GROUP-39

B.Sc. Micrology Jobs

1) General awareness, Reasoning, Mathematics, Science, History including Haryana related history, current affairs, literature, Geography, Civics, Environment, Culture etc.- (**Weightage 20%)**

2) Computer terminology, Fundamentals, word software, excel software, Power point, internet, web browsing, Communication, emails, downloading and uploading data on websites etc**. -**

(Weightage 10%)

3) Subject related syllabus- **(Weightage 70%)**

Structure and Function of Biomolecules

Water and Carbohydrates: Water and its physicochemical properties; Classification of carbohydrates; Occurrence, characteristics, structure and functions of monosaccharides, disaccharides, oligosaccharides and polysaccharides; structure and conformation of sugars; monosaccharides: stereoisomerism and optical isomerism; chemical reactions of the functional groups; sugar derivatives; Glycoproteins; peptidoglycan, proteoglycan, N-linked and O-linked glycoproteins bacterial cell wall polysaccharides; blood group polysaccharides; glycobiology, glycol-mics

Amino acids and nucleotides: Structure, nomenclature, classification, acid-base properties of amino acids and their applications, chemical reactions of amino acids; stereoisomerism and optical properties of amino acids; non-natural amino acids; Structure and properties of purines and pyrimidine bases; structure and functions of nucleotides.

Lipids: Classification of lipids; structures, nomenclature and properties of fatty acids; structure, properties and functions of acylglycerols, plasmalogens, phospholipids, sphingolipids, glycolipids, steroids, prostaglandins and eicosanoids, bile acids lipoamino acids; chemical composition and biological role of lipoproteins; structure and functions of fat-soluble vitamins.

Hormones: General characteristics, classification, chemistry and functions of thyroid, parathyroid, adrenal, pancreatic, gastric and reproductive hormones; hypothalamus and pituitary; detection of hormones; hormone replacement therapy; pheromones.

Cell Biology

Prokaryotic and eukaryotic cells, Common and distinguishing features between them.

Plasma membrane: An overview of membrane functions; Brief history of studies on plasma membrane structure, chemical composition of membranes: membrane lipids, membrane carbohydrates and membrane proteins, Glycocalyx, membrane lipids and membrane fluidity, the dynamic nature of the plasma membrane, methods of introducing a membrane-impermeable substance into a cell.

Membrane transport of small molecules:

Principles of membrane transport, Passive diffusion, facilitated diffusion and carrier proteins, ion channels, active transport driven by ATP hydrolysis and by ion gradients

Mitochondria: Mitochondrial structure and function, mechanism of oxidative phosphorylation, critical roles of mitochondria in cell metabolism besides ATP production

Chloroplast and other plastids: structure of chloroplast, role of chloroplasts in photo-synthetic metabolism, different types of plastids

Peroxisomes: structure and functions of peroxisomes and their involvement in photorespiration.

Cell wall: bacterial and eukaryotic cell wall

Endoplasmic reticulum: ER and protein secretion, targeting proteins to the ER, insertion of proteins into the ER membrane, protein folding and processing in the ER, SER and lipid synthesis

Golgi-apparatus: Organization of the Golgi-complex, protein glycosylation within the Golgi, lipid and polysaccharide metabolism in the Golgi

Lysosomes: Major characteristics and its role in intra-cellular digestion.

The Cytoskeleton: Micro-filaments: structure and organization, muscle contractility; Microtubules: structure and dynamic organization of microtubules, Microtubule organizing centres: centrosomes and basal bodies; Microtubule motor proteins; Cilia and flagella: structure and functions, Intermediate filaments: intermediate filament proteins; assembly, intracellular organization and functions of intermediate filaments

Cellular interactions: Extracellular matrix: matrix structural proteins, matrix polysaccharides, matrix adhesion proteins, Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes; Interactions of cells with other cells: Adhesion junctions, Tight junctions, Gap junctions and Plasmodesmata.

