RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER

SYLLABUS FOR SCREENING TEST FOR THE POST OF SENIOR SCIENTIFIC OFFICER DNA DIVISION STATE FORENSIC SCIENCE LABORATORY (HOME DEPARTMENT)

I- BIOCHEMISTRY -

Introduction to basic concepts, Ionic Equilibrium, Chemistry of bio-molecules, Nucleic acids, Protein structure, Enzymes, Enzyme kinetics. Carbohydrate metabolism, Lipid metabolism, Nitrogen metabolism, Nucleic acid metabolism, Prokaryotic Gene Expression, Regulation of prokaryotic genes expression and operon, Eukaryotic gene expression: DNA binding proteins, Transcription factors (TFs), Eukaryotic RNA polymerase, Characterization of TATA box, Gene expression and Chromosome remodeling, Regulation of gene expression at transcriptional level.

Bioenergetics and Metabolism: Survey of metabolism: carbon, oxygen, nitrogen cycle catabolism, use of mutants and isotopes in the study of metabolism, compartmentation, food chain and energy flow. Cell bioenergetics: First and second law of thermodynamics, internal energy, enthalpy, entropy, concept of free energy, standard free energy, change of a chemical reaction, redox potentials ATP and high energy phosphate compounds. Electron transport chain and oxidative phosphortylation.

II- MOLECULAR BIOLOGY -

Extracellular matrix and cell-cell interaction, Nucleus, Chromosomes, Cell cycle, Apoptosis, Cancer, Viruses, Bacteria, Bacterial plasmids, Cyanobacteria, Fungi, Microbial metabolism, Microbial pathogenesis. Medically important bacteria: Mode of infection and pathogenesis of Staphylococcus, Clostridium, Streptococcus, Enteropathogenic bacteria, Salmonella and Mycobacterium.
Water and Osmoregulation, Cytoplasmic fluidity, Membrane-Structure and Function. Concept of membrane electrical potential, Cell Receptors, Signal Transduction, Intracellular Membrane and Protein Flow, Fluid Flow Circulation in Humans.
DNA: Chemical composition of DNA, C-value paradox, DNA replication Prokaryotic DNA replication, Eukaryotic-replication, DNA damage, RNAs: types, Genetic Engineering, restriction enzymes, DNA Modifying enzymes, Cloning vectors, Cloning hosts. Post transcriptional processing of RNA: Processing of rRNA, Processing of pre-tRNA, Pre-mRNA processing, Capping and polyadenylation, Splicing, Pre-mRNA Editing, Self splicing introns, Informosomes, mRNA stability and turn over, Genetic code, Prokaryotic Translation, Eukaryotic translation, Translational apparatus, Regulation of protein synthesis, Post translational processing, Processing of Pre-pro-proteins. Protein stability and turnover.

Cell signalling: Hormones and their receptors, cell surface receptor, signalling through G-protein coupled preceptors, signal transduction pathways, second messengers, regulation of signalling pathways.
Mammalian systems: Stem cells- Different kinds of stem cells and their characters, transformation into different types, cell types-molecular approach, Bone marrow, multipotent stem cells, Hematopoietic stem cells and their mode of differentiation and development into a variety of circulatory cells. Molecular approach Embryonic cells-pleuripotent cells, induction of differentiation and the factors and the mechanism. Stem cell engineering, applications and prospects.

Renewal of tissues and tissue engineering: Renewal of cells that are lost in adult tissues such as epidermal cells, mammary gland cells, photoreceptor cells in retina, liver cells. Differentiation and development of muscle cells-embryonic somites to myoblasts, myogenic genes and expression, muscle developmental factors such as MEFs and MRFs, terminal differentiation of myoblasts.

III- GENETICS -

Mendelism, Extensions of Mendelian principles, Evolution of genes concept, Linkage and chromosomal mapping, Inbreeding depression and Heterosis, sex linkage and sex determination, chromosomal and gene mutations. Population genetics, Quantitative genetics, Evolutionary genetics.
Cytogenetic aspects of cell division, Variation at the genetic level: DNA markers – VNTR, STR, microsatellite, SNP and their detection techniques – RFLP, genotyping, RAPD, AFLP etc., Construction of DNA libraries, Genome sequencing Molecular Evolution, Techniques for studying bacteriophages and Transposable phage (phage Mu).

Chromosomal anomalies and Techniques in the study of chromosome and their applications: Short term (lymphocyte) and long term (fibroblast) cultures, chromosome preparations, karyotyping, banding, chromosome labeling. *In situ* hybridization, chromosome painting, comparative genome hybridization (CGH), somatic cell hybrids and gene mapping, premature chromosome condensation.

Variation at the genetic level: DNA markers – VNTR, STR, microsatellite, SNP and their detection techniques – RFLP, genotyping, RAPD, AFLP etc. Gene expression: Basic processes and Gene regulation and Introduction to Human Genetics: History of early perception, development and documentation; genome organization; Chromosome structure, function and implications for disease.

Study tools in Human Genetics: Human genome mapping methods; Physical mapping: Introduction to physical map markers- Human genome analysis: Conception, mapping cloning and sequencing, Outcome- Generation of 'OMICS' era, significant leads.

IV- MICROBIOLOGY -

Diversity Of Prokaryvotic And Eukaryotic Microbes.
Archaea, Bacteria, Fungal Systematics and Diversity, Mycorrhizal fungi, Agriculturally important toxigenic fungi, secondary metabolites from fungi, Genomics and Biodiversity of yeast, Antagonistic interactions in yeasts, Biotechnological application of yeasts.

