

KERALA PUBLIC SERVICE COMMISSION

SYLLABUS FOR THE POST OF RANGE FOREST OFFICER IN KERALA FOREST & WILDLIFE DEPARTMENT

Optional subject- Zoology

Module I: Diversity of Animals (Weightage: 10 marks)

Lower Metazoans: Porifera, Cnidaria-Polymorphism, Ctenophora, Platyhelminthes, Nematelminthes, Annelida, Arthropoda, Mollusca and Echinoderms: Classification with examples. Hemichordates: Position in the animal kingdom, Chordates: Cephalochordates and Urochordates. Vertebrate Phylogeny-Agnatha, Ostracoderms and Gnathostomes Placoderms, Acanthodians, Chondrichthyes and Osteichthyes. Structural and Functional adaptations of fishes. Terrestrial Vertebrates: Tetrapod phylogeny - modern Amphibians, diversity, distribution, status and threats. Reptiles- diversity, Birds and Mammals: diversity. Class Mammalia: Prototheria, Metatheria and Eutheria. Phylogeny of Mammalian orders. Scientific names and common names of organisms under all phylums.

Module II: Wildlife Biology and Conservation (Weightage: 25 marks)

Definition of Wildlife, Values of Wildlife. Need of Wildlife Conservation. Wildlife habitats - Forest Habitat (eg: Shola forest of Western Ghat); Desert Habitat (eg: Thar Desert); Aquatic habitat (eg: Vembanad lake); Wetland habitat (eg: Sunderbans delta); Mangrove habitat (eg: Pichavaram mangrove forest). Mention Biodiversity Hotspots in India. Ecological significance of Keystone species, Edge species and Umbrella species. *In-situ* conservation -National Parks, Biosphere reserves, Wildlife Sanctuaries, Mangrove forests with examples in India and Kerala (Brief description). *Ex-situ* conservation- Zoological Parks with examples in India and Kerala, Captive breeding (Brief description with examples). IUCN Red Data Book Project Tiger, Project Elephant, Project Cheetah, Project Rhino and Project Crocodile. Wildlife conservation organizations, agencies and schemes - WWF, Nagar Van Yojana (NVY), BNHS, Wildlife Conservation Society(WCS), IUCN, ASEAN-WEN. Indian Wildlife (Protection) Act, 1972; Biological Diversity Act of 2002.

Major threats to Wildlife: Habitat loss and fragmentation, Over exploitation, Climate change, Poaching, Pollution. Invasive species. Man-animal conflict and its management. Wildlife monitoring (Brief account) — Direct count (Block count, Transect methods, Point counts, Visual encounter survey, Waterhole survey), Indirect count (Call count, track and signs, pellet count, pugmark, camera trap, M-stripe). Wildlife Research Institutes- KFRI, KSBB, IIFM, Salim Ali Centre for Ornithology and Natural History (SACON).

Module III: Wildlife Ecology (Weightage: 25 marks)