Nucleus: Nuclear envelope and traffic between the nucleus and the cytoplasm, structure of the nuclear envelope, nuclear pore complex, Organization of Nucleolus

The Cell cycle: Overview of eukaryotic cell cycle, Regulation of cell cycle by cell growth and extracellular signals, cell cycle checkpoints, Regulators of cell cycle progression: protein kinases and cell cycle regulation, families of cyclins and cyclin-dependent kinases, DNA damage check points

Cell death and cell renewal: Apoptosis (Programmed cell death), caspases: the executioners of apoptosis, central regulators of apoptosis: TheBcl-2family; Stem cells and their properties, medical applications of adult stem cells, embryonic stem cells and therapeutic cloning.

Proteins and Proteomics

Primary structure of proteins: An overview of protein structure; hierarchy of protein structure; Ramachandran plot; Determination of primary structure of protein – determination of N and C-terminal residue; Determination of amino acid composition of protein and determination of sulfhydryl groups; location of disulphide bonds; Chemical synthesis of peptides; Structure and function of some biologically important polypeptides. Secondary and tertiary structure of proteins: Alpha helix and beta structure; Collagen helix and other types of helical structures; Super secondary structures; Amino acid sequence and three-dimensional structure; Domains; Forces stabilizing the secondary and tertiary structure

Sequencing, protein folding and denaturation: Protein sequencing; Sequenators; Quaternary structure of protein; Structure and function of haemoglobin and cytochrome c; Denaturation and renaturation of proteins; Characteristics of molten globule state; Proteins involved in folding; Models of protein folding; Chaperones and Levinthal paradox; Protein conformation and diseases.

Protein purification and separation techniques: Protein purification; criteria of purity, and fold purification; Ion-exchange, gel-filtration and affinity chromatography techniques; High performance liquid chromatography (HPLC); Iso-electric focusing (IEF); Native-PAGE and SDS-PAGE; Detection and quantification of proteins in gels; Recovery of proteins from gels.

Proteomics: Overview and tools; Two-dimensional PAGE; Protein spot detection; Mass spectrometry: matrix assisted laser desorption ionization MS, Electrospray ionization MS, and tandem MS for protein identification; Identification of protein-protein interactions; Protein complexes; X-ray crystallography; Transmembrane domains; Functional proteomics; Application of proteome analysis.

Bioenergetics and Metabolism-I

Bioenergetics: Concept of Free energy; standard Free energy; Relationship between standard free-energy change and equilibrium constant; Coupled reactions; High-energy compounds. Biological oxidation: Oxidation & reduction; Oxidation-reduction half reactions; Nernst equation, measurement of standard reduction potentials; Calculation of Delta-G from standard reduction potentials; Enzymes involved in oxidation and reduction (oxidases, dehydrogenases, hydroperoxidases and oxygenase's). Introduction to Metabolism and Experimental approaches for studying metabolism.

Carbohydrate Metabolism: Reactions, energetics and regulation of glycolysis; Feeder pathways for glycolysis; Fate of pyruvate under aerobic and anaerobic conditions; Pasteur effect; Pyruvate dehydrogenase complex and its regulation; Reactions, regulation and amphibolic nature of TCA Cycle; Anaplerotic reactions; Glyoxylate cycle; Pentose Phosphate Pathway; Gluconeogenesis; Cori cycle; Biosynthesis of lactose and sucrose; Glycogenesis and Glycogenolysis; Control of glycogen metabolism; Maintenance of blood glucose levels.

Lipid Metabolism: Mobilization and hydrolysis of triacylglycerols; Fatty acid oxidation: Franz Knoop's experiment; β-oxidation of saturated, unsaturated and odd-chain fatty acids; Peroxisomal β-oxidation; Minor pathways of fatty acid oxidation (α- and ω- oxidations); Formation and utilization of Ketone bodies; Biosynthesis of saturated fatty acids; Elongation and desaturation of fatty acids; Biosynthesis of triacylglycerols; Regulation of fatty acid metabolism; Cholesterol biosynthesis and its regulation; Biosynthesis of glycerophospholipids and sphingolipids; Breakdown of sphingolipids by lysosomal enzymes; Formation of prostaglandins, prostacyclin's, thromboxane's and leukotrienes from arachidonic acid.