Virology: Animal Viruses Classification, Morphology and Chemistry of Viruses, Working with viruses, Virus replication Strategies, Replication patterns of specific viruses. Pathogenesis of viral infection, Anti-viral strategies prevention and control of viral diseases. Plant and microbial viruses classification, Morphology and Chemistry of Viruses.

Microbial Pathogenicity: Classical view of microbial pathogenicity, Molecular microbial pathogenicity, Emerging and re-emerging pathogens, Molecular mycological epidemiology, Environmental change and infectious diseases, Anti microbial resistance, newer vaccines, Rapid diagnostic principles.

V- BIOTECHNOLOGY -

Organization of structure and functions of prokaryotic and eukaryotic cells

(a) Cell wall and cell membrane: physical structure of biological membranes in prokaryotes and eukaryotes, lipid bilayer, membrane proteins, other constituents, diffusion, osmosis, active transport regulation of intracellular transport and electrical properties.
(b) Structural organization and functions of cell organelles, Cytoskeletons structure and motility function.
(c) Organization of genomes: genes and chromosomes, operon unique and repetitive DNA interrupted genes, gene families structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.
(d) Cell division and cell cycle, Apoptosis, Necrosis and Autophagy.

Recombinant DNA Technology and Applications: Restriction and Modification systems in E. coli and their use in recombinant library constructions. Restriction and Modifications enzymes and their uses. Basic techniques for RDT including Agarose gel electrophoresis, PAGE, Pulse field electrophoresis. Basic Biology of plasmids including their replication, copy number, incompatibility of plasmids and development of Plasmid Vectors. Cloning and expressions vectors. Basic DNA sequencing methods, introduction to Next Generation Sequencing (NGS) Polymerase chain reaction and its application in research. Oligonucleotide synthesis, purification and its application in screening of libraries, cloning and mutagenesis, Synthetic gene assembly.
Strategies for constructing cDNA libraries and screening using Nucleic acid and antibody probes. Subtractive Libraries, Expression based strategies for cloning of functional genes, differential mRNA display. Strategies for constructing Genomic libraries and screening using nucleic acid probes. Understanding of operon Lac, Trp, Arabinose, Tetracycline

and their application in studying biological processes and development of vectors. Use of Tags to aid solubility and purification of DNA safety guidelines and regulatory aspects.

VI- IMMUNOLOGY AND PHYSIOLOGY -

Cells and molecules involved in innate and adaptive immunity, antigens, antigen city and immunogenicity B and T cell epitomes, structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, 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-medicated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired.

Physiology: Blood and cardiovascular System, Digestive System, Muscular system, Respiratory system, Nervous system, Sense organs, Excretory, Endocrinology and Reproductive system.

VII- TOOLS AND TECHNIQUES -

(a) Biochemical Methods: Chromatography lon exchange, Gel Filtration and Affinity chromatography.
Electrophoresis: Native and SDS-PAGE, Iso electric focusing 2D-PAGE and its applications.

(b) UV/VIS spectrophotometer, Beer-Lambert's law and its use in determination of protein/nucleic acid concentration.

(c) Fluorescence, Spectroscopy: Basic concepts of excitation and emission Quenching, Theory and application of FRET.

(d) Centrifugation: basic concepts of centrifugation. Calculation of g value from RPM. Density gradient centrifugation. Sedimentation velocity and Sedimentation equilibrium, Separation of sub-cellular components and macromolecules using high speed and ultracentrifugation.

(e) Microscopy: Bright field, phase contrast fluorescence, confocal and electron microscopy.

(f) Isotope Tracer Technique: Types of radiations measurement scintillation and gamma counters Background noise quenching, Applications interaction of radiation with matter, passage of neutrons through matter interaction of gamma rays with matter units of measuring radiation absorption. Radiolysis of water, free radicals in water Autoradiography.

(g) Biostatistics and Computer Applications: Measures of central tendency and dispersion: mean, median range, standard deviation and variance. Correlation and simple linear regression. Sampling: Sampling techniques, sampling errors, framing Hypothesis, level of significance, tests of significance (F & t test), chi-square test. Computer Oriented statistical techniques. Frequency table of single discrete

variable, computation of mean, variance and standard deviation, t-test correlation coefficient.

VIII- FORENSIC SCIENCE –

1. Definition and scope of forensic science- History and Development of forensic science, organization of the forensic science laboratory. Central and state forensic science laboratories, Directorate of forensic sciences. Functions of a forensic scientist.
2. Physical Evidence: Their significance, class and individual characteristics, identification and individualization of physical evidence, locards's exchange principle mobile forensic science laboratory and its deployment in scenes of crimes.
3. The scene of Crime: Crime scene search for physical evidence, photography, sketching, collection, preservation, packing and transportation of evidence, maintaining the chain of custody.
4. Microscopy: principles and different types of microscopes and its forensic applications.
5. Types and distribution of body fluids: Blood, blood stains, semen, seminal stains, urine (formation, composition, properties); amniotic fluid, sweat (formation, composition, properties); saliva, vaginal fluid, epithelial cells, etc., their analysis and forensic significance.
6. Wild life DNA analysis and its applications in forensic science.
7. Intellectual Property Rights (IPR) and its importance in DNA profiling with case studies.

Forensic DNA profiling –International, national and state level cases.

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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. **Medium of Screening Test: Bilingual in Hindi & English.**
7. **There will be Negative Marking.**

(For every wrong answer, one-third of marks prescribed for that particular question will be deducted).