FURTHER DETAILS REGARDING MAIN TOPICS OF

PROGRAMME No. 04/2021 (Item No: 10)

SCIENTIFIC OFFICER

CHEMICAL EXAMINERS LABORATORY

Category Number: 308/2019

BIOCHEMISTRY

MODULE – I : Biomolecules and Biochemical techniques

Overview of physical aspects in Biochemistry, Classification, Structure and functions of carbohydrates, Lipids, Proteins and nucleic acids. Methods for the isolation, purification and characterization of protein, denaturation of proteins and nucleic acid. Nucleic acid sequencing, proteome analysis.

Microscopy:- Basic principles, instrumentation and applications of microscopy. Bright field, phase-contrast, fluorescence and confocal microscopy. Electron microscope – scanning and transmission electron microscopy. Principle methodology and applications of different types of electrophoresis, blotting and PCR techniques.

MODULE – II : Nutrition and Biochemical basis of diseases.

Nutritional aspects of Carbohydrates, lipids, proteins and fiber Nutritional Value of vitamins, minerals – Physiological and Biochemical functions, Daily requirement, Protein energy malnutrition - Kwashiorkor, Marasmus- aetiology, metabolic disorders and management. Diseases related to digestion and absorption of food.

Composition of blood, Plasma Proteins, Formed elements – overview, Coagulation, Hemoglobin metabolism and Chemistry of Respiration, Abnormal Hemoglobin and their deficiencies, Renal Function, Liver and detoxification, Liver diseases, Renal function test, liver function test. Inborn errors of metabolism, Antibiotics – action of Penicillin, Streptomycin, Tetracyclin, Chlorophenicol, Rifampicin .

MODULE -III: Metabolism and Enzymology

Metabolism of carbohydrates -glycolysis, glycogen metabolism, citric acid cycle, Pentose Phosphate pathway, Gluconeogenesis, Bioenergetics – Ultrastucture of Mitochondria, electron transport chain, oxidative Phosphorylation, Metabolism of lipids – Fatty acid synthesis and degradation, Ketone, bodies, Cholesterol metabolism – Eicosanoids, phospholipid metabolism, Metabolism of lipoproteins, Metabolism of amino acids and nucleic acids. Regulation of metabolic pathways. Associated metabolic disorders.

Nomenclature and classification of enzymes, isolation and purification of enzymes, Enzyme Kinetics, Enzyme inhibition, vitamins as coenzymes,. Active site, Mechanism of Enzyme action, Regulation of enzyme activity, Allosteric enzymes, Isoenzymes, Industrial and clinical applications of enzymes.

MODULE-IV: Molecular biology and immunology

Genetic information carriers-DNA replication(prokaryotes and eukaryotes) and Repair, Transcription and translation(prokaryotes and eukaryotes), post transcriptional processing, post translational modifications, types of RNA, genetic code, regulation of transcription and Translation, operons, gene silencing , micro RNA, epigenetics.

Overview of the Immune system, Cellular components of the immune system, Nature of Antigen and Antibody , Innate immunity, Soluble factors, Inflammation, Phagocytosis. Adaptive Immunity, Lymphocyte, T and B cell maturation, Clinical Immunology, Antigen – antibody interactions, Diagnostic techniques, Applications, Immunodeficiencies , Immuno therapy.

Chemistry

Unit I - Structural and Solid state Chemistry

Theories of Metal Complexes - LFT CFT, Spectral and Magnetic properties of transition metal complexes, Term symbols, Selection rules for electronic transition, Spin orbit coupling. Organometallic compounds- Isolobal analogy. Metal carbonyls, Complexes with linear π donor ligands, Olefins, acetylenes, dienes and allyl complexes. Complexes with cyclic π donors, Fluxionality. Interhalogens, Sulphur-Nitrogen compounds, Phosphazines and Boron compounds, Wade’s Rule. Metallaboranes and metallacarboranes. Spectral and Magnetic properties of Lanthanides and Actinides, Shift Reagents.