Mitochondrial Electron Transport Chain and Oxidative Phosphorylation: Mitochondrial Transport Systems; Nature, order and organization of the components of electron transport chain; electron flow from NADH and $FADH_2$ to O_2; sites of ATP production; inhibitors of electron transport chain; Coupling between oxidation and phosphorylation; Chemiosmotic hypothesis of oxidative phosphorylation; Mechanism of ATP synthesis: Structure of proton-translocating ATP synthase; Binding Change Mechanism for proton-driven ATP synthesis; Uncoupling of oxidative phosphorylation; Control of oxidative phosphorylation.

Metabolism–II

Amino acid degradation: General reactions of amino acid metabolism: Transamination; Oxidative, non-oxidative deamination and decarboxylation reactions; Role of glutamine in ammonia transport; Glucose-Alanine Cycle; Urea Cycle; Metabolic breakdown of individual amino acids (both essential and non-essential)

Amino acid biosynthesis: Biosynthesis of non-essential and essential amino acids; Regulation of amino acid biosynthesis; Amino acids as biosynthetic precursors of phosphocreatine, glutathione, dopamine, non-epinephrin and epinephrin, GABA, histamine, serotonin, polyamines (spermine and spermidine), and indole-3-acetic acid. Porphyrins: Structure of porphyrins; Important porphyrins occurring in nature; Biosynthesis of heme and its regulation; Degradation of heme; Regulation of hemebiosynthesis; Chlorophyll biosynthesis.

Nucleotide metabolism: De novo biosynthesis and regulation of purine and pyrimidine nucleotides; Salvage pathways of purines and pyrimidines; Ribonucleotide reductase and formation of deoxyribonucleotides (dNTPs) from ribonucleotides (NTPs); Catabolism of purine and pyrimidine nucleotides; Chemotherapeutic agents as inhibitors of enzymes in nucleotide biosynthetic pathways; Biosynthesis of nicotinamide coenzymes, flavin coenzymes and coenzyme A. Integration of metabolism: basic strategy of catabolic metabolism; Recurring motifs in metabolic regulation; Major metabolic pathways and control sites; Key junctions in metabolism (glucose-6-phosphate, pyruvate and acetyl CoA); Organ specific metabolic profile; Metabolic changes induced by food intake and starvation; Ethanol metabolism in the liver.

Secondary plant metabolism: Primary and secondary metabolites; Isoprenoids: introduction, different classes with examples; biosynthesis of carotenoids (Limonene, Lycopene and β-Carotene); Alkaloids: definition, classification according to their heterocycles with examples; physiologically active alkaloids (used in medicine and plant chemical defence); Phenylpropanoids: Introduction; overview of products of the phenylpropanoid metabolism; Biosynthesis of lignin; Flavonoids: nature; classification of aglycons with examples; functions of flavonoids; Nature of Tannins, Cyanogenic glycosides and Glycosylates

Clinical Biochemistry

Clinicalbio-chemistryandqualityassurance:biologicalsamples(blood,urineandcerebrospinalfluid):chemical composition, collection,processing, storage and reservation;Qualitycontrol:accuracy, precision, Specificity, Sensitivity, Levy Jining's chart.

Blood: clinical significance and functions of plasma proteins (albumin, alpha 1-antitrypsin, haptoglobin, caeruloplasmin, transferrin, C-reactive protein); Disorders of haemoglobin: thalassemia, anaemia (different types) and porphyria's.

Clinical enzymology: Enzymes as diagnostic tool; Clinically important enzymes: alkaline phosphatase, acid phosphatase, aldolase, creatine kinase, LDH, AST, ALT, lipase, amylase and 5'-nucleotidase; isoenzymes and their diagnostic importance. Organ function tests: Assessment of liver, kidney, exocrine pancreas and G.I. tract function tests. Detoxification: Phase I and Phase II reactions.

