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Syllabus

TRB Zoology

Unit I : ANIMAL DIVERSITY AND PHYLOGENY

- Concepts of species and hierarchical taxa, biological nomenclature. Levels of structural organization –Unicellular, colonial and multicellular forms. Organization of Coelom, Symmetry and Metamerism.
- Structure and life history of Protozoa – Entamoeba histolytica, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae, Plasmodium falciparum, Trypanosoma gambiense and Leishmania donovani.
- Canal systems in Porifera. Polymorphism and Metagenesis in Coelentrates.Types of Corals and Coral reefs.
- Structure and life history of helminth parasites – Fasciola hepatica, Taenia solium, Wuchereria bancrofti and Ascaris lumbricoides.
- Adaptive Radiation in Polychaetes. Torsion in Gastropods. Invertebrate larval forms and their evolutionary significance.
- Structure, affinities and life history of Minor Phyla – Ctenophora, Rotifera, Chaetognatha, Onychophora, Siphunculida, Entoprocta, Ectoprocta and Phoronida.
- Origin and outline classification of Chordata – Phylogeny, evolutionary significance and inter-relationships of Hemichordata, Urochordata and Cephalochordata and their relation with other deuterosomes. Retrogressive metamorphosis.
- Origin, Evolution and general characters of Agnatha (Ostracoderms and Cyclostomes). Early Gnathostomes (Placoderms).
- General characters and classification of fishes. Accessory respiratory organs in fishes. Adaptive Radiation in Bony fishes.
- Origin, Evolution and adaptive radiation of Amphibia. Parental care in Amphibia.
- Origin and evolution of Reptiles. Skulls of reptiles and its importance in biosystematics. Outline classification of Reptiles. Poisonous and Non poisonous snakes.
- Origin and evolution of Birds. Origin of flight and flight adaptations in birds. Flightless birds
- Origin of mammals. Primitive mammals – Prototheria, Metatheria and Eutherian Mammals. Aquatic adaptations in Mammals.
- Structure and functions of integument and its derivatives (glands, scales, feathers and hairs). Comparative account of jaw suspension, girdles and limbs. Comparative study of integument, brain, heart and urinogenital organs in Vertebrates.

Unit II ENTOMOLOGY AND ECONOMIC ZOOLOGY

- General characters and classification of Insects up to Order level with examples.
- Beneficial insects – Silkworm – common cultivable species, rearing of silkworm, diseases of silkworm, by-products of sericulture, economic importance of silk. Honeybees – common species of honeybees, rearing in modern hives, by-products of apiculture, economic importance of honey, beewax and propolis.
- Harmful insects– Insects as plant pests – pests of rice, cotton, sugarcane, coconut and stored grains. Pest control strategies – physical, mechanical, chemical and biological, IPM.

- Poultry farming – Breeds of Poultry for egg and meat, common diseases of poultry.
- Dairy farming –Economically important dairy cattle breeds of India, white revolution, diseases of cattle, dairy by-products.

Unit III CELL AND MOLECULAR BIOLOGY

- Cellular organization – Prokaryotic and Eukaryotic cells, Ultrastructure, organization and functions of cell membrane, Nucleus, Endoplasmic reticulum, Golgi bodies, Lysosomes, Mitochondria and Ribosomes. Structure and function of cytoskeleton and its role in mobility.
- Organization of Genes and Chromosomes – Structure of chromatin and chromosomes, heterochromatin, Euchromatin and Giant chromosomes.
- Cell division and cell cycle, regulation and control of cell cycle –Mitosis and meiosis, their regulation, steps in cell cycle, Significances of Mitosis and Meiosis, Mitotic Apparatus.
- Structure and function of DNA (A, B, C and Z forms) and RNA (tRNA, mRNA and rRNA). DNA replication and DNA repair mechanisms.
- RNA synthesis and processing – Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing and polyadenylation. Genetic code. Translation – components of protein synthetic machinery, steps involved in translation – formation of initiation complex, initiation factors and their regulation, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, elongation and elongation factors, termination and translational proof-reading, translational inhibitors, Post-translational modification of proteins.
- Control of gene expression at transcription and translation level –Regulating the expression of prokaryotic and eukaryotic genes – lac and trp Operon, role of chromatin in gene expression and gene silencing.
- Cellular communication – General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix and integrins.
- Cell signaling – Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers and regulation of Signaling pathways.
- Cancer – Types of cancer. Characteristics of cancer cells, Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and cell cycle, virus-induced cancer, physical and chemical carcinogenic agents, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth.
- Programmed cell death (Apoptosis), aging and senescence.