Definition and scope of wildlife ecology, Different types of forests. Ecological Principles: Population dynamics: growth, regulation, and interactions; Community ecology: species interactions, trophic levels, and biodiversity. Ecological Principles: Population dynamics: growth, regulation, and interactions; Community ecology: species interactions, trophic levels, and biodiversity. Wildlife Adaptations; Behavioural and physiological adaptations of wildlife species; Adaptations to different habitats and environmental conditions. Population Monitoring Techniques: Sampling methods: Direct count, (Block count, Transect methods, Point count, Visual encounter survey, Waterhole survey), Indirect count (Cell count, Track and signs, Pellet count, Pug mark and Camera count) and remote sensing and GIS applications in wildlife research. Migration and Dispersal: Causes and patterns of migration; Ecological significance of dispersal in wildlife populations. Communication and Social Organization: Types of communication in wildlife; Social structure and organization in wildlife populations. Territoriality and Home Range: Concepts of territoriality and home range, Factors influencing territory size and shape. Human-Wildlife Interactions: Understanding human-wildlife interactions; Impacts of human activities on wildlife behaviour and ecology. Conservation Strategies: Protected areas: types, design, and management; Habitat conservation: restoration, enhancement, and creation (*In-situ* and *Ex-situ* Conservation strategies). Community-Based Conservation: Principles and approaches of community-based conservation –in India and Kerala. Wildlife Laws and Policies: Overview of wildlife laws and policies in India; IWPA 1972 and its ramifications; Role of international conventions and treaties in wildlife conservation (Brief Account only) Gadgil Commission & Kasturirangan Commission. Threatened Species Conservation; Conservation status and threats to endangered species; Conservation efforts for flagship and keystone species; Control of Invasive species in forests with special reference to Kerala Forests. Wildlife Management Techniques: Population control methods: culling, contraception, and translocation; Disease management in wildlife populations. Human-Wildlife Conflict Management: Causes and mitigation strategies for human-wildlife conflicts. Conflict resolution through stakeholder

engagement and conflict-sensitive conservation. Environmental Impact Assessment: Principles and procedures of EIA; Role of wildlife ecology in EIA for development projects. Research Techniques in Wildlife Ecology: Field research methods: trapping, tracking, and observation techniques; Non-invasive studies eDNA, Photogrammetry and AI. Data analysis and interpretation for wildlife ecology research.

Module IV: Biochemistry (Weightage: 10 marks)

Carbohydrates: Structure, classification monosaccharides (trioses, tetroses, pentoses, hexoses, aldoses, ketoses), Disaccharides, polysaccharides, (homo and heteropolysaccharides) and biological importance of carbohydrates. Proteins: Structure, classification of amino acids and protein, structure levels of proteins, Primary, Secondary (α -helix, sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins., haemoglobin as atypical protein, Denaturation, Renaturation and biological functions of proteins Lipids: classification- simple lipids, (neutral fats and waxes), conjugated lipids (phospholipids, sphingolipids, glycolipids, lecithin, cephalins, cerebrosides, gangliosides), derived lipids (fatty acids, steroids, prostaglandins), biological functions of lipids. : Carbohydrate metabolism – glycogenesis, glycogenolysis, gluconeogenesis, hexose monophosphate shunt, metabolic pathway of glucose- glycolysis, Krebs cycle, Electron transport series, chemiosmotic theory, energetics: hormonal control of carbohydrate metabolism. : Carbohydrate metabolism – glycogenesis, glycogenolysis, gluconeogenesis, hexose monophosphate shunt, metabolic pathway of glucose- glycolysis, Krebs cycle, Electron transport series, chemiosmotic theory, energetics: hormonal control of carbohydrate metabolism. Lipid metabolism: Lipid metabolism – hydrolysis of lipid, beta-oxidation, mention alpha and omega oxidation of fatty acids, hormonal control of lipid metabolism. Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action. Iso enzymes, Clinical uses of Isoenzymes, co-enzyme, enzyme activation and inhibition. Enzyme kinetics; Chemical nature, mechanism of enzyme action Equation of Michaelis-Menten. Factors affecting rate of enzyme catalyzed reactions; Concept of K_m and V_{max} .

Module V: Evolution, Ethology and Chronobiology (Weightage: 15 marks)

Evolution: The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, genome evolution. Geological Timescale. Major events in evolutionary timescale. Tools and techniques in estimating evolutionary time scale. Mass extinction and its consequences. Fossils- fossilization and its significance, Types of fossilization. Population Genetics. Gene pool, gene frequency, Hardy-Weinberg Law. Rate of

change in gene frequency through natural selection, migration and random genetic drift. Founder effect. Cytogenetic and molecular basis of origin of Man-African origin of modern man- Mitochondrial Eve, Y chromosomal Adam