Metabolicdisorders:Disordersofcarbohydratemetabolism:Diabetesmellitus, diabetic ketoacidosis,hypoglycemia,glycogenstorage disease and galactosemia; glucose tolerance test; disorders of lipid: Refsum's disease, fatty liver and lipotropic factors, hypo lipoproteinemia and hyper lipidaemia. Atheros sclerosis: pathogenesis and risk factors; Disorder of amino acid metabolism: Maple syrup urine disease, phenylketonuria, Alkaptonuria, cystinuria and homocystinuria; disorder of nucleic acid metabolism: Gout, Lesch-Nyhan Syndrome, Hypouricemia, Oro tic Aciduria; disorders of calcium, magnesium, phosphorous, iron, copper and selenium metabolism; disorders of fat soluble (A, D, E and K) and water soluble vitamins (Thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, vitamin B12 and ascorbic acid)

Hormone disturbances: disturbances related to protein hormones (anterior and posterior pituitary), steroid hormones and thyroid hormones.

Electrolyte and acid base balance: disorders of electrolytes (hypernatremia, hyponatremia, hypokalaemia, hyperkalaemia, hyperchloremia, hypochloraemia); water and acid base balance (metabolic and respiratory acidosis, metabolic and respiratory alkalosis)

Neuropsychiatric disorders: Alzheimer's & Parkinson's disease.

Enzymology

Introduction: Historical perspectives; General characteristics; Nomenclature and classification; Introduction to the following terms with examples – Holoenzyme, apoenzyme, cofactors, coenzymes, prosthetic groups, metalloenzymes, turnover number, enzyme activity units, and specific activity.Multienzyme systems and multifunctional enzymes with specific examples and significance. Enzyme specificity: Types of specificity; three-point attachment theory to explain stereospecificity; Lock-and-key hypothesis; Induced- fit hypothesis; Hypothesis involving strain or transition-state stabilization.Enzyme Catalysis: Role of NAD+/NADP+, FMN/FAD, coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, lipoic acid, biocytin, Vitamin B12 Coenzyme, and tetrahydrofolate coenzymes in enzyme catalysis; Common features of active sites;Reactionco-ordinate diagram; Proximity & orientation, acid-base catalysis, and covalent catalysis; Mechanism of action of chymotrypsin, ribonuclease, carboxypeptidase, and lysozyme

Enzyme assay: Introduction; Kinetic and coupled enzyme assays. Enzyme Kinetics: Factors affecting enzyme activity; Arrhenius plot; Derivation of Michaelis-Menten equation for uni-substrate reactions; Km and its significance; Kcat/Km and its importance; Measurement of Km and Vmax by Lineweaver-Burk plot and other linear transformations of MM equation; Bi-substrate reactions: Sequential and ping-pong mechanisms with examples and determination of Km and Vmax for each substrate (derivations excluded); Use of initial velocity studies, product-inhibition studies and isotope exchange at equilibrium for determining the kinetic mechanism of a bi-substrate reaction.

Methods of studying fast reactions: A brief account of rapid mixing techniques, flash photolysis and relaxation methods. Enzyme inhibition: Reversible (competitive, non- competitive, and uncompetitive) and irreversible (affinity labels and suicide inhibitors) enzyme inhibitors; Determination of Ki. Investigation of active site structure: Methods for identification of binding and catalytic sites- Trapping the enzyme-substrate complex, use of substrate analogues, chemical modification of amino acid side chains in enzymes, enzyme modification by proteases and effect of changing pH.

Enzyme regulation: Coarse and fine control of enzyme activity; Enzyme induction & Repression; Feedback inhibition; Allosteric enzymes with aspartate trans-carboxylase as an example; Concerted and sequential models for action of allosteric enzymes; Negative and Positive Cooperativity; Hill plot; Scat chard plot; Regulation by reversible and irreversible covalent modification of enzymes; Isoenzymes. Ribozyme and Abzyme

Molecular Biology-1

Basic Concepts of Genetic Information: Nucleic acids as the genetic material - experimental evidences; Chargaff's rules Structure of DNA, Structural polymorphism of DNA (A, B and Z-DNA) various forces responsible for stability of DNA, DNA topology, topological and geometric properties, DNA supercoiling, Topoisomerases in prokaryotes and eukaryotes, DNA organization in prokaryotes and eukaryotes, C-value paradox, denaturation: different ways for carrying out denaturation, renaturation: requirements, kinetics, significance, various classes of DNA: highly repetitive, moderately repetitive and unique sequence, RNA: structure and types.

