

RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER

SYLLABUS OF COMPETITIVE EXAMINATION FOR THE POST OF SENIOR SCIENTIFIC OFFICER BIOLOGY DIVISION (M.Sc. ZOOLOGY) STATE FORENSIC SCIENCE LABORATORY (HOME DEPARTMENT)

UNIT-I

CELL STRUCTURE, MOLECULES AND THEIR INTERACTION:

- Structural organization and functions of cell organelles: Plasma membrane, intracellular organelles (Nucleus, Mitochondria, Golgi-bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes) and types and structure of Chromosomes
- pH, buffer and buffer system.
- Bio-molecules-Structure, composition and function (carbohydrates, lipids, proteins and nucleic acids)
- Enzymes- types and their functions, regulation, enzyme inhibition, iso-enzymes.
- Structure and Functions of nucleic acids, Processes of DNA Replication, Transcription and Translation.
- Cell division and cell cycle in eukaryotic organisms.

UNIT-II

HUMAN ANATOMY AND PHYSIOLOGY:

- Tissues of body: epithelia and glands, their classification and functions, connective tissues, cartilage- structure and types,
- Bones- formation, gross structure, fracture and healing, Structure and growth of teeth, types, dentition-pattern and formula, eruption sequence and age determination, dental anomalies and their significance in personal identification, bite marks of human/animals and their analysis.
- Structure and functions of major organ systems and their physiology- Integumentary, digestive, skeleton, respiratory, endocrine, nervous, cardiovascular, excretory, reproductive, muscular and neuromuscular systems, blood physiology.

UNIT-III

ECOLOGY, ENVIRONMENT AND MICROBIOLOGY:

- Ecosystem and their types, ecological factors, types of pollution,

- Types of waste, BOD, COD, effect on human health, algal blooms and identification and composition, eutrophication and their effects.
- Various types of planktons and diatoms. Diatom tests and its importance in drowning cases, precautions in collection, preservation and forwarding of biological samples for diatom test, methods of isolation of diatoms from different body tissues/bone marrow and water samples.
- Isolation and classification of various microbes from soil, water and food. Cell structure of bacteria and fungi, spores.

UNIT IV

ANIMAL CLASSIFICATION AND BASIC GENETICS:

- Chemotaxonomy, Cytotaxonomy, Molecular Taxonomy and General classification of Animals (classification of Invertebrates up to order, classification of chordates up to class)
- Mendelian and non-mendelian inheritance, linkage, recombination and crossing over, chromosomal basis of inheritance, sex linked inheritance, chromosomal aberration.

UNIT- V

FORENSIC TECHNIQUES: ANTHROPOLOGY

- Anatomical description of skeletons of human and animals as relevant to forensics, ossification and identification of bones for determination of age, sex, race, stature etc. forensic anthropometry/osteometry and tools involved.
- Determination of personal identity - sex differences in skull, pelvis and other bones. Calculation of stature from long bones, identification of burnt bones. Recovery and identification of skeletal remains in accidents, crimes and mass disasters.
- Recovery, packing and storage of fleshed and burnt bone remains of human/ animal of forensic importance.
- Facial reconstruction and superimposition techniques, Craniofacial superimposition techniques as photographic and video superimposition.

UNIT-VI

TOOLS AND TECHNIQUES IN BIOLOGY:

- Microscopy: Principles and working of Compound, Comparison, Phase-contrast, stereo-zoom, Polarizing, Fluorescence, confocal microscopy, Scanning electron and transmission electron microscope
- Spectroscopy: Colorimeter analysis and UV light source Principle and significance of UV-Vis spectroscopy, Fluorescence spectroscopy, FRET, Luminescence, Circular Dichroism, Infra-Red spectroscopy, Raman

spectroscopy, Nuclear Magnetic Resonance, X-ray diffraction, Mass spectrometry

- Tissue preparation (1) Fixation and preparation of FFPE blocks (2) Sectioning by rotary microtome, cryostat, vibratome and ultrathin sectioning. (3) Staining: Various staining techniques- simple and double staining, histochemical staining for bio molecules, decalcification of bones and tooth, immunocytochemical staining.
- Electrophoresis: Principle, Agarose and Polyacrylamide gels, Capillary electrophoresis, buffers, staining of the gel
- Statistical analysis - Sample collection and processing, regression and correlation, ANOVA, probability, t-test, importance of p-value, Chi square test.
- Immunological techniques: Immuno-electrophoresis, immune-precipitation, agglutination, RIA, ELISA, FACS, immune-fluorescence microscopy, Immuno-electron microscopy, Fluorescence In-situ hybridization (FISH), Chromatin immuno-precipitation.

