

# **RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER**

## **SYLLABUS FOR SCREENING TEST FOR THE POST OF SENIOR SCIENTIFIC OFFICER SEROLOGY DIVISION (M.Sc. ZOOLOGY) (STATE FORENSIC SCIENCE LABORATORY, RAJASTHAN, JAIPUR)**

### **UNIT-I**

#### **CELL STRUCTURE, MOLECULES AND THEIR INTERACTION:**

Structural organization and functions of cell including Plasma membrane, intracellular organelles (Nucleus, Mitochondria, Golgi-bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes) and types and structure of Chromosomes, Cell division and cell cycle.

Bio-molecules-Structure, composition and function (carbohydrates, lipids, proteins and nucleic acids), pH, buffer and buffer system, Enzymes- types and their functions, regulation, enzyme inhibition, iso-enzymes. Nucleic acids, their structure and functions, types of DNA and RNA, replication mechanism, Proteins synthesis.

### **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, diatoms, preparation and identification and their forensic importance. Diatom tests and its importance in drowning cases, precaution 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. Soil and water analysis for various microbes, isolation, classification, cell structure of bacteria and fungi, spores, microbes of soil and spoiled food.

### **UNIT IV**

#### **BIOSYSTEMATICS, TAXONOMY, ANIMAL CLASSIFICATION AND GENETICS:**

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

### **UNIT V**

#### **TOOLS AND TECHNIQUES IN BIOLOGY:**

Tissue preparation- fixation, preparation of paraffin and plastic blocks, sectioning- rotary microtome, cryostat, vibratome and ultrathin sectioning. Staining- various staining techniques- simple and double staining, histochemical staining for bio molecules, Decalcification of bones and tooth, immunocytochemical staining. Chromatographic techniques- Paper, TLC, GLC, HPLC, GCMS, Electrophoresis- gel, agar, SDS and rocket; Statistical analysis- data collection and processing, regression and correlation, ANOVA analysis, probability, t-test, p value,  $\chi^2$  test (Chi square).

## **UNIT- VI**

### **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 of and identification of skeletal remains in accident, crimes and mass disasters, recovery, packing and storage of fleshed and burnt bone remains of human/ animal of forensic importance. Skeletal pathology and trauma of bones, facial reconstruction and superimposition, craniofacial superimposition techniques as photographic and video superimposition.

## **UNIT-VII**

### **PHYSICAL EVIDENCE COLLECTION & PACKAGING OF EXHIBITS FROM CRIME SCENE:**

Physical evidence, types and importance in a criminal investigation, Protecting a scene of crime – various steps involved, contamination issues. Reconstructing of crime scene, Protection of Packaging & transportation Biological Evidences their documentation and Chain of Custody Legal and court procedure pertaining to expert testimony, admissibility of scientific evidence under 293 CrPC.

### **MICROSCOPY AND ITS APPLICATION :**

Basic principles and working of simple, Compound, Comparison, Phase-contrast, stereo-zoom, Polarizing, Fluorescence, confocal microscopy, Scanning electron and transmission electron microscope, colorimeter analysis and UV light source.

Spectroscopy: 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.

## **UNIT-VIII**

### **EXAMINATION OF BODY FLUIDS & THEIR STAINS:**

Introduction to various types of body fluids, Composition, Physical pattern and Identification of seminal stains: Occurrence and significance. Species Determination. Age of semen stain. Detailed Laboratory examination of semen stain. Polymorphic Enzymes in semen and their significance. D.N.A.typing of

semen sample. Examination of Saliva, Urine, Perspiration and other physiological fluids presumptive tests (U.V. test, Florence test, Spermine (Barberio) test, Choline test, Acid phosphatase test) and confirmatory test including Azoospermic semen stain (p-30, *Prostate-specific antigen* or PSA, Microscopic examination), Morphological structure of spermatozoa of human and animals, Identification of lochial and menstrual blood stains by microscopic, biochemical and immuno-electrophoretic method, Identification and examination of other body fluids/stains–vaginal, saliva, urine, faeces, vomit etc., Secretor and non –secretor. Identification and examination of body tissues of human/animal.

### **IMMUNOLOGICAL TEST:**

Presumptive & Confirmatory Tests for blood and origin. Application of immunological techniques in forensic serology Determination of species by precipitin test (diffusion method) and Gelelectrophoresis. 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, Application of ABO blood group in disputed paternity cases, polymorphic enzymes and polymorphic proteins in the reference of forensic serology. HLA antigen. Secretor and non secretor status. Blood grouping in biological fluids other than blood. Determination of ABO blood group by absorption inhibition, absorption elution and mixed agglutination method.