DNA replication, mutations and DNA repair: Possible modes of DNA replication, Meselson-Stahl experiment, DNA polymerases and other enzymes involved in DNA replication, Okazaki fragments, Mechanism of replication in prokaryotes and eukaryotes, inhibitors of DNA replication, molecular basis of mutations, DNA repair mechanisms like direct, base-excision, nucleotide-excision, mismatch, SOS and recombinational repair.

Transcription and post-transcriptional modifications: RNA polymerase/s in prokaryotes and eukaryotes, DNA footprinting technique, initiation, elongation and termination of transcription in prokaryotes and eukaryotes, inhibitors of transcription, RNA replicase, reverse transcriptase, post-transcriptional modifications: different types of introns and their splicing mechanisms, processing of mRNA, rRNA and tRNA precursors, overlapping genes and split genes.

Protein synthesis, targeting and degradation: Characteristics of the genetic code, biological significance of degeneracy, decoding the code, Wobble hypothesis, ribosomes structure and function in prokaryotes and eukaryotes, Aminoacyl tRNA-synthetases, various factors and steps involved in protein synthesis in prokaryotes and eukaryotes, polyribosomes, post-translational processing, signal hypothesis and protein targeting to lysosomes, Plasma membrane, extracellular matrix and different compartment of mitochondria and chloroplast, protein degradation.

Food Biochemistry

Classes and sources of nutrients (overview), energy value of foods, Basal metabolic rate, specific dynamic action, nutritional importanceofcarbohydrates, Glycaemic index,fibresinnutrition,nutritionalimportanceoflipids,essentialfattyacids,nutritional importance of proteins, nitrogen balance, mutual supplementation of proteins, concept of balanced diet,

Vitamins:majorfunctions,dietarysources,deficiencysymptomsof fat-soluble and water-soluble vitamins,hypervitaminosisof fat-soluble vitamins; Minerals: major functions, dietary sources, deficiency symptoms and toxicity symptoms of major and trace minerals

Food toxicity and safety: Microbial contamination, environmental contamination, natural toxins, agricultural residues, intentional food additives.

Applications of major enzymes in food industry

Nutritional disorders:Lipoproteins and cardiovascular disease: ‘good’ and ‘bad’ cholesterol, risk factors for cardiovascular disease.

Nutrition and Cancer: Associations between nutritional factors and common cancer sites; effect of different foods, beverages, physical parameters and other additional factors on cancer.

Molecular Biology – II

Gene regulation: Various levels of control of gene expression in prokaryotes and eukaryotes, operon concept, regulation of expression of lac, galactose, araBAD, tryptophan operons and lambda phage’s, regulation of ribosome synthesis, motifs involved in DNA- protein, protein-protein interactions;Variousregulatory sequences in eukaryotes, molecular aspects of regulation of gene expression at transcription level viz. repression by nucleosomes, DNase sensitivity and hypersensitivity, histone modifications etc., at post-transcriptional level like regulation of RNA splicing, RNA transport, RNA stability; at translational, post-translational and protein degradation level.

Transposable genetic elements: non-replicative and replicative transposition, transposable genetic elements in bacteria, yeast, maize, drosophila and significance of transposable elements.

Interaction of nucleic acids with small molecules: Reactions of nucleic acids with non-carbon electrophiles, nitrogen electrophiles, carbon electrophiles, anticancer drugs, photochemical modifications of nucleic acids, effects of ionizing radiations on nucleic acids.

Molecular Biology of Cancer: Benign and malignant tumors, types of cancers, cancer causing agents-radiations, chemical compounds, DNA and RNA viruses; mechanism of carcinogenesis; important characteristics of cancerous cells; proto-oncogenes and oncogenes, gain of function mutations of proto-oncogenes-growth factors, growth factor receptors, intracellular signal transducers, nuclear transcription factors, cell cycle control proteins, apoptotic proteins, DNA repair proteins into oncogenes; Rb and P53 as tumor suppressor genes, telomerase expression and immortalization of cells.

Drosophila development and its regulation: Various stages of oogenesis, blastula ion, gastrulation to form three cell layers, morphogen gradient, details of three classes of pattern control genes like egg-polarity genes, segmentation genes, homeotic selector genes and imaginal discs.

