DETAILED SYLLABUS FOR THE POST OF RESEARCH OFFICER (CHEMISTRY / BIOCHEMISTRY)

AYURVEDA MEDICAL EDUCATIONAL(DRUGS STANDARDIZATION UNIT)

(Category Nos: 130/2020)

(TOTAL MARKS – 100)

PART I : BIOCHEMISTRY (50 Marks)

I TECHNIQUES IN BIOCHEMISTRY (10 MARKS)

Microscopy- Basic principles, instrumentation and applications of microscopy. Bright field, Phase-contrast, Fluorescence and Confocal Microscopy, Electron Microscope – Scanning and Transmission Electron Microscopy, Atomic Force Microscopy. Histopathology – definition, fixation, decalcification, tissue processing, cutting, staining and analysis.

Electrophoresis: Basic principles, instrumentation and applications of electrophoresis. Factors affecting electrophoresis. Electrophoretic techniques – Agarose gel, SDS-PAGE, Capillary, 2-D and Pulsed field. **PCR and Immunological techniques**: DNA amplification by PCR - Conventional, Reverse-Transcriptase, Inverse, Quantitative Real-time, Nested and Multiplex PCR. Primer designing.

Spectroscopy: Principle, Concept of absorptions, transmission, scattering, phosphorescence, fluorescence, luminescence, diffraction spectra. Principle, instrumentation, working and application of UV, Visible and IR spectroscopy, spectrofluorimetry, flame photometry, atomic absorption spectrometry, luminometry.

NMR and mass spectrometry: Principle, instrumentation, working and application of Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR), Mass spectrometry - GC-MS, HPLC-MS and LC-MS/MS, Matrix-assisted laser desorption/ionization, Time- of Flight Mass spectroscopy (MALDI-TOF MS), MS – MS, ICP -AES, X-ray crystallography.

II. PLANT SECONDARY METABOLITES (10 MARKS)

Introduction and classification of secondary metabolites and their functions. Phenols, Flavonoids, Lignins, Lignans, Neolignans, Tannins and Quinones. Alkaloids - Nicotine, Caffeine and Cocaine. Toxic secondary metabolites, secondary metabolites of medicinal importance.

Phytochemical analysis: Preparation of extracts of crude drugs/herbs by successive solvent extraction method to record the percentage yield and for subjecting them to phytochemical

screening. Cold and hot extraction methods. Qualitative chemical examination - Detection of phytoconstituents – Alkaloids, phenolics, flavonoids, glycosides, steroids, triterpenoids, saponins, tannins.

III. ENZYMOLOGY (10 MARKS)

Nomenclature and classification of enzymes. Energy of activation and its significance. Enzyme specificity, measurement and expression of enzyme activity - Definition of Unit, international unit (IU), katal. Coenzymes- classification - vitamin and nonvitamin coenzymes. Mechanism of enzyme action- Active site, Mechanism of enzyme action - general acid-base catalysis, covalent catalysis, proximity and orientation effects, role of metal ion in enzyme catalysis, mechanism of serine proteases - chymotrypsin, lysozyme, and ribonuclease.

Enzyme kinetics

Order of reaction, progress curve for enzyme catalyzed reactions. Factors affecting the velocity of enzyme catalyzed reaction - enzyme concentration, temperature, pH, inhibitors and activators, Michaelis-Menten equation; Km and Vmax values and their significance, Lineweaver-Burk plot and its physiological significance. Enzyme inhibition – competitive, non-competitive, uncompetitive and mixed. Allosteric and feedback inhibition with examples, suicide inhibition. Dose-response curves of enzyme inhibition. Regulation of enzyme activity-covalent regulation, allosteric regulation, Feedback regulation. Multienzyme complex- Mechanism of action and regulation.

Enzyme Technology- Isolation and purification of enzymes and criteria of purity- specific activity. Industrial uses of enzymes. Immobilization of enzymes and their applications. Designer enzymes - Abzymes, Ribozymes. Serum enzymes in health and disease-diagnostic and therapeutic applications.

IV. CELL BIOLOGY (5 MARKS)

Cell Structure and function of plasma membrane, different models, membrane proteins, membrane lipids and membrane fluidity. Transport across cell membrane, passive transport, active transport, co-transport-symport and antiport. Ion channels, Aquaporins, Regulation of cell volume, Internalization of macromolecules - Endocytosis, pinocytosis, phagocytosis and exocytosis. Receptor mediated endocytosis, coated pits, clathrins.