Unit IV GENETICS

- Mendelian principles – Dominance, segregation, independent assortment.
- Concept of gene – Allele, multiple alleles and pseudoalleles.
- Modern concept of gene – Cistron, Muton and Recon.
- Extensions of Mendelian principles – Codominance, incomplete dominance, gene interactions, Epistasis, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- Sex determination in man.

- Gene mapping methods – Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids.
- Cytoplasmic Inheritance – Inheritance of mitochondrial genes, maternal inheritance, shell coiling in Limnaea, Milk factor in mice, extra nuclear inheritance by endosymbionts – Kappa particles in Paramecium.
- Microbial genetics – Methods of genetic transfers –transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating.
- Human genetics – Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders and syndromes.
- Mutation – Types, causes and detection, mutant types –lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Significance of mutation.
- Structural and numerical alterations of chromosomes – Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
- Quantitative genetics –Polygenic inheritance, heritability and its measurements, QTL mapping.
- Recombination – Homologous and non-homologous recombination including transposition.
- Population genetics – Hardy-Weinberg equilibrium, derivation of Hardy Weinberg equilibrium, factors affecting Hardy-Weinberg equilibrium. Determination of allelic frequency in a population.
- Animal breeding – Inbreeding, Outbreeding and Heterosis.

Unit V. ANIMAL PHYSIOLOGY

- System Physiology – Digestion and absorption of Carbohydrates, Proteins and Lipids, BMR, Nutritional disorders.
- Blood and Circulation – Blood and its composition, function, haemopoiesis and haemostasis, mechanism of blood clotting.
- Cardiovascular system – Structure of myogenic heart, cardiac cycle, pacemaker, Pulse pressure and blood pressure, ECG.
- Blood vessels – Arteries, veins and lymphatic vessels.
- Respiratory Physiology – Respiratory structures – Invertebrates, vertebrates-fishes, birds and mammals. Respiratory pigments, Transport of gases, exchange of gases, neural and chemical regulation of respiration.
- Muscle Physiology – Types of muscle cells, ultrastructure of thestriated muscle fibre, physiology of muscle contraction.
- Neurophysiology – Central Nervous system, Peripheral and Autonomic nervous system. Structure of Neuron, types, transmission of nerve impulses, action potential, synapse, conduction of nerve impulse across a synapse, neurotransmitters, Neuroanatomy of the brain and spinal cord and Reflex action. EEG.
- Sensory Physiology – Receptors – Photoreceptors, Mechanoreceptors and Gustatoreceptors. Echolocation. Bioluminescence, Mimicry and colouration. Lateral line system in fishes.
- Renal Physiology – Ammonotelism, Uricotelism and Ureotelism process, structure of kidney and Nephron, Mechanism of urine formation, Counter current principle, micturition, regulation of water balance, electrolyte balance and acid-base balance.

- Thermoregulation and Stress adaptation – Thermoregulation in homeotherms, poikilotherms – acclimation and acclimatization, physical, chemical and neural regulation of body temperature, adaptation to high altitudes, deep sea adaptation.
- Endocrinology – Endocrine glands, mechanism of hormone action – peptide and steroid hormones, membrane receptors and signal transduction. Hormones and diseases, neuroendocrine regulation. Invertebrate hormones.