Genomics: Structural genomics-construction of cytological maps based on banding pattern, physical maps based upon contigs, sequence-tagged sites (STSs), expressed-sequence tags (ESTs), genetic maps based upon RFLP, microsatellites, variable number tandem repeats; Map position- based cloning of genes; The human genome project; functional genomics- DNA microarray, serial analysis of gene expression (SAGE); comparative genomics- prokaryotic, chloroplast, mitochondria and eukaryotic genomes; evolution of genomes in the cereal grasses and mammals.

Immunology

Introduction to immune system: Memory, specificity, diversity, innate and acquired immunity, self vs non-self-discrimination, structure and functions of primary and secondary lymphoid organs. Cells involved in immune responses: Phagocytic cells and their killing mechanisms; T and B lymphocytes. Nature of antigen and antibody: Antigens vs immunogen, hatpins, structure and functions of immunoglobulins; isotypic, allotype and idiotypic variations.

Humoral and cell mediated immune responses: Kinetics of primary and secondary immune responses, complement activation and its biological consequences, antigen processing and presentation, cytokines and costimulatory molecules- role in immune responses, T and B cell interactions.Major Histocompatibility Complex(MHC) genes and products:polymorphism of MHC genes, role of MHC antigens in immune responses, MHC antigens in transplantation.

Generation of diversity in immune system: Clonal selection theory- concept of antigen specific receptor, organization and expression of immunoglobulin genes- generation of antibody diversity, Organization and expression of T-cell receptor genes- generation of T cell receptor diversity. Immunization: Active & passive immunization.

Tolerance vs activation of immune system: Immune tolerance, immunosuppression, hypersensitivity (Types I, II, III and IV). Immune responses in diseases: Immune responses to infectious diseases- viral, bacterial and protozoal; cancer and immune system, immunodeficiency disorders and autoimmunity.

Plant Biochemistry

Chemical and physical composition of higher plant cell wall. Light reactions of Photosynthesis: Photosynthetic pigments, chlorophyll excitation by absorption of light energy and its return to the ground state, Requirement of an antenna to capture light, van Neil equation, Hill equation, Cyclic electron transport in purple photosynthetic bacterium, Red drop and Emerson enhancement effect, Photosystem I & II, Non-cyclic, cyclic and pseudo cyclic photosynthetic electron transport, Inhibitors of non-cyclic electron transport, Regulation of energy distribution between PS I and PS II, Photophosphorylation: coupling between electron transport and phosphorylation, chemiosmotic hypothesis, chloroplast ATP synthase, binding change mechanism of ATP synthesis and uncouplers of photophosphorylation.

Pathway and regulation of CO_2 assimilation in C3, C4 & CAM plants. Photorespiration: pathway and significance. Metabolism of Sucrose and Starch: Biosynthesis and degradation of starch and sucrose; role of fructose 2, 6- bisphosphate in carbon partitioning between sucrose and starch. Electron transport in plant mitochondria: Electron transport complexes and pathway of electron flow in plant mitochondria; cyanide - resistant respiratory pathway.

Nitrogen Metabolism: Nitrogen Cycle; Nitrate Assimilation: nitrate uptake, nitrate & nitrite reduction and regulation of nitrate assimilation. Biological nitrogen fixation: Nitrogen fixing organisms, structure and mechanism of action of nitrogenase, Legume-

Rhizobium symbiosis (A brief account), Leghaemoglobin, Strategies for protection of nitrogen as againsttheinhibitory effect of oxygen, Uptake hydrogenase, Ammonia assimilation, nifgenes of Klebsiella pneumoniae and their regulation, and synthesisofamidesandureides.Sulphateas simulation:sulphateuptakeanditsassimilationintocysteine.

Biochemical defence mechanisms in plants against pathogens; Plant hormones: Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinin’s, ABA and ethylene. Phytochromes as light sensors.