Cell Cycle and Cancer- Cell division- Phases of eukaryotic cell cycle, check points —cyclins, maturation promoting factor (MPF), Cyclin dependent kinases, growth factors, inhibition of cell cycle progression.

Programmed cell death, Caspases. Intrinsic and Extrinsic pathways. Pro and anti-apoptotic pathways and cell survival, necrosis, autophagy. Cancer – Development and causes of cancer, metastasis, tumour viruses, oncogenes, tumour suppressor genes, Biomarkers – CEA, PSA, p53, Ras, c-myc.

V. PHARMACOLOGY (10 MARKS)

Introduction to pharmacology, sources of drugs, Classification of drugs based on sources, dosage forms, route of administration, site of action of drugs. Mechanism of action, concept of receptors, combined effect of drugs, factors modifying drug action. Dose response curve- ED50 and LD50.

Pharmacokinetics- Absorption and distribution of drugs, importance of drug – protein interaction. Drug metabolism: chemical pathway of drug metabolism, phase I and phase II reactions, role of cytochrome P450, non- microsomal reactions of drug metabolism, drug metabolizing enzymes. Drug elimination of liver and kidney.

Clinical Toxicology: Definition, classification of toxicity – occupational, environmental and pharmaceutical. Types of toxins and their mechanism of action. Factors affecting toxicity- Drug tolerance, intolerance, addiction, allergy, hypersensitivity, antagonism and synergism. Methods of detection. Drug abuses and their biological effects. Clinical symptoms of toxicity and marker parameters.

VI: Immunology, Microbiology, Bioinformatics and Biostatistics (5 Marks)

Immune system and function, Immunological techniques, vaccines, classification of microbes-bacteria, virus, fungi, properties, cultivation of microbes, identification of microbes, sterilization techniques, microbial conjugation, basics of bioinformatics, tools of bioinformatics, biological databases, data mining, protein data Bank, molecular Modelling and Docking
Average, statistical dispersion, coefficient of variation, standard deviation, standard error, t-test, basics of correlation, probability, regression, statistical packages SPSS, Excel and Anova.

PART II : CHEMISTRY (50 Marks)

Module 1 (10 marks)

Regions of electromagnetic spectrum. Different units of energy (erg, joule, calorie, cm-1, Hz, 0 A and eV) and their inter conversions. Interaction of radiations with matter. Various types of molecular spectra. Born-Oppenheimer approximation. Rotational spectroscopy: microwave spectra of diatomic molecules, energy expression, selection rule, rotational energy levels, determination of bond length, effect of isotopic substitution. Vibrational spectroscopy: Harmonic oscillator. IR spectra of diatomic molecules. Energy expression. Selection rules, frequency of separation, calculation of force constant, anharmonic oscillators. Morse equation. Fundamental and overtone transitions, combination bands, degree of freedom of polyatomic molecules. Raman spectroscopy: Stoke's and anti stoke's lines and their intensity difference, rotational Raman spectrum. Selection rule. Frequency of separation, vibrational Raman spectrum, Mutual exclusion principle.Electronic spectroscopy: Frank-Condon principle. Singlet and triplet states dissociation and pre-dissociation. Electronic spectra and diatomic molecules. Dissociation

energy, electronic spectra of polyatomic molecules (qualitative idea only). NMR spectroscopy: Principle of NMR, nuclear spin. Interaction of nuclear spin with external magnet. Precession. Relaxation, Chemical shift. Low resolution spectra. Delta and tau scales. Spin-spin coupling and high resolution spectra. Electron spin resonance spectroscopy: principle. Types of substances with unpaired electrons, interaction of electron magnet with external magnet. Energy level spliting. Lande splitting factor, presentation of ESR spectrum. The normal and derivative spectra. Hyperfine splitting. Simple examples like methyl and benzene radicals.