Ethology: Definition; Importance of studying animal behaviour, Ethology - Origin and history (Brief description); Ethologists: Karl Von Frisch, Ivan Pavlov, Konrad Lorenz, Nikolaas Tinbergen. Types of Behaviour – Stereotyped behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct vs learned behaviour, Associative learning – classical, operant conditioning. Habituation and imprinting. Social organization of vertebrates (example-Primates). Types of reproductive Behaviour (Brief account), Mate choice, Intra and inter sexual selection (male rivalry and female choice). Sexual conflicts during parental care

Chronobiology: Biological oscillation (concept of average, amplitude, phase and period). Biological rhythm – characteristics; types – short- and long-term rhythms, circadian rhythms, tidal rhythms and lunar rhythms; Circannual. Biological clock. Concept of synchronisation and masking; Zeitgeber, photic and nonphotic zeitgebers. Photoperiod and regulation of seasonal reproduction of vertebrates; mention role of melatonin. Relevance of Biological clock in Chrono-pharmacology; Chronomedicine and Chronotherapy.

Module VI: Animal Physiology (Weightage: 25 marks)

Nutrition: Constituents of normal diet and their daily requirements. Physiological calorie value of food stuffs. Mechanism of Digestion. Mechanism of absorption of monosaccharides, amino acids and lipids and vitamins. The role of hormones and neurotransmitters in the control of gastrointestinal Motility. Energy balance and obesity- causes and consequences. BMR and its significance.

Excretory System: Introduction: Brief description of different types of excretory organs in different animal groups (flame cells, green glands, malpighian tubules). Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus- structure, parts and function. Urine formation (glomerular filtration, tubular reabsorption and tubular secretion) Regulation of water balance -Mechanism of concentration of urine – Counter Current system. Renal regulation of acid- base balance & electrolyte balance. Micturition reflex.

Respiratory system: Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia). Physiological anatomy and histology of respiratory passage and lungs. Mechanism of pulmonary ventilation (inspiration & expiration). Alveolar ventilation. Role of surfactant in alveolar expansion. Pulmonary volumes and capacities – definition & normal values (tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, functional residual capacity, inspiratory capacity, vital capacity,

total lung capacity). Exchange of gases- partial pressures involved-lung and tissues. Oxygen dissociation curve – factors affecting binding of oxygen to haemoglobin (PO_2 , PCO_2 , CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin). Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

Nervous system: Organisation of human brain. Cerebrum and cerebral lobe. Cerebral cortex and its functional areas. Cortical white matter. Brain stem, Cerebellum, Diencephalon. Functional brain systems - Limbic system and reticular formation. Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function. Diseased states of brain - schizophrenia, Alzheimer's disease, Senile dementia & Parkinson's disease. Memory- types of memory- somatosensory, short term, intermediate long term and Long term memory, consolidation of memory. PNS and Autonomic nervous system. Spinal cord – structure. Reflex action, reflex arc.

Special senses: Vision: Structure of eyeball, Fluid systems of the eye, Layers of Retina and photoreceptors (rods & cones). Neuronal cell types and neural circuitry of the retina and visual pathways from retina to visual cortex Image formation. Hearing: Structure of Ear, Mechanism of hearing, Mechanism of balance. Taste: Primary sensations of taste. Taste buds, Physiology of taste, Smell: Olfactory membrane and receptor cells Physiology of olfaction, Tactile response: Mechanoreceptor, Pain receptors, Thermal receptors.

Cardiovascular system: Structural organization of myogenic heart (in human beings). Physiological anatomy of cardiac muscle – specialized tissue. Cardiac cycle. Neural and chemical regulation of heart function. Blood volume and blood pressure. Physiological anatomy of coronary blood flow, Ischemic heart disease. Lymphatic System. Lymph channels of the body. Composition and formation of lymph. Functions of lymph and lymphatic system including.

Muscle physiology: Skeletal, Smooth and Cardiac muscles, physiology of muscle contraction, muscle proteins, molecular mechanism of muscle contraction, muscle twitch, rigor mortis, summation.

