments – scaffolding and stabilization of protein; Ubiquitination and protein degradation
12. Analysis of genetic expression *in situ* and *ex situ* and its application, DNA fingerprinting and its application in forensics and in disease diagnosis.
13. Methods of gene editing, knock-out processes, genetic modification and recombination techniques and cloning techniques
14. Development of genetically modified organisms (GMO), modifications in ES cells and their application (with examples); benefits and consequences

8CC-ZO-21: THEORY (4 Credit/100 Marks)
Advanced Cell Biology and Physiology

1. General idea of being immortal – altered control of proliferation and growth
2. Genesis of Tumour/Cancer; Tumor microenvironment, tumor cell movement and metastasis
3. Types of cell death –programmed and non-programmed, Cell death mechanisms – extrinsic and intrinsic conditions of cell death
4. Aging and senescence – mechanism of cellular senescence
5. Electric signals in neurons – types of ion channels involved in neuronal signaling, their structure and mechanism of action
6. Membrane potential, Action potential phases, Propagation of signal through axon
7. Synapse – signal transmission in synapse, excitatory and inhibitory signals, electrical and chemical transmission, Neuromuscular junction
8. Types of CNS and ANS neurotransmitters and receptors – their structure and function, Neuropeptides and their roles
9. Vertebrate central endocrine glands and their function, Hypothalamo-pituitary axis, Neuroendocrine system, Pineal gland and Suprachiasmatic nuclei
10. Endocrine control of growth and development, Endocrine control of calcium metabolism in bone development
11. Physiology of olfaction or smell, Olfactory receptors, Molecular mechanism of transduction of olfactory cues and signaling
12. Physiology of vision, structure of Rod and Cone photoreceptors, Photopigments, mechanism of phototransduction, light and dark adaptation
13. Physiology of hearing, Sound transduction mechanism from inner-ear to brain and signalling
14. Cardiac conduction system and electrocardiogram, Mechanism of neuronal and hormonal regulation of blood pressure
15. Regulation of breathing, Control of respiratory centre, Chemoreceptor regulation of breathing
16. Mechanism of secretion regulation of HCl and digestive enzymes in stomach and intestine, Brain-Gut axis and its role in appetite/hunger and digestion at different conditions

8CC-ZO-22: THEORY (4 Credit/100 Marks)
Advanced Biochemical Processes

1. Overview of structure of Carbohydrate and Lipid – Structure of saturated and unsaturated fatty acides and cholesterol
2. Protein folding and evolution of functional proteins – primary to quaternary structure development, role of chaperon
3. Modification of protein structures and association of different moieties in functional protein development
4. Membrane protein assembly – Ligand-receptor interaction – Structures and function of growth receptors, cytokine receptors, steroid hormone receptors
5. Passive and active transport proteins, Ionophores, β-Barrels, Aquaporins, selective ion-channels, Na-K-ATPase, Ca-ATPase, ABC transporter
6. Serine proteases – chemistry and function, Zymogen
7. Protein tyrosine kinase – process of phosphorylation and dephosphorylation in signaling
8. Protein pumps and ATP synthesis, Structure and function of ATP synthase
9. Oxidation and reduction reaction, NAD^+ and FAD as electron carrier, electron transport chain and mechanism of electron transport, ROS generation, Oxidative phosphorylation
10. High energy compounds with phosphoryl group transfer potential, Thioesters as energy rich compounds and their role
11. Cholesterol metabolism, HMG-CoA in regulation of cholesterol synthesis, Atherosclerosis
12. NO biosynthesis, different forms and role of NO synthases, function of NO as signaling molecule
13. DNA motifs, SH2 and SH3 domains, Homeobox domains, Sumo proteins, Ubiquitins

14. Ribozymes and their function – Ribosome structure and function as 'gene machine'
15. Secondary messengers in signaling – cAMP, IP_3, Ca^+ and calmodulin, DAG

