Himachal Pradesh
Public Service Commission

No.3-6/2025-PSC (R-II) **Dated: 27-01-2026**

Syllabus of Paper-II i.e. Descriptive type Subject Aptitude Test (SAT) for recruitment to the post of Scientific Officer (Chemistry & Toxicology), Group-B (Job Trainee) in the Department of Forensic Services under the Department of Home, H.P. The SAT paper shall be of 03 hours duration, having 120 Marks. The SAT paper shall have two parts, i.e., Part I and Part-II and shall cover the following topics of Master's Degree in Forensic Science/ Chemistry/ Bio-Chemistry/ Bio-Technology/ MS/M. Pharma level.

Part-I (60 Marks)

1. GENERAL FORENSIC SCIENCE:

- Introduction to Forensic Science: Definition, nature and scope of forensic Science in crime investigation, Frye's and Daubert standards.
- History and Development of Forensic Science-The evolution of scientific investigation methods and techniques, Forensic science set-ups in the national and international forums, FBI, GEQD etc. Modern instrumental methods/techniques viz LVA (Layered Voice analysis), audio comparison and video comparison, BEOS (Brain Oscillation Electrical Signature), DNA Profiling and Digital Forensics etc.
- Principles of Forensic Science - Locard's Exchange Principle, Law of natural variation, law of comparison, law of probability, law of individualisation etc.
- Scope of Forensic Science- Multidisciplinary and multi-professional nature, need for forensic Science.
- Crime Scene Management-Systematic approach in crime scene investigation including securing the scene, identifying evidence, collection, packaging and forwarding of evidence, chain of custody etc., photography, videography, 3D recording, sketching and notes preparation, various search methods. Reconstruction of the crime scene, hypothesis formulation, and testing of the hypothesis.
- Types of Evidence-Physical, digital and trace evidence, location and identifying evidence. The significance of evidence in linking the perpetrator to the crime, de-linking the innocent. Standard Operating Instructions for the collection and preservation of Physical, Digital and trace evidence from the scene of crime.
- Chemometrics: Introduction to chemometrics; application of statistical tools in interpretation of data, multivariate analysis (PCA, PLS, cluster analysis, discriminant analysis); calibration models; pattern recognition; and their applications.
- Report writing- Preparation of scientific test report, essential of reports' admissibility of test reports. Writing of the scene of crime reports. Expert testimony, Examination-in-chief, cross- examination, re-examination. Related Laws -BNS, BNSS, BSA 2023, IT Act 2000, POCSO Act, NDPS Act, MVA Act etc.

- Concept of Quality Management System- Quality, Quantity assurance, Quality control, ISO/IEC 17025, ISO 9001 standard, accreditation, certification, Calibration, proficiency testing, blind testing, inter and intra laboratory comparison, internal audit, uncertainty measurement, Z score, limit of detection (LOD), limit of quantification (LOQ), Verification and validation methods.
- Laboratory Information Management Systems – The management of laboratory information, protection of data, traceability of record and transparency in laboratory operations.
- Research Methodology - Research design, hypothesis formulation, sampling, data collection techniques, statistical interpretation, literature review, and scientific paper writing skills. Plagiarism - types of plagiarism, plagiarism detection tools, and ethical responsibilities in research and report preparation. Citation index and impact factor.
- Ethics - Impartiality, honesty, confidentiality and adherence to professional conduct throughout forensic practice.

2. ORGANIC CHEMISTRY

- IUPAC nomenclature of organic compounds.
- Chemistry of aliphatic & aromatic compounds, aldehyde & ketone, carboxylic acids, amines, nitro compounds.
- Alcohol & alcoholic beverages and their analysis.
- Concept of aromaticity.
- Chemistry & classification of petroleum products (petrol, diesel, kerosene) and their analysis.
- Fire chemistry and analysis of incendiary material from debris.
- Dyes & pigments and their analysis.
- Chemistry of common pesticides & insecticides (organochloro, organophosphate, carbamates, pyrethroids, zinc and aluminium phosphide), plant poisons (strychnine, brucine, nicotine, atropine, hyoscyamine, dhatura, atropa belladonna, marking nut, nux vomica, oleander, aconite, abrus and croton) & animal poison (snake venom) and their analysis from biological matrices.
- Chemistry of narcotic drugs & psychotropic substances and their analysis in crude form & from biological matrices.