UNIT-VII

CRIME SCENE MANAGEMENT & ACTS:

- Introduction to the crime scene and their types.
- Securing and documenting the crime scene (Note making, Sketching, Photography, videography of crime scene)
- Crime Scene Processing: Evaluation of crime scene, role of the first arriving officer at the crime scene, Searching techniques of Crime scene
- Processing of physical evidence: discovering, recognizing and examination of physical evidence, Collection, Safety measures for evidence collection
- Introduction to physical evidence, Types of physical evidence, classification and Role of physical evidence in Criminal Investigations & Trails
- Preservation, packaging, sealing, labelling and forwarding of physical evidence, maintaining the chain of custody
- Reconstruction of crime scene.
- Forensic aspects of The Bharatiya Nyaya (Second) Sanhita, Bharatiya Nagarik Suraksha Sanhita and the Bharatiya Sakshya Act, The Criminal Procedure (Identification) Act

UNIT-VIII

EXAMINATION OF BODY FLUIDS & THEIR STAINS:

- Introduction to Body Fluids and Their Forensic Significance: An overview of various body fluids such as semen, saliva, urine, perspiration, faeces, vomit, and vaginal secretions, along with their role in forensic investigations.
- Identification and Examination of Seminal Stains: composition, occurrence, physical pattern, and forensic significance of seminal stains, along with their identification using presumptive tests (U.V. test, Florence test, Spermine (Barberio) test, Choline test, Acid Phosphatase test) and confirmatory tests (p-30, Prostate-Specific Antigen (PSA), Microscopic examination), Morphological and Biochemical Examination of Spermatozoa.
- Examination of Other Physiological Fluids: Forensic identification and examination of saliva, urine, perspiration, faeces, vomit, and vaginal secretions using appropriate presumptive and confirmatory tests, Identification of Lochial and Menstrual Blood Stains, Importance of Secretor and Non-Secretor Status
- Immunology and related techniques: Innate and Adaptive immunity, B cell / T cell –structure, development, diversity and recognition. Antigen and Antibodies –structure, types and function of antibody, monoclonal antibodies, antigen, hapten, adjuvants, antigen-antibody interaction and their application. Blood groups- ABO, MN, Rh polymorphic blood groups, Presumptive & Confirmatory Tests for blood and its origin: precipitin test (diffusion method)., Application of ABO blood group in disputed paternity cases, polymorphic enzymes and polymorphic proteins in the reference of forensic serology. HLA antigen. Determination of ABO blood group by absorption inhibition, absorption elution and mixed agglutination method.

UNIT-IX

FORENSIC DNA ANALYSIS AND ITS APPLICATIONS:

- Sources of DNA at Crime scenes, Procedure for collection and preservation of biological samples for DNA analysis,
- History of DNA fingerprinting and DNA polymorphism, Genes and DNA markers in forensic DNA analysis
- DNA extraction and quantification techniques including Real Time PCR
- Polymerase Chain Reaction and its variants used in DNA Forensics.
- Various commercial kits for STR profiling, STR profile analysis and its interpretation, Statistical analysis of DNA profiles: Random Match

Probability and Likelihood Ratio.

- Trace DNA typing and its guidelines, Y-STR and X-STR markers analysis, Mitochondrial DNA analysis and its forensic importance.
- Sanger DNA Sequencing method and principles of Next Generation Sequencing Methods.
- Various national/international guidelines for forensic DNA analysis and Interpretations.

UNIT-X

WILDLIFE FORENSICS and ENTOMOLOGY:

- Definition and advances in wildlife forensics; Threats to the natural resources and wild species inhabiting globally.
- Importance of Wildlife Conservation; Classification of Species as per IUCN Red Data Book; CITES; Wildlife (Protection) Act, 1972 of India and other related acts.
- Different Methods of Poaching; Morphological identification and examination of wildlife parts and products for species identification.
- DNA Barcoding for animal species identification.
- Morphology and anatomy of plants, types of plants yielding drugs of abuse– opium, cannabis, coca, tobacco. Identification of plants of Cannabis sativa (Ganja & bhang), opium (Papaver somniferum), tobacco (Nicotiana tabacum) etc. in criminal cases.
- Introduction, History, Significance, Classification and Biology of insects and other arthropods relevant to PMI estimation.
- Life cycle and forensic applications of insects, Dipterans larval development & succession on carrion and its relationship to PMI, impact of ecological factors on insect's developments, rearing insects & calculating PMI, Forensic Entomo-toxicology- identification of drugs and toxins from the insects and larvae feeding on the body.
- Collection and preservation of entomological evidence at a crime scene.