Endocrinology: Vertebrate endocrine system. Endocrine glands. Synthesis, physiologic role, control and mechanisms of hormone action. Neuro-endocrine regulation of hormone action. Disorders of hormonal imbalance in Man.

Reproductive physiology: Anatomy and histology of adult testis and ovary. Reproductive cycles of mammals and their hormonal control. Physiology of implantation, pregnancy, parturition, and lactation.

Module VII: Immunology (Weightage: 10marks)

Types of immunity: Innate and Acquired immunity, Active immunity and Passive immunity, Cell-mediated immunity and Humoral immunity. Cells involved in Immunity (B cell and T cells): Types and functions. Interferons and MHCs: Organisation of MHC locus in mice and humans. Lymphoid Organs: Primary and Secondary. Immunoglobulins: Structure, Types and functions. Complement system: Classical, Alternate and Lectin pathways. Active and Passive Immunisation: Types of vaccines (Inactivated vaccines, Attenuated vaccines, DNA vaccines, mRNA vaccines, and Conjugate vaccines). Types of Hypersensitivity: Gell and Coombs classification. Autoimmunity: Rheumatoid arthritis and Lupus erythematosus (Brief account). Immunodeficiency diseases: Types of immunodeficiency diseases (DiGeorge syndrome, Selective IgA deficiency and AIDS). Transplantation Immunity: Types of grafts, Immunological basis of transplantation reactions, and Immunosuppression. Immunological techniques for infectious disease diagnosis: Widal test, ELISA, FISH and GISH. Hematopoiesis and its regulation. Monoclonal Antibodies. Production of Monoclonal Antibodies (Hybridoma technology). Clinical uses of Monoclonal Antibodies.

Module VIII: Developmental Biology (Weightage: 10 marks)

Gametogenesis, fertilization and early development: Production of gametes- Spermatogenesis and Oogenesis, Ultrastructure of gametes, Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals) Zygote formation-Encounter of sperm and egg, Capacitation, Acrosome reaction, Activation of ovum, Amphimixis, Prevention of Polyspermy, Cleavage and blastula formation; Gastrulation in humans. Morphogenetic movements: Epiboly and Emboly (Invagination, Involution, Infiltration, Ingression, Delamination, Convergence, Divergence). Cell fate and cell lineages. The stem cell concept- Progenitor cells, Adult stem cells, Mesenchymal stem cells, Multipotent adult stem cells, Pluripotent Embryonic stem cells. Significance of organizer and embryonic induction. Assisted Reproductive Techniques: GIFT, ZIFT, TET, ICSI.

Module IX: Genetics (Weightage: 10 marks)

Mendel's experiments: Law of inheritance, Law of segregation and Law of independent assortment. Gene concept, Different types of genes, One gene - one enzyme concept. Interaction of genes, Allelic-incomplete dominance, Lethal genes and Codominance, Epistasis - dominant and recessive, Lethal alleles, Polygenic inheritance (Skin colour in humans), Pleiotropism and Multiple alleles, ABO Blood group system. Cytogenetics; Linkage (Complete and Incomplete linkage), Significance of linkage. Crossing over -

Mechanism and its importance. Chromosome mapping, Pedigree Analysis (Brief account only). Sex-linked, Sex-limited, and Sex-influenced inheritance in animals. Mutation: Spontaneous and induced mutation. Structural chromosomal aberrations (Duplications, Deletions, Inversions and Translocations) and Numerical chromosomal aberrations (Aneuploidy, Euploidy and Polyploidy). Chromosomal anomalies in man: Autosomal (e.g. Down syndrome, Edwards syndrome) and autosomal (e.g. Klinefelters syndrome, Turner's syndrome). Sex determining mechanism - Sex chromosomal mechanism (XX-XY, XX-XO, ZZ-ZW). Genic balance theory, Environmental factors on sex determination, Hormonal control of sex differentiation. Mention Barr bodies, Dosage compensation and Lyon hypothesis, Sex mosaicism, Gynandromorph and Intersex.