3. APPLICATION OF BIOCHEMISTRY TO BIOTECHNOLOGY:

- Isolation of peptides for Sequence analysis. Peptide mapping, chemical and enzymatic hydrolysis of proteins.
- Extraction and fractionation of RNA and DNA,
- Isolation of plasmids, plasmid derived vectors, phages and yeast vectors, Enzymes involved in recombinant DNA technology, Genomic and cDNA library. Ti plasmid as tool for genetic engineering in plants,

- Bacterial transformation screening of transformants, N-labelling Random labeling of nucleic acid probes, Nick translation, Hybridization and blotting techniques. dot blot. Northern and Southern blot, South-Western blot analysis, biotin-avidin system applications in detection of bio-molecules. Techniques to study DNA protein interactions, Transgenic animals and plants, knockout animals, Chemical Synthesis of oligonucleotides, Polymerase Chain Reaction (PCR), Basic principle, method, Variations of PCR,
- Amplification of specific DNA fragments: Applications in medicine and forensic sciences. Techniques to detect polymorphism: RAPD, RFLP, AFLP etc. DNA based diagnosis of genetic disorders,
- Recombinant DNA technology in medicine and industry. In situ Hybridization, gene therapy,
- Monoclonal Antibodies and Vaccines: Definition and nature of monoclonal antibodies (MCA); Antigen preparation for MCA production; Methodology producing MCA; Immunization and generation of immune response, Myleoma cells for hybridization; cell fusion and selection of hybrids using HAT medium.

4. DRUG DELIVERY SYSTEM:

- Sustained Release (SR) and Controlled Release (CR) Formulations: a. Introduction & basic concepts, advantages/disadvantages, factors influencing, physicochemical & biological approaches for SR/CR formulation, mechanism of Drug Delivery from SR/CR formulation. b. Polymers: introduction, definition, classification, properties and application,
- Dosage forms for personalized medicine: Introduction, definition, pharmacogenetics, categories of patients for personalized medicines. Customized drug delivery systems; Bioelectronic Medicines; 3D printing of pharmaceuticals; Telepharmacy,
- Rate-controlled Drug Delivery Systems: Principles & fundamentals, types, activation; Modulated drug delivery systems: Mechanically activated, pH activated, enzyme activated, and osmotic activated drug delivery systems; feedback regulated drug delivery systems; principles & fundamentals,
- Gastro-Retentive Drug Delivery Systems: Principles, concepts, advantages and disadvantages, modulation of GI transit time, approaches to extend GI transit,
- Buccal drug delivery systems: principle of muco-adhesion, advantages and disadvantages, mechanism of drug permeation, methods of formulation and its evaluation,
- Ocular Drug Delivery Systems**:** Barriers to drug permeation, methods to overcome barriers,
- Transdermal Drug Delivery Systems: Structure of skin and barriers, penetration enhancers, transdermal drug delivery systems, formulation and evaluation,
- Protein and Peptide Delivery: Barriers for protein delivery; formulation and evaluation of delivery systems for proteins and other macromolecules,

- Vaccine delivery systems: Vaccines, uptake of antigens, single-shot vaccines, mucosal and transdermal delivery of vaccines.

Part-II (60 Marks)

1. INORGANIC CHEMISTRY

- Periodic table, compounds of nitrogen and phosphorus, transition metals, Inner transition elements – spectra and magnetic properties, analytical applications, trace elements and their detection.
- Concept of Atoms & molecules, bonding (Ionic, covalent or polar), hybridization.
- Concept of acid and base.
- Chemistry of main group elements.
- Chemistry of noble gases.
- Aqueous and non-aqueous solvents, concept of polarity.
- Coordination compounds, bonding theories, spectral and magnetic properties.
- Porphyrins, metallo-enzymes, heme as oxygen transport, Bohr effect and Models of cooperative interactions in haemoglobin, sodium/potassium pump.
- Nuclear reactions, fission and fusion.
- Significant figures and errors in analysis.
- Explosives, classification of explosives, detonators, precursor compounds, pyro techniques, propellant etc.