## **UNIT-IX**

### **FORENSIC GENETICS AND ROLE OF DNA FINGERPRINTING:**

History of DNA fingerprinting, utility of DNA fingerprinting in crime investigation in parentage dispute, wild life, veterinary and agriculture etc., Legal and Ethical issues. Collection, preservation and transport of samples viz, semen, saliva, hair, bone, flesh etc for DNA profiling, DNA methodology for isolation, typing, interpretation of results, STR analysis, polymerase chain reaction, types and it's application, mitochondrial analysis, determination of sex & species and racial origin. **Analytical** techniques: Chromatography, Gel filtration, Ion exchange and affinity chromatography, Electrophoresis, SDS-PAGE, AGE, PFGE, Southern, Northern and Western blotting, ELISA, DNA foot printing, PCR, Asymmetric PCR, methylation-specific PCR, Nested PCR, Inverse PCR, reverse transcriptase PCR, Real-time-PCR, Protein sequencing methods, DNA sequencing methods, Next Generation Sequencing RFLP maps, RAPD markers, AFLP markers, SNP analysis.

## **UNIT-X**

### **WILD LIFE FORENSICS:**

Wild life, Importance of protected and endangered species of Animals. National and International scenario of wild life, Sanctuaries and National parks. Relevant provision of wild life and environmental act. Types of wildlife crimes, different methods of poaching of wildlife animals, Illegal Trade of wildlife material, Identification and examination of different kinds of wildlife crime exhibits. Examination of fabricated hides, ivory, nail etc. Identification of Wild life and domestic animal.

### **FORENSIC ENTOMOLOGY:**

Introduction, History, Significance, Classification and Biology of insects and other arthropods, Life cycle and forensic application of insects, Importance of some bacteria, Micro Organism and Insects in Forensic Science. Determination of time since death (postmortem interval i.e. PMI) - Dipterans larval development & succession on carrion and its relationship to determine time of death, impact of ecological factors on insects developments, rearing insects & calculating PMI, identification of larval instars, determining whether the body has been moved, linking suspect to the scene, 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.

### **HISTOLOGICAL AND ANATOMICAL EXAMINATION OF SOME PLANTS YIELDING DRUG:**

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.

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## SEROLOGY DIVISION (M.Sc. BIO-CHEMISTRY)

### UNIT-I

**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 of classification of monosaccharides, disaccharides, and polysaccharides, Glycolytic pathway, TCA cycle, pentose phosphate pathways, 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, non-essential and non-standard amino acids.

**Nucleic acid chemistry:** Structure of purine, pyrimidine, nucleoside & nucleotides, De-Novo synthesis of purine and pyrimidine, Synthesis of nucleoside di- and triphosphates, deoxynucleotides, degradation of purine and pyrimidine nucleotides, salvage pathways of nucleotides synthesis, different types of DNA and RNA, Watson-Crick model of DNA, Structure of mRNA, tRNA and rRNA.

### UNIT-II

**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 action various enzymes including chymotrypsin, 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

**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.

**Cell Biology:** Membrane models, chemical composition of membrane, membrane proteins, endocytosis, phagocytosis, liposomes and its application.

Structure and functions of intracellular organelles such as nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, plastids, peroxisomes.

### UNIT-IV

**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.

**Immunity:** innate and acquired immunity, antibody, major histocompatibility complex, complement systems, T and B-cell maturation and differentiation, antigen processing and presentation, hypersensitive reaction and autoimmune diseases, polyclonal and monoclonal antibodies.

### UNIT-V

**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.

## **UNIT-VI**

**Immunological techniques:** Immuno-electrophoresis, immune-precipitation, agglutination, RIA, ELISA, FACS, immune-fluorescence microscopy, Immuno-electron microscopy, Fluorescence In-situ hybridization (FISH), Chromatin immuno-precipitation.

**Statistics:** Data collection and processing, Regression and Correlation, ANOVA analysis Probabilities; t-test, p-value;  $\chi^2$  test.

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### **Pattern of Question Papers:**

1. Objective Type Paper
2. Maximum Marks : 100
3. Number of Questions : 100
4. Duration of Paper : Two Hours
5. All Questions carry equal marks
6. There will be Negative Marking
7. The candidate has to choose either Zoology or Bio-Chemistry

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