Crystalline state - Crystal systems and lattice types, Bravais lattices. Crystal symmetry, Point groups and space groups. Miller indices, Reciprocal lattice concept, X-Ray diffraction by crystals, Structure factor, Fourier synthesis. Perosvskite, Spinels, Inverse spinel structures.

Solid state Chemistry- Superconductivity, Photoconductivity, Photovoltaic effect. Colour in inorganic solids. Dielectric properties- Ferroelectricity, pyroelectricity, piezoelectricity.

Unit II- Stereochemistry and Spectroscopy in Organic Compounds

Structure and Stereochemistry, Correlation of structure and reactivity, Aromaticity of annulenes, Non-benzenoid aromatics, Molecular chirality, Stereochemical nomenclature of compounds with chiral centres, axis and planes, Prostereoisomerism, Non-carbon chiral centres, Atropisomerism. Reactions of sp3, sp2 Carbon and aromatic systems, Cram's rule. Felkin-Anh Model. Reactive Intermediates and Rearrangement Reactions.

Pericyclic Reactions, electrocyclic, cycloaddition and sigmatropic reactions, 1,3-dipolar cycloadditions, ene reactions, cheletropic reactions, Woodward-Hoffmann selection rules. Organic Photochemistry, Primary photoprocesses aromatic photo rearrangements. Chemi and bioluminescent reactions. Organic structure elucidation by spectroscopy- 1H and 13C NMR chemical shifts and coupling constants of organic compounds. UV-VIS spectra of enes, eneones, arenes and conjugated systems. Woodward-Fieser rules, Structural features by IR. Mass Spectroscopy in organic structure analysis

Unit II- Theoretical Chemistry and Kinetics

Quantum Mechanics- Wave functions, Concept of Commutators. Eigen function and eigen values, Tunnelling. Zero point energy and significance, Radial probability distribution function and graphs. Maxwell-Boltzman, Bose-Einstein and Fermi-Dirac statistics. Symmetry elements and symmetry operations- Point groups, Applications of character tables to spectroscopy.

Molecular Spectroscopy- Theory of Microwave spectroscopy, Infrared spectroscopy, Raman spectroscopy, Electronic spectroscopy, Resonance spectroscopy-NMR, ESR & Mossbauer.

Influence of temperature and pressure on transport properties, Mean free path, Collision diameter, Collision Theory. Activated complex theory. Order and molecularity of reactions. Steady state approximation. Kinetics of fast reactions, Relaxation spectrometry, Flash photolysis. Factors influencing reaction rates in solution. Catalysis-Mechanism and theories of homogeneous and heterogeneous catalysis.

Unit IV- Instrumentation methods in Chemical Analysis

Instrumentation and application of Radiation Analysis Methods- Detection counters. Geiger counter, scintillation counters, Neutron activation analysis. Isotope dilution methods. radioactive tracer techniques and its applications. Electroanalytical Methods- Principles, Instrumentation and applications of Electrogravimetry, Coulometry, Polarography, Amperometry, Cyclic voltametry, Potentiometry and Conductometry. Thermal and Surface Analysis Methods- Principles, instrumentation and applications of

TG, DTG, DTA, DSC. Introduction to, SEM, TEM, AFM STM, and other surface characterization techniques.

Chromatographic Methods- Principles, instrumentation and applications of column chromatography, paper chromatography, thin layer chromatography, ion-exchange chromatography, gas chromatography and liquid chromatography. Hyphenated techniques,

Instrumentation of of UV-Visible Spectrometer, IR and Spectroflurometer, AAS, AES, , ICP AES, XPS Radiation Sources for UV Visible and Infrared Monochromators. Detectors-CCD, Photomultiplier Tube, Michelson Interferometer.

Forensic Science

Unit I

Forensic science: definition, history and development, ethics in forensic science.

Courts : types, powers and jurisdiction.

Forensic jurisprudence.