2. ORGANIC CHEMISTRY:

- **Stereochemistry:** Isomers and their properties, Threo and Erythro isomers, Chirality, Optical isomerism, Geometrical isomerism, Conventions for configurations- D,L and R,S systems,Streoselective and Streospecific reactions, epimerization, epimers, anomers and mutarotation,

  Axial Chirality (Allenes and Biphenyls), Planar chirality, Helicity, Chirality involving atoms other than carbon atoms, Prochirality:Prostreoisomerism and Asymmetric synthesis, Conformational and streoisomerism of acylic and cyclic systems, cyclohexane, decalins, effect of conformation on reactivity in acylic and cyclohexane systems.
- **Pericyclic Reactions:** Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5 hexatrienes, and allyl system. Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions: conrotatory and disrotatory motions, 4n and 4n+2 and allyl systems. Cycloadditions- antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions, and chelotropic reactions.

Sigmatropicrearrangements: Suprafacial and Antarafacial shifts of H, sigmatropic shifts involving carbon moieties, Claisen, Cope and aza-Cope rearrangements, Ene reaction.

- **Photochemistry I**: Introduction and Basic principles of photochemistry. Interaction of electromagnetic radiations with matter, Types of excitations, fate of excited molecules, quantum yield, transfer of excitation energy, actinometry. Photochemistry of alkenes: cis-trans isomerization, dimerization of alkenes, photochemistry of conjugated olefins, photo- oxidation of alkenes and polyenes Photochemistry of Aromatic compounds: Isomerization, addition and substitution, photo-reduction of aromatic hydrocarbons, Photochemistry – II: Photochemistry of Carbonyl compounds: Norrish Type I and II, Intermolecular and Intramolecular hydrogen abstraction, Paterno-Buchi reaction, α and β- cleavage reactions of cyclic and acyclic carbonyl compounds, Formation of oxetane and cyclobutane from α,β unsaturated ketones, Photo-reduction of carbonyl compounds, Photo- rearrangement of enones, dienones, epoxyketones, Photo Fries rearrangement.

3. EXTRACTION TECHNIQUES:

- Sample extraction techniques and removal of interference from sample extracts
- Batch, continuous and counter-current extraction.
- Headspace extraction, liquid-liquid extractions (LLE), solid phase extraction (SPE), membrane–based extraction, micro extraction, solvent extraction, pressurized liquid extraction (PLE), microwave-assisted extraction (MAE), ultrasonication and supercritical fluid extraction (SFE).
- Qualitative and quantitative aspects of extraction.
- Pharmacology, Pharmacokinetics and Metabolism.
- Absorption, distribution, Pathways of drug metabolism, Drug Toxicity.

4. PHYSICAL CHEMISTRY

- Basic principles of quantum mechanics – hydrogen atom, angular momentum.
- Normality, morality, molality, equivalent weight, molecular weight, Titrimetric methods for analysis etc.
- Melting point, boiling point, colligative properties, vapour pressure, pH, solubility, hydrolysis, chemical & ionic equilibrium.
- Basic principles and selection rules of rotational, vibrational and electronic spectroscopy.
- Chemical thermodynamics (first, second and third law of thermodynamics, Maxwell equations)
- Electrochemistry (oxidation & reduction, electrochemical series and Nernst equation)
- Chemical kinetics – empirical rate laws, Arrhenius equation and theories of reaction rates.
- Concept of catalysis.