DSC-23: THEORY (4 Credit/100 Marks)
Ecosystem Function and Services

1. Niche theory: Niche concepts, niche width, niche overlap, niche dynamics
2. Ecological energetics: Laws of thermodynamics, concept of productivity and energy subsidy, complexity theory, energy flow model
3. Population growth models; Population cycle; Ricker model; Comprehensive theory of population regulation
4. Life history strategies: Evolution of life history traits, strategies related to longevity; clutch size; life history optimization
5. Ecological modeling: Predator-prey models, Epidemiological models, Foraging models
6. Meta-population concept, models of persistence and extinction risks
7. Inter specific interactions – competition, predation, mutualism
8. Community stability and functions – Food web models and network, disturbance and Implications
9. Community equilibrium, resilience and threshold for extinction process, effect of introduced and invasive species, Species invasion model
10. Evolutionary backdrop of ecology – distribution, abundance and biodiversity
11. Biodiversity and ecosystem function, Species Complementarity, Sampling effect, Redundancy
12. Insurance hypothesis: The effect of habitat fragmentation and dispersal on ecosystem
13. Decline of global biodiversity and loss of ecosystem function
14. Economics of biodiversity and ecosystem function
15. Ecosystem services, types and valuation

DSE (Minor) Papers offered by the Zoology Department to other Science Majors

NEC-ZO-01: THEORY (4 Credit/100 Marks)
Animal Diversity

Unit 1: Basics of Animal Classification - Concept of Classification, Systematics and Taxonomy; Hierarchy, Taxonomic types; classification outline of Animal Kingdom.
Unit 2: Codes of Zoological Nomenclature; Principle of priority; Synonym and Homonym.
Unit 3: Protozoa - General characteristics and Classification up to Phylum. Study of *Amoeba* (Structure, locomotion, reproduction & nutrition)
Unit 4: Porifera - General characteristics and Classification up to Classes; canal system in Porifera.
Unit 5: Cnidaria & Ctenophora - General characteristics and Classification up to Classes; polymorphism in cnidarians.
Unit 6: Platyhelminthes & Nemathelminths - General characteristics and Classification up to Classes; Life cycle of *Taenia solium* and *Ascaris lumbricoides.*
Unit 7: Annelida - General characteristics and Classification up to Classes; Metamerism in annelids.
Unit 8: Arthropoda - General characteristics and Classification up to Classes; Social life in insects.
Unit 9: Mollusca - General characteristics and Classification up to Classes; Pearl Formation
Unit 10: Echinodermata - General characteristics and Classification up to Classes; Water Vascular system in Starfish.
Unit 11: Protochordates - Salient features and Classification.
Unit 12: Pisces - General characteristics and Classification; Osmoregulation; Migration of Fishes.
Unit 13: Amphibia - General characteristics and Classification; Adaptations for terrestrial life, Parental care in Amphibia.
Unit 14: Reptiles - General characteristics and Classification; Terrestrial adaptations in reptiles.
Unit 15: Aves - General characteristics and Classification; Flight adaptations in birds.
Unit 16: Mammals - General characteristics and Classification; Primates; Dentition in mammals.

NEC-ZO-02: THEORY (4 Credit/100 Marks)
Aquatic Biology and Economic Zoology

Unit 1: Aquatic Biomes: Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone and marine benthic zone.
Unit 2: Freshwater Biology: Origin and classification of lakes, Lake as an Ecosystem.
Unit 3: Marine Biology - Salinity and density of Sea water, Continental shelf and Adaptations of deep-sea organisms.
Unit 5: Adaptations of deep-sea organisms.
Unit 6: Coral Reefs and their biology; Types, examples and importance.
Unit 7: Management of Aquatic Resources: Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills and Eutrophication.
Unit 8: Induce breeding and culture of IMC, Ecohatchery.
Unit 9: Semi-intensive and intensive fish farming
Unit 10: Apiculture – Types of honeybees in India; Colony organization and commercial beekeeping technique; Artificial beehive; Production of honey and biproducts.
Unit 12: Bee Diseases and Enemies.
Unit 13: Sericulture – Types of silk and silk insects; Lifecycle of silkworm (Mulberry); Silk culture procedure (Mulberry); Status of silk industry in India.
Unit 14: Pests and Diseases of Silkworm.
Unit 15: Major crop pests and their management.