Organisation of forensic science laboratories of centre and state, NCRB and NICFS.

Crime scene: Nature, types, preservation of scene of crime, collection and preservation of evidence.

Unit II

Physical evidences: Nature, types, search methods, collection and preservation.

Hair and fibres- types, structure, examination with different instruments.

Soil- nature, types, examination, forensic importance.

Paints, lacquers, varnishes- nature, composition and forensic examination.

Examination and analysis of cement, mortar and concrete.

Unit III

Forensic medicine

Modes and manners of death, sexual offences-Medico-legal importance, Amendments in laws related to sexual offences.

Post-mortem changes and estimation of time since death,

Individual identification from skeletal remains, determination of species of origin, sex, age, stature.

Skull superimposition and recent advancements in facial reconstruction.

Human dentition, type of teeth, bite marks, estimation of age from teeth.

Cheiloscopy.

Asphyxia: classification and signs.

Injuries & Wounds: types, classification and medico-legal importance.

Unit IV

Toxicology

Analysis of Illicit liquors.

Analysis of ethyl alcohol in biological fluids and breath.

Plant poisons- active principles and mode of action.

Metabolism and chemical examination of drugs of abuse, narcotics, sedatives, hypnotics.

Toxicity and analysis of insecticides and pesticides.

Identification and extraction of common poisons from viscera, tissues and body fluids including clean-up procedures.

Unit V

Ballistics

Classification and examination of firearms and projectiles.

Ammunition- composition and examination.

Basics of Internal, external and terminal ballistics.

Analysis of gunshot residues.

Phenomena associated with projectile- Yaw, Richocet, Accidental discharge.

Determination of range and velocity in firearms.

Fire and Arson

Analysis of incendiary materials and petroleum products.

Explosives: definition, types and analyses.

Bombs and IEDs and their examination.

Investigation in explosion and arson related cases.

Unit VI

Instrumentation

Microscopy- Comparison, Stereoscopic, Polarising, Stereoscopic, Fluorescent and Electron microscope

X-Rays and x-ray based techniques- fluorescence and diffraction.

Neutron Activation Analysis

Mass spectroscopy.

Spectrometry- UV, Visible, IR, Raman, Atomic Absorption, Emission.

Chromatography- TLC, GC, HPLC, HPTLC, and associated hyphenated techniques.

Electrophoresis, immunoassays.

Photography- types and application.

Unit VII

Computer forensics- types of digital evidences, seizure and examination.

Mobile phone forensics- tools and analysis.

Biometric systems of identification-relevance and application.

Voice analysis- introduction, significance, voice spectrography and analysis

Structure of human voice apparatus.

Criminal profiling: Polygraph –principles, PDD, Narco-analysis, Brain mapping.

Unit VIII

Biology and Serology

Blood stains- identification and detection, blood group systems.

Determination of blood groups of stains and species of origin.

Detection of seminal and other fluids and their blood groupings.

Red cell enzymes, serum proteins and significance.

DNA structure, profiling, extraction and application.

RNA profiling and application.

Disputed paternity and maternity.

Unit IX

Tool marks: Types and examination, Restoration of erased markings.

Track marks: examination of foot prints, shoe prints, tire marks preservation and casting.

Wild life forensics: Wild life (Protection) Act 1972, scope, evidences and identification.

Forensic entomology, insects of forensic importance and application.

Forensic psychology: delusion-types, difference between psychosis and neurosis, lucid interval, sections related with criminal responsibility of insane, rules related with criminal responsibility of insane persons(McNaughten's rule, Curren's rule, Durrham's rule), irrestible impulse test – New Hampshire doctrine.

Unit X

Documents: types and forensic examination.

Age of documents, Inks, papers and their scientific examination.

Examination of alterations, obliterations and additions.

Hand writings: class and individual characteristics, factors affecting handwriting, indentations, secret writings and writings on charred documents, anonymous and disguised writings.

Examination of typescripts and printed matters.

Examination of credit cards and similar materials.

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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