Nutritional Biochemistry

Composition of human body, Energy content of foods, respiratory quotient of food stuffs, measurement of energy expenditure (directandindirectcalorimetry), BMR: measurementandsignificanceofBMR, factorsaffectingBMR; Specific dynamic action (SDA); Carbohydrates:nutritional importance, sources of available carbohydrates; fibres innutrition: beneficial effects, adverse effects and their sources, glycaemic index, alternative sweeteners; Lipids: nutritional importance, major classes of dietary lipids, properties and composition of plasma lipoproteins, essential fatty acids and their physiological functions; Proteins: nutritional importance, nitrogen balance, assessment of nutritive value of proteins, concept of balanced diet.

Minerals:nutritionalsignificance,dietary sources,deficiencysymptomsandtoxicity'ssymptomsofmajorand trace minerals Vitamins: dietary sources, physiological functions and specific deficiency diseases associated with fat- and water-soluble vitamins, hypervitaminosis of fat-soluble vitamins

Food toxicity and safety: Microbial contamination, Environmental contamination, Natural food toxins and Antinutrients: naturally occurring food borne toxicants, protease inhibitors, hemagglutinin, hepatotoxins, allergens, oxalates, toxin from mushrooms, animal foodstuffs andseafoods; Agricultural residues, Intentional food additives:typesoffoodadditives-attributes and related health concerns; Nutraceuticals: different types of Dietary supplements and typical ingredients of Functional foods

SECTION D

Applications of major enzymes in food industry

Nutritional disorders: Lipoproteins and cardiovascular disease: 'good' and 'bad' cholesterol, development of cardiovascular disease and risk factors for cardiovascular disease

Protein energy malnutrition: etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkor diseases

Nutrition and Cancer: Associations between nutritional factors and common cancer sites; effect of different foods, beverages, physical parameters and other additional factors on cancer.

Human Physiology

Gastrointestinal Physiology: Secretory functions of the alimentary tract: General principles of alimentary tract secretion; Basic mechanism of stimulation of alimentary tract glands; Basic mechanism of secretion by glandular cells; Lubricating and protective properties of mucus and importance of mucus in gastrointestinal tract; Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids and proteins

Respiration: Components of respiratory system and their functions; transfer of blood gases- O_2 and CO_2; Bohr effect; role of chloride ions in oxygen transport; effect of 2,3-BPG on O2 affinity of Hb; Clinical importance of 2,3-BPG.

Acid Base Balance: Acid base balance; Role of blood buffers; respiratory and renal mechanism in the maintenance of blood pH;

Excretory System: Structure of nephron; formation of urine; tubular re-absorption of glucose, water and electrolytes; tubular secretion; regulation of water and electrolyte balance; role of kidneys and hormones in their maintenance.

General principles of nervous system: Structure of a neuron, resting potential, action potential, propagation of action potentials as an impulse; types of synapses; role of Ca+2 in release of neurotransmitter from pre-synaptic membrane; function of receptor proteins and secondary messenger on the postsynaptic neuron; Characteristics of some important neurotransmitters (Dopamine, GABA, Glutamate, Acetylcholine, Serotonin, NO).

Blood Cells and Blood Clotting: Blood components and their function; plasma proteins; blood coagulation.

Hormones: Classification and mechanism of action, physiological functions, regulation of growth hormones, ADH, oxytocin, thyroid hormones, mineralocorticoid, glucocorticoid, insulin, glucagon, parathyroid hormone, and male and female reproductive hormones.

Bio-signalling: General features of signal transduction, G protein-coupled receptors and Second messengers (cAMP, diacyl glycerol, inositol triphosphate and Ca 2+ ions), receptor tyrosine kinases

Clinical Diagnostics in Health and Disease

Introduction to health and disease; General biochemical test: Blood group, Hb, total cell count, differential cell count (TLC and DLC), ESR, bleeding time, clotting time, Urine analysis (protein, sugar and pigments), blood sugar, GTT and acetylated Hb. General microbiological tests: culture and sensitivity (urine and blood) tests. Biochemical tests in clinical medicine– diagnostic tests and their clinical significance:Liver function tests: SGOT, SGPT, ALP;Kidney function tests: Urea and creatinine; Cardiac function tests: blood pressure, lipid profile – HDL-c, LDL-c, total cholesterol, triglycerides, electrolytes;lung function tests.