NEC-03: THEORY (4 Credit/100 Marks)
Animal Behaviour, Evolution, Ecology and Conservation

Unit 1: Introduction to Ethology - Origin and history of Ethology; Proximate and ultimate causes of behaviour.
Unit 2: Basics of Behavioural Pattern in Animals - Instinct and Learned Behavior; Fixed Action Pattern, Associative learning, classical and operant conditioning, Habituation, Imprinting.
Unit 3: Social Behaviour - Concept of Society and Social Behaviour; Society Structure and Communication among Honey Bees; Altruism.
Unit 4: Evolutionary Theories - Concept of Evolution; Lamarckism; Darwinism; Synthetic theory.
Unit 5: Origin of Life - Chemical origin of life; RNA world hypothesis; Evolution of eukaryotes.
Unit 6: Speciation - Concept of species; Sympatric, Allopatric, Parapatric Speciation.
Unit 7: Introduction to Ecology - Basic concept, biotic and abiotic or physical factors.
Unit 8: Population - Attributes of population: Life tables, fecundity tables, survivorship curves, dispersal and dispersion, Geometric, exponential and logistic growth, equation and patterns
Unit 9: Community - Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect.
Unit 10: Ecological succession - Definition; Characteristics; Types; Examples.
Unit 11: Ecosystem - Ecosystem types and Biomes; Food chain; Energy flow through the ecosystem; Ecological pyramids.
Unit 12: Wild life Conservation - General idea of Wild life and it's conservation; *In-situ* and *ex-situ* conservation strategies.
Unit 13: Wildlife Reserves - Conservation of wild habitat, Sanctuary, Wild-life Reserve types with examples.
Unit 14: Tiger Conservation - Tiger reserves in India; Management strategies and challenges.

NEC-ZO--04: THEORY (4 Credit/100 Marks)
Insect Biology, Disease and Health and Nutrition

Unit 1: Insect – General features and basic classification; General morphology – head, eyes, mouth parts, legs and their adaptations.
Unit 2: Insect Physiology – Respiration and endocrine system, Sensory receptors, Growth and metamorphosis.
Unit 3: Insect-plant interaction, role of allo-chemicals in host plant.
Unit 4: Insect as mechanical and biochemical vectors, adaptations as vectors and host specificity.
Unit 5: Dipteran as disease vectors – mosquito, house-fly, sand-fly.
Unit 6: Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis.
Unit 7: Visceral and cutaneous Leishmaniasis, Phlebotomus fever; Myiasis.
Unit 8: Helminth Parasites – mechanism of infection and consequences.
Unit 9: Basic concept of food and nutrition; Concept of balanced diet and dietary pattern of various groups.
Unit 10: Nutritional biochemistry – Carbohydrate, Lipid, Protein definition, classification, dietary sources and importance.
Unit 11: Vitamins and Minerals – types, dietary sources, biological function and importance.
Unit 12: Major nutritional deficiency disorders – protein deficiency disorders, vitamin deficiency disorders, mineral deficiency disorders – remedial measures and government programmes.
Unit 13: Lifestyle health problems – hypertension, diabetes mellitus, obesity; Social health problems – smoking, alcoholism and drug dependence.
Unit 14: General concept of food hygiene; Different types of water borne infections and their prevention; Brief account of food spoilage and preventive measures.

SEC Papers offered by the Zoology Department

NSE-ZO-01: THEORY (4 Credit/100 Marks)
Sericulture

Unit-1: Introduction: Definition, history and present status; Silk route
Unit-2: Types of silk worms, Distribution and Races, Exotic and indigenous races
Unit-3: Mulberry and non-mulberry Sericulture
Unit-4: Biology of Silkworm; Life cycle of *Bombyx mori*
Unit-5: Structure of silk gland and secretion of silk
Unit-6: Rearing of Silkworms; Selection of mulberry variety and establishment of mulberry garden, Rearing house and rearing appliances
Unit-7: Disinfectants: Formalin, bleaching powder, RKO
Unit-8: Silkworm rearing technology: Early age and Late age rearing
Unit -9: Types of mountages Spinning, harvesting and storage of cocoons
Unit-10: Pests of silkworm: Uzi fly, Dermestid beetles and vertebrates.
Unit-11: Pathogenesis of silk worm diseases: Protozoan, viral, fungal and bacterial
Unit -12: Control and prevention of pests and diseases.
Unit-13: Entrepreneurship in Sericulture; Prospects of Sericulture in India.
Unit-14: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.