5. TOOLS & TECHNIQUES:

- Theory, principle & applications: UV -Visible, I.R., FT–IR, Atomic absorption spectroscopy, Mass spectrometry, Raman spectroscopy, N.M.R, X-ray diffraction (XRD), X-ray fluorescence (XRF), TGA and DTA, Column, Paper, Thin Layer Chromatography (TLC), HPTLC, ion-exchange chromatography. Gas Chromatography (GC), Head Space Gas Chromatography (HS-GC), Gas Chromatography Mass spectrometry (GC–MS), Liquid Chromatography Mass spectrometry (LC–MS), High Performance Liquid Chromatography (HPLC). Radio analytical techniques and activation analysis.

6. GENOMICS AND BIOINFORMATICS:

- Introduction to Genomics, Proteomics, Open Reading Frames (ORFs), Detecting ORFs. Concepts of Introns, Exons.
- Notion of homology: Orthologs, Paralogs, Analogs. Understanding Identity, Homology & Similarity with reference to evolutionary relationships.
- History of Genome sequencing project, the human Genome project-The human genome sequence annotation–Repeats, coding regions, non-coding regions; Genome Sequencing strategies: Hierarchical and Whole genome Sequencing strategies,
- Nucleotide and Protein databases: Primary, secondary and composite database (GenBank, EMBL, DDBJ, Uniprot, Swissprot, PIR, PDB, Genpepts). NCBI, EBI, DDBJ. Nucleotide sequence flat files. Sequence formats: Genbank, FASTA, ASN.
- Introduction to metabolic pathway databases on the web-KEGG, EcoCyc, and Metacyc. Enzyme databases-BRENDA, LIGAND database. Molecule visualization softwares: RasMol, Pymol, Cn3D, VMD etc.
- Information retrieval from biological databases- NCBI resource, Entrez, PubMed, MEDLINE. Introduction to sequence alignment: Pairwise Sequence Alignment, Global alignment and Local alignment, general, gap, and affine penalty. DotPlot, scoring functions, Substitution Matrices- PAM and BLOSUM matrices. Heuristic algorithms, Word methods or k-tuple methods, Dynamic Programming-implementation of the Needleman and Wunsch algorithm and Smith-Waterman Algorithm for pairwise alignment and testing alignment score, Multiple Sequence Alignment- consensus sequence, motifs and profiles. SP (Sum of Pairs) measure, Position specific scoring matrices, Hidden Markov Model, Clustal W, Clustal X, Blasta and Fasta, Blastp, Blastx, tBlastx, Blastn, PSI-BLAST,
- Significance of alignment: Scores, E value, p value. Comparative Genomics, Methods for predicting protein structure (secondary and tertiary).

7. MOLECULAR PHARMACEUTICS (NANO TECH AND TARGETED DDS):

- Targeted Drug Delivery Systems: Concepts, events and biological processes involved in drug targeting. Tumor targeting and brain specific delivery,
- Targeting Methods: Introduction, preparation and evaluation. Nanoparticles & liposomes: Types, preparation and evaluation,

- Micro Capsules/Micro Spheres: Types, preparation and evaluation, monoclonal antibodies; preparation and application, preparation and application of niosomes, aquasomes, phytosomes, electrosomes,
- Pulmonary Drug Delivery Systems: Aerosols, propellents, containers types, preparation and evaluation, intranasal route delivery systems; types, preparation and evaluation,
- Nucleic acid based therapeutic delivery systems: Gene therapy, introduction (ex-vivo & in-vivo gene therapy). Potential target, diseases for gene therapy (inherited disorder and cancer). Gene expression systems (viral and nonviral gene transfer). Liposomal gene delivery systems. Biodistribution and pharmacokinetics. Knowledge of therapeutic antisense molecules and aptamers as drugs of the future.

8. PHARMACOKINETICS AND METABOLISM:

- Types of Metabolic reactions, Drug Metabolism: phase I and II (Analgesics, Tranquilizers, Barbiturates and Benzodiazepines)
- Factors influencing Metabolism, Pesticide intricacies: Organophosphate insecticides, Carbamates, Forensic relevance,
- Plant Poison: Nature (Cardiac, Deliriant, Spinal) Active constituents, Mode of action, Isolation and Identification.

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Secretary HPPSC