Unit VI. DEVELOPMENTAL BIOLOGY AND IMMUNOLOGY

- Gametogenesis, fertilization and early development – Production of gametes, cell surface molecules in sperm-egg recognition in animals, types of fertilization and mechanism of fertilization, embryo sac development and zygote formation, cleavage, blastula formation, embryonic fields, fate maps – presumptive organ forming areas, gastrulation and formation of germ layers and embryogenesis. Parthenogenesis.
- Morphogenesis and organogenesis – Ectodermal, Mesodermal and Endodermal derivatives, formation of primary organ rudiments, involvement of genes in the development process. Organogenesis with reference to brain, eye, heart and kidney in amphibians, birds and mammals. Post embryonic development-larval formation, metamorphosis (frog and insect).
- Regeneration – hydra, flatworms and salamanders. Aging and senescence. Stem cells – properties, types and applications.
- Human Reproduction – Reproductive organs, Menstrual cycle, Human Fertilisa-tion process, reasons for infertility and assisted reproductive technology (ART) – Intra Uterine Insemination (IUI), In vitro fertilization (IVF) and types – GIFT, ZIFT, ICSI and ET, Twins – types, Cryopreservation of gametes, Birth control methods.
- Immunology – Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes.
- General properties, structure, types and functions of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions.
- Primary and Secondary Lymphoid organs – 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, acquired immune-deficiencies.
- Vaccines and immunization schedule.
- Immune responses to bacterial, viral and parasitic infections.

Unit VII. ENVIRONMENT, CONSERVATION AND MANAGEMENT

- The Environment – Physical environment, biotic environment, biotic and abiotic interactions. Habitat and Niche – Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.
- Population Ecology – Characteristics of a population, population growth curves, population regulation, life history strategies (r and K selection), concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Species Interactions – Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

- Community Ecology – Nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones. Ecological Succession – Types, mechanisms, changes involved in succession, concept of climax.
- Ecosystem Ecology – Ecosystem structure, ecosystem function, energy flow and mineral cycling (C,N,P), primary production and decomposition, structure and function of some Indian ecosystems – terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).
- Biogeography – Major terrestrial biomes, theory of island biogeography, biogeographical zones of India.
- Biodiversity – Definition, types, Hotspots, Flagship species, Keystone species, Biodiversity concerns. Biodiversity conservation – In situ and ex situ conservation, concept of protected areas, National parks, sanctuaries, Red data book, Gene bank, threatened and endangered species. Salient features of Wildlife Protection Act, 1972 and Biological Diversity Act, 2002. Threats to survival and conservation strategies for Elephant, Tiger, Olive Ridley Sea Turtle, White Rumped Vulture and Gangetic Dolphin.
- Environmental issues – Pollution – definition, types, sources, effects. Global warming, climate change, glacial melting and rising sea levels, floods, drought and desertification, creating buffer zones, sustainable development, carbon sequestration, carbon sink, carbon foot print, carbon credit, carbon trading and carbon budget. Environmental Exploitation – Exploitation and depletion of natural resources. Urbanisation, deforestation, habitat loss, remote sensing and GIS in conservation.
- Environmental Management – Environmental Summits – Conventions, Climate change conventions, Environmental laws and Acts. E-wastes and its eradication. Clean energy sources – solar, wind, hydel, biofuel, hydrogen as fuel. Effluent Management – Hazardous and biomedical waste management. Emission standards – BS6, AQI, WQI. Clean potable water – Desalination, rain water harvesting,conserving water bodies.

Unit VIII. EVOLUTIONARY PRINCIPLES AND ANIMAL BEHAVIOUR

- Emergence of evolutionary thoughts – Lamarck, Darwin–concepts of variation, adaptation, struggle, fitness and natural selection, Spontaneity of mutations, the evolutionary synthesis.
- Origin of cells and unicellular evolution – Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane, Urey-Miller Experiment, The first cell, Evolution of prokaryotes, Origin of eukaryotic cells.
- Paleontology and Evolutionary History – The evolutionary time scale, Major events in the evolutionary time scale, Stages in primate evolution. Evolution of Man. Human racial diversity.
- Molecular Evolution – Concepts of neutral evolution, molecular divergence and molecular clocks, Molecular tools in phylogeny, classification and identification, Protein and nucleotide sequence analysis, origin of new genes and proteins, Gene duplication and divergence.
- Adaptive radiation, Isolating mechanisms, Speciation, Allopatric and Sympatric, Convergent evolution, Sexual selection, Co-evolution.
- Brain, Behaviour and Evolution – Approaches and methods in the study of behaviour, Proximate and ultimate causation, Altruism and evolution-Group selection, Kin selection, Reciprocal altruism.
- Neural basis of learning, memory, cognition, sleep and arousal, Biological clocks.