Computational Chemistry

Brief description of computational methods: ab initio, semi empirical, DFT and molecular mechanics. RHF, ROHF &UHF methods Basis sets, STO &GTO. Z-matrix of simple molecules H2O, CO2 & NH3. Common computational and visualization softwares

Module 2 (5 marks)

Applications of potential measurement:- Determination of ionic product of water, hydrolysis constant and solubility product, pH value using quinhydrone and glass electrode, potentiometric titrations of acid-base and redox reactions, Polarography, Coulometry, conductometry, Voltametry, Amperometry

Colloidal state: Types of solutions – true, colloid and suspensions, Purification of colloids – ultra filtration and electrodialysis, Kinetic, optical and electrical properties of colloids. Ultra microscope, Electrical double layer and zeta potential. Coagulation of colloids, Hardy-Schulz rule. Gels: Elastic and non-elastic gels, Imbibition and syneresis, Gel Electrophoresis, Micelles and critical micelle concentration, sedimentation and streaming potential, Application of colloids – Cottrell precipitator, purification of water and delta formation-Turbidometry and Nephelometry

Module 3 (5 marks)

Basic concepts of organic reactions-electron displacement effects- aromaticity

Organic reactions- substitution, addition, elimination and rearrangements- mechanism

Concept of molecular chirality- R and S nomenclature -carbon and nitrogen compounds-Chiral pool, chiral auxiliary, chiral reagents and chiral catalysts- Stereochemistry of biphenyls and allenes- Pro-stereoisomerism-asymmetric synthesis- Geometrical isomerism- chemistry of vision-

EZ- nomenclature- conformational analysis of ethane, butane , cyclohexane and substituted cyclohexane- effect of conformation in reactivity of substitution and elimination

Esterification and ester hydrolysis reactions- mechanism

Hammet equation – Linear free energy relation

Module 4 (10 marks)

Alkaloids: - Extraction and structural elucidation of conine, nicotine and importance of quinine, morphine and codeine. Terpenes: - Essential oils, isolation of citral and geraniol ,Isoprene and special isoprene rule. Vitamins: - Classification and structure -structures of vitamin A, B1 and C

Classification of chromatographic methods. Theory of chromatography. Applications of chromatographic methods. Adsorption and partition chromatography. Paper, thin layer and column chromatographic methods

Common Spray reagents and Developing agents in chromatography.

Centrifugal TLC, LC, pressure column chromatography, HPLC and GC, column matrices. Detectors. Affinity and chiral separations using HPLC

Principle, application and working of HPTLC

GC MS and LC MS Principle, instrumentation and applications

Applications of UV, IR, ^{1}H NMR, ^{13}C NMR , 2D NMR and Mass spectroscopy- problems based on spectral data

Module 5 (10 marks)

Atomic absorption spectroscopy- flame emission spectroscopy- applications – colorimetry- spectrophotometry- laws of spectrophotometry- Beer- Lambert's lawapplications of spectrophotometry- thermal methods- introduction to TG, DTA and DSC instrumentations and applications. Tools for measuring nanostructures XRD, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy(STM), Scanning Electron Microscopy(SEM), Transmission Electron Microscopy(TEM)

Principles of Green chemistry, Green synthesis,

The concepts of molecular recognition, host, guest and receptor systems. Forces involved in molecular recognition. Hydrogen bonding, ionic bonding, p-stacking, vander Waal's and hydrophobic interactions. Introduction to molecular receptors-design principles: Tweezers, Cryptands and Carcerands, Cyclophanes, Cyclodextrins and Calixarenes- Typical examples Molecular recognition and catalysis- catalysis by cation receptors, anion receptors and cyclophanes. Molecular recognition in DNA and protein structure

Module 6 (10 marks)

Organometallic Compounds : Definition – Nomenclature and classification – sigma complex – Pi complex – those containing both sigma and Pi bonds – 18 electron rule – Metal carbonyls – mononuclear and polynuclear (give examples of carbonyls of Fe, Co, Ni) – preparation and properties of carbonyls of iron and nickel – Bonding in organometallic compounds like ferrocene, dibenzene chromium, Ziese's salt – Dinitrogen complexes – Application of organometallic compounds. Bioinorganic Chemistry : Role of metal ions in biological systems – Biochemistry of iron, haemoglobin and myoglobin , mechanisms of their actions – Photosynthesis – Sodium-Potassium pump - Biochemistry of magnesium and calcium

Electronic, IR, NMR , ESR and Mossbauer spectroscopy of complexes. Coordination complexes of lanthanides and actinides

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