NSE-ZO-02: THEORY (4 Credit/100 Marks)
Aquarium Fish keeping

Unit-1: Introduction to Aquarium Fish Keeping
Unit-2: The potential scope of Aquarium Fish Industry as a Cottage Industry,
Unit-3: Exotic and Endemic species of Aquarium Fishes
Unit-4: Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes
Unit-5: Biology of Aquarium Fishes - Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish
Unit-6: Food and feeding of Aquarium fishes, Use of live fish feed organisms.
Unit-7: Preparation and composition of formulated fish feeds; Present advancement in fish feed formulation.
Unit-8: Aquarium Fish Diseases – viral, bacterial, protozoan, fungal and others.
Unit-9: Fish Transportation, Live fish transport – Fish handling, packing and forwarding techniques.
Unit-10: Maintenance of Aquarium, Budget for setting up an Aquarium Fish Farm as a Cottage Industry
Unit-11: Plants used in aquarium for beautification and other purposes
Unit-12: Entrepreneurship in Aquarium Fish keeping – local and export markets.
Unit-13: Use of biotechnology in advancements of modern aquarium fish keeping methods.

NSE-ZO-03: THEORY (4 Credit/100 Marks)
Medical and Forensic Entomology

Unit-1: Introduction – Impact of arthropods on human health
Unit-2: Concept of vectors - Mechanical vectors and biological vectors; General ideas of vector-borne disease and their control
Unit-3: Mosquitoes as vector - Mosquito borne diseases: Malaria, Dengue, Chikungunya and Filariasis (Biology, Symptoms and Treatments); Mosquito control measures
Unit-4: Houseflies as vector - Role in food-borne illness, Controlling the spread of houseflies and disease
Unit-5: Other flies - Sandflies and Leishmaniasis; Tsetse flies and Trypanosomiasis (diagnosis/types, risk-factors, treatment and prevention)

Unit-6: Ticks and Mites - General features; Differences between ticks and mites; Soft ticks and Hard ticks
Unit-7: Tick-borne diseases - Rickettsiosis and Tick-borne encephalitis
Unit-8: Fleas, Mites and Lice - Rat flea, Itch mite, Lice born disease - disease relationship and control measures
Unit-9: Forensic Entomology - A brief idea and status of Forensic Entomology, Subfields of forensic entomology
Unit-10: Forensically relevant insects and other arthropods – tools used and case studies
Unit-11: Insect succession on corpse; Post-mortem interval (PMI) estimation
Unit-12: Application of Forensic Entomology and its limitations
Unit-13: Methods of collection, preservation and analysis of insect vectors and forensic specimens.

MDC Paper offered by the Zoology Department for Other Subjects

NMD-ZO-01 – THEORY (Credit 4/100 Marks)
ZOOLOGY – Fundamentals of Zoology

Unit 1: What is Life; Domains of Life and Life forms; Animals as a life form.
Unit 2: Animal forms and functions – Basics of non-chordate and chordate life forms.
Unit 3: Cell as the unit of life; Cell organelles and their functions.
Unit 4: Genesis of Cell; Cell division – amitosis, mitosis and meiosis.
Unit 5: Fundamentals of heredity – Concepts of allele and Mendelism; Concept of Gene and DNA.
Unit 6: Concept of 'Central dogma' – DNA to Protein.
Unit 7: Primary concept of regulation of gene expression.
Unit 8: Enzymes as the catalysts of cellular metabolism; ATP as the energy currency.
Unit 9: Tissue as collection of cells and their functions; Organization and function of organs and systems.
Unit 10: Origin and evolution of life on earth; Darwinism as the evolutionary theory; Generation of species concept.
Unit 11: What is Ecology; Concepts of limiting factors, population, community and succession.
Unit 12: Primary concepts of ecosystem structure and function, Ecological services.
Unit 13: Distribution of animals on earth; Biomes and Zoogeographical realms.
Unit 14: Biodiversity meaning and importance; IUCN; Anthropocene and biodiversity loss.
Unit 15: Conservation meaning and strategies; Wildlife and biosphere reserves – example and importance.