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BIOLOGY DIVISION (M.Sc. BIO-CHEMISTRY)

UNIT-I

FOUNDATION OF BIOCHEMISTRY:

- Foundation of Biochemistry: Cellular and chemical foundations of life, Water: unique properties, weak interactions in aqueous systems, ionization of water, buffering action in biological system.
- Carbohydrate chemistry: Structure and classification of monosaccharides, disaccharides, and polysaccharides, Glycolytic pathway, TCA cycle, pentose phosphate pathways, and glycogen metabolism.
- Lipid Chemistry: Building blocks of lipids - fatty acids, glycerol, ceramide; Structural lipids in membranes – glycerophospholipids; sphingolipids and sterols, Composition and synthesis of lipoproteins and transportation, oxidation of fatty acids, biosynthesis of lipids, cholesterol metabolism.
- Protein Chemistry: Structure and classification of amino acids, peptide, polypeptide, Ramachandran plot, protein folding, Primary, Secondary, Tertiary and Quaternary structure of proteins; essential
- Nucleic acid chemistry: Structure of purine, pyrimidine, nucleoside & nucleotides, Synthesis pathways of purine and pyrimidine, nucleosides, nucleotides and deoxynucleotides, Structure and function of DNA and various types of RNA.

UNIT-II

ENZYMOLGY:

- Enzyme chemistry: Enzyme definition, basic principle of enzyme action, activation energy, General characteristics of enzymes; nature of enzymes - protein and non-protein (ribozymes – RNaseP, abzymes), apoenzyme, holoenzyme. Fischer's lock and key hypothesis, nomenclature and classification of enzymes, mechanisms of various enzymes including chymotrypsin and lysozyme.
- Enzyme kinetics: Kinetics of single substrate reaction, Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Determination of K_M and V_{max} , K_{cat} , specificity constant. Enzyme Inhibition: Reversible and irreversible inhibition, kinetics of bi-substrate reaction.
- Enzyme regulation: Allosteric enzymes, symmetrical and sequential model, Hill's coefficients, cooperativity, Enzyme regulation and feedback control, enzyme activity regulation by post translational modification.

UNIT-III

GENTICS AND CELL BIOLOGY

- Classical genetics: Mendelian and non-Mendelian inheritance, genetic linkage, recombination and crossing over, chromosomal basis of inheritance, mutagenesis, genetic basis of sex determination, extra-nuclear inheritance.
- Molecular Genetics: Structure of chromatin and chromosomes, Central dogma of molecular biology, replication, transcription, translation, regulation of gene expression: transcriptional, translational and post-translational and various DNA repair mechanisms.
- Cell Biology: Membrane models, chemical composition of membrane, membrane proteins, endocytosis, phagocytosis, liposomes and its application. Cell cycle and cell division (meiosis and mitosis), Structure and functions of intracellular organelles such as nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, plastids, and peroxisomes.

UNIT-IV

DEVELOPMENTAL BIOLOGY

- Basic concept of development: Basic features of development in animals, gametogenesis, types of eggs, fertilization, cleavage, and blastula, modification of development in evolution, generation of multicellular embryo, formation of germ layers, patterning of vertebrate body plan.
- Reproductive Biology: Reproductive strategies and reproductive cycles in vertebrates, spermatogenesis, oogenesis, hormonal regulation in gametogenesis in male and female, In-vitro fertilization, embryo transfer technology.
- Nervous System: Organization of nervous system, somatic nervous system; sympathetic and parasympathetic system; structure and function of neuron and glial cells.
- Musculo-skeletal System: Bone structure and function; smooth, cardiac and skeleton muscles, muscle contraction.
- Endocrinology: Endocrine glands including pituitary, thyroid etc.; hormones, regulation of hormone secretion, peptide hormones and steroid hormones, biochemistry of hormone action.

UNIT-V

BLOOD AND ITS COMPOSITION

- Blood: Components & functions of blood, lymph, CSF; Plasma and serum, major plasma proteins, Erythrocytes, Leukocytes, Platelets- structure and function; role of platelets in coagulation, Biochemical mechanism of blood clotting and fibrinolytic system.
- Glycogen storage diseases: Von Gierke, Pompe, Cori and McArdle.

- Anemia and amino acid metabolism: Hemophilia and thrombosis, Hemoglobin, sickle cell anemia, thalassemia, phenylketonuria, alkaptonuria, albinism, etc.
- Electrolyte and acid balance: Acid-base balance, regulation of electrolyte and water balance, renin-angiotensin system in human body.
- Clinical analysis: Functional test of liver, kidney, thyroid, pancreas, tissue biopsy, liquid biopsy, circulating nucleotides as molecular diagnosis.

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Pattern of Question Papers:

1. Objective Type Paper
2. Maximum Marks: 150
3. Number of Questions: 150
4. Duration of Paper: 2.30 Hours
5. All Questions carry equal marks
6. There will be Negative Marking
7. The candidate needs to choose either Zoology or Biochemistry