Module X: Biotechnology (Weightage: 10 marks)

Genetic engineering and recombinant DNA technology, Steps involved in rDNA technology. Essential tools in recombinant DNA technique: DNA modifying enzymes, Restriction endonucleases, Ligases, Polymerases, and Alkaline phosphatase. Vectors used for cloning and their applications: Plasmidvector, Cosmid vector, Phage vector, BACs, YACs, Expression vectors. Gene transfer techniques: Electroporation, Lipofection, Ultrasonication and Microinjection (Brief account only). Mention gene gun. Screening of Transformants: Antibiotic Selection and Blue/White Screening Methods. cDNA library and genomic library (Brief account only). Techniques in Biotechnology Polymerase Chain Reaction: Basic steps and applications of PCR. Mention RT-PCR and its diagnostic value. Hybridoma technology and monoclonal antibodies. Blotting Techniques: Southern, Northern and Western blotting. Mention DNA fingerprinting. Molecular hybridisation techniques for genome analysis: RFLP, AFLP, RAPD (Brief account only). Human Genome Project. DNA sequencing (Sanger method and Automated sequencing). Recent trends in Gene technology: Gene Targeting (Knock-ins and Knockouts). Targeted Genome Editing (CRISPRs-Cas9). Application of biotechnology in the industry (Eg. Bioprocess and Fermentation Technology), Environment (Eg. Bioremediation) and Medical sectors (Eg. Recombinant insulin production). Food and Agriculture: Application of biotechnology in food (Eg. Single-cell protein) and agriculture sectors (Eg. Genetically modified crops and transgenic animals).

Module XI: Ecology and Disaster Management (Weightage: 25 marks)

Concept of an ecosystem. Interrelationships between the living world and the environment. Structure of an ecosystem: Brief account on abiotic and biotic factors. Primary production and energy flow in an ecosystem. Pond as a typical ecosystem (Trophic relationships, producers, consumers and decomposers). Population Ecology: Characteristics of a population. Ecotypes. A brief account of metapopulation. Exponential and logistic growth, equation and patterns, r and K strategies. Population regulation– density-dependent and independent factors. Community Ecology: Community characteristics: stratification, species diversity, species abundance, species dominance community periodicity. Brief accounts on a niche, trophic level and guild. Ecological succession: Types and different stages. Eg. Succession in an aquatic ecosystem. Environmental Pollution: Types of pollution (Air, water, and soil). Sources of pollution, eutrophication, effects of pollution on the ecosystem, pollution indicators. Control and management (bioremediation, sewage treatment, green chemistry). Air pollution mapping software (eg. AirNow, IQAir, AirVisual). Sustainable development, ecosystem approach. Environment Impact Assessment, pollution sensors, green audit.

Disaster management: Disaster: Definition. Classification of disasters- human-induced and natural. Natural Hazards (Cyclone, Tsunami, Heat Wave, Landslide, Urban Floods, Floods and Earthquakes). Man-made hazards (Chemical, nuclear and biological). Cause and impact of disasters Disaster management: Prevention, mitigation strategies, preparedness. Policies and agencies: National Disaster Management Plan, 2019, Kerala State Disaster Management Plan, 2016. Kerala State Disaster Management Authority (KSDMA) and National Disaster Management Authority (NDMA). Need of Disaster management strategies: A case study on Kerala flood 2018. Role of Information Technology in Disasters

Module XII: Cell Biology (Weightage: 15 marks)