- Development of behaviour, Social communication, Social dominance, Use of space and territoriality, Mating systems, Parental investment and Reproductive success, Parental care, Aggressive behaviour, Habitat selection and optimality in foraging, Migration, orientation and navigation, Domestication and behavioural changes.

Unit IX. BIOPHYSICS AND BIOCHEMISTRY

- Structure of atoms, molecules and chemical bonds.
- Stabilizing interactions – Vander Waals, electrostatic, hydrogen bonding, hydrophobic interactions etc.
- Principles of biophysical chemistry – pH, buffer reaction kinetics, thermo-dynamics and colligative properties.
- Composition, structure and functions of biomolecules – Carbohydrates, Proteins, Lipids, Nucleic acids and Vitamins.
- Bioenergetics, glycolysis, oxidative phosphorylation, couples reaction, group transfer, biological energy transducers.
- Principle of catalysis, enzyme classification and enzyme kinetics, enzyme regulators, mechanism of enzyme action, isozymes, coenzymes and cofactors, enzyme inhibitors and inhibition. Metabolism of Carbohydrates, Proteins and Lipids.

Unit X. BIOSTATISTICS

- Collection of Data – Primary data and Secondary data, Methods of collecting Primary data and Sources of Secondary data, Concept of Statistical Population and Sample, Census and Sampling Methods. Variable – Discrete and Continuous.
- Classification of Data – Types of classification, Characteristics of Frequency Distribution.
- Presentation of Data – Tabulation – Parts and types of tables. Diagrams – One dimensional diagrams – Bar diagram, Two-dimensional diagrams – Pie Chart. Graphs – Histogram, Frequency Polygon, Frequency Curve, Ogives.
- Descriptive Statistics – Measures of Central Tendency – Arithmetic Mean, Median and Mode (Properties and Computation for unclassified, discrete and continuous data).
- Measures of Dispersion – Range, Quartile Deviation, Mean Deviation and Standard Deviation (Properties and Computation for unclassified, discrete and continuous data).
- Correlation – types, methods for measuring correlation and computation of Karl Pearson's coefficient and Spearman's rank correlation.
- Simple Regression – Regression coefficients, Regression equations (including computation), Regression lines.
- Probability – Addition and Multiplication rule, Permutation and Combination. Probability distributions – Binomial, Poisson and Normal distributions, Properties of Normal distribution.
- Inferential Statistics – Hypothesis testing – Null and alternative hypothesis, Levels of Significance, Degrees of freedom, errors. Parametric and Non parametric tests – Steps in hypothesis testing.
- Student's 't' test – Population and Sample Means, Means of Independent samples, Means of Dependent samples.
- Chi square test for predicted expected values and goodness of fit for pre fixed ratio.
- F-test and ANOVA – One way and Two way analysis.

Unit XI. BIOTECHNOLOGY

- Recombinant DNA technology – Molecular tools, host cells, Isolation and purification of nucleic acids, Cloning vectors, methods of gene transfer. Gene cloning strategies, Blotting techniques, PCR, gene libraries, screening strategies. DNA sequencing methods, Protein sequencing methods, methods for analysis of gene expression at RNA and protein level, large scale expression, microarray based techniques. Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques. Human Genome project.
- Biotechnology in health care – Gene therapy, DNA in the diagnosis of genetic diseases. DNA finger printing. Pharmaceutical Products of DNA Technology – Human protein replacements and therapeutic agents for human diseases. Insulin, Recombinant vaccines, production of monoclonal antibodies.
- Microbial Fermentation Technology – Production of low and high molecular weight compounds. Enzyme Technology – Commercial production of enzymes, immobilization of enzymes and cells, therapeutic applications, Biosensors, Bioreactors.
- Animal cell culture methods and Applications,Transgenic animals.
- Biodegradation and Bioremediation. IPR, Patenting, Trade Mark, Copy rights. GMOs and GM foods–Pros and Cons. Microbial warfare, Microbial weapons, bioterrorism.

Unit XII. TOOLS AND TECHNIQUES IN BIOLOGY

- Histochemical and Immuno techniques – Antibody generation, Detection of molecules using ELISA, RIA, immunoprecipitation, flow cytometry and immune fluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.
- Biophysical Method – Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
- Radiolabeling techniques – Detection and measurement of different types of radioisotopes normally used in Biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
- Microscopic techniques – Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.