Cell: Characteristics of a prokaryotic cell and a eukaryotic cell. Fluid mosaic model of the plasma membrane. Cytoskeleton: Microtubules, Microfilaments and intermediate filaments. Endomembrane Systems: Brief account of structure and functions of endoplasmic reticulum, Golgi apparatus, Lysosome, and Vacuoles. Ribosomes: Basic structure and function. Mention types (Prokaryotic ribosomes, Archaeal ribosomes, Eukaryotic ribosomes). Ribosome locations (Free ribosomes and Membrane-bound ribosomes). Mitochondria: Structure (Outer and inner membranes), Functions. Mention mitochondrial diseases. Nucleus: Structure of interphase nucleus, Chromatin (Euchromatin and Heterochromatin), Nucleolus, Structure of a metaphase chromosome. Brief accounts of giant chromosomes (Polytene chromosomes, Lamp brush chromosomes). Cellular Processes (Cell Growth and Division): Cell cycle - Stages (G1, S, G2 and M phases), Mitosis and meiosis. Cell cycle regulation. Cellular Transport Mechanisms: Passive and active transport, Endocytosis, Exocytosis, and Vesicle trafficking. Cell Signalling: Concept of cell communication. Brief accounts on cell signalling pathways and receptor-ligand interactions. Extracellular (Glucagon), Intracellular (Cyclic AMP), and Intercellular (Calcium) messengers. Types of Signalling Molecules: Hormones, Neurotransmitters, Growth factors, Cytokines, and Extracellular matrix components.. Modes of Cellular Signalling: Mention Endocrine signalling, Paracrine signalling, Autocrine signalling and Synaptic signalling. Signal Transduction Pathways: Signalling molecules (ligands), cell surface receptors, intracellular signalling molecules (e.g., kinases, second messengers), and target proteins (e.g., transcription factors). Examples of common signalling pathways - MAPK (mitogen-activated protein kinase) pathway, the PI3K/Akt pathway, and the cAMP (cyclic adenosine monophosphate) pathway.

Module XIII: Molecular Biology (Weightage: 10 marks)

Nucleic Acids: Nucleic Acids: Molecular composition, Nucleic acid sequences, Types (DNA, RNA, Mention Artificial nucleic acids). DNA: Typical structure; Alternative forms of DNA (A DNA, B DNA, Z DNA); Brief account of biological functions. RNA: Structure of tRNA (Cloverleaf model), Types of RNA (Messenger RNA, Ribosomal RNA, Signal recognition particle RNA, Transfer RNA, Transfer-Messenger RNA). Biological functions of RNA. Central Dogma of Molecular Biology: Definition, Central dogma reverse (Teminism), One gene-one enzyme hypothesis, One gene-one polypeptide hypothesis. DNA Replication: DNA replication in Prokaryotes and Eukaryotes (Proof for Semi-conservative model, Messelson and Stahl experiment). Transcription: Brief account of transcription in Prokaryotes and Eukaryotes. Mention reverse transcription and post-transcriptional modifications. Genetic Code: Concept of genetic code. Mention codons. Characteristics of genetic code (Reading frame and start and stopcodons). ble hypothesis. Translation: Steps and basic mechanism of translation in prokaryotes and eukaryotes. Gene Regulation: Operon, Inducible and repressible Operon system, lac operon, trp operon.

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.

Distribution of Weightage of marks

Module I: Diversity of Animals (Weightage: 10 marks)

Module II: Wildlife Biology and Conservation (Weightage: 25 marks)

Module III: Wildlife Ecology (Weightage: 25 marks)

Module IV: Biochemistry (Weightage: 10 marks)

Module V: Evolution, Ethology and Chronobiology (Weightage: 15 marks)

Module VI: Animal Physiology (Weightage: 25 marks)

Module VII: Immunology (Weightage: 10 marks)

Module VIII: Developmental Biology (Weightage: 10 marks)

Module IX: Genetics (Weightage: 10 marks)

Module X: Biotechnology (Weightage: 10 marks)

Module XI: Ecology and Disaster Management (Weightage: 25 marks)

Module XII: Cell Biology (Weightage: 15 marks)

Module XIII: Molecular Biology (Weightage: 10 marks)