Molecular diagnosis of viral diseases: HIV (I and II), H1N1, Chikungunya, Dengue, viral hepatitis (B and C). Diagnosis of infectious diseases: tuberculosis, cholera, Typhoid and malaria; TORCH – panel; Infection in pregnancy; microscopic examination of body fluids, ELISA and PCR tests.

Biostatistics and Bioinformatics

Fundamentals of Statistics: Arithmetic mean, median, mode: measures of variation: standard deviation, variance, coefficient of variation; properties; correlation: types and methods; simple, multiple, linear and nonlinear correlation, spearman's correlation, rank correlation; regression: linear and curvilinear regression (for X and Y only), regression lines by least square method, regression equations of X on Y and Y on X only; sample size; power of study.

Tests of Significance: Null hypothesis; standard error; level of significance; degrees of freedom; significance of mean for large samples; significance in means for small samples (students t-test); significance in ratio of two samples; F test (for difference between variance of two samples); chi square test; analysis of variance (ANOVA) test for one and two way classification; applications of various online tools: SPSS, Minitab, XLSTAT etc.

Fundamentals of Bioinformatics: Introduction to bioinformatics; concept of databases; biological databases; integration of databases; applications and problems in information retrieval from biological databases; Pairwise sequence comparisons by DOT-MATRIX and dynamic programming; Global (Needleman and Wunsch algorithm) and local (Smith and Waterman algorithm) alignments; Measures of sequence similarity (Alignment score, % sequence identity; percentage similarity; statistical scores–E, P and Z); Heuristic approaches for database searching; BLAST and FASTA; multiple sequence alignment; SP scoring; multidimensional dynamic programming; progressive sequence alignment approach.

Applications of Bioinformatics: Gene, ORF of a gene, promoter and regulatory elements prediction; phylogenetic analysis (phylogeny, Phylogenetic tree, construction methods of Phylogenetic tree and Phylogenetic programs); protease digestion mapping; protein structure analysis; protein secondary structure prediction; Homology modelling (principles and procedures); docking; determination of metabolic pathways.

Biotechniques

Radioisotope techniques: Basic concepts (types of radioactive decay, rate of radioactive decay, radioactive isotopes and their half-lives and units of radioactivity); GM and scintillation counter; autoradiography; specific activity of a radioisotope; safety aspects; applications of radioisotopes in biological sciences. Centrifugation: Basic principles; different types of centrifuges; types of rotors; analytical and preparative ultracentrifugation methods.

Molecular biology techniques: Isolation of DNA and RNA, purification and quantification of nucleic acids;Electrophoresis of nucleic acids: agarose gel electrophoresis, pulse field electrophoresis; capillary electrophoresis; microchip electrophoresis; DNA sequence analysis methods: Sanger dideoxy method, Maxam Gilbert chemical method and Fluorescence method; Polymerase chain reaction: principles, process, design and optimization; different types of PCR: allele specific, nested, multiplex and real-time PCR; ligase chain reaction; SNP and application in molecular diagnostics; DNA fingerprinting: applications and prospects; restriction fragment length polymorphism (RFLP) and its uses.

Immuno-techniques: Immunoprecipitation; agglutination; RIA; ELISA; ELISPOT; immunoblotting; immunofluorescence assays; cytotoxic assay; hybridoma technology for production of monoclonal

antibody - principles, techniques and applications; designing chimeric and humanized antibodies; vaccines: types and their role in prevention of diseases.

Spectroscopy: Nature of electromagnetic radiations; principles of biophysical methods used for analysis of biopolymer structure - UV, Visible, Infrared, Raman, Fluorescence and NMR spectroscopy; ORD and CD; Atomic absorption spectroscopy.

Genetic Engineering

Gene cloning strategies: Isolation and purification of nucleic acid and its quantification and analysis; Molecular tools and their applications; Restriction endonucleases; DNA modification enzymes; Site directed mutagenesis; Cloning vectors; Ligation of DNA fragments: Linkers, adapters and homopolymer tailing; Construction of genomic library: mRNA enrichment; Reverse transcription; Synthesis of cDNA and library construction.

Expression vectors: Choice of expression system; Expression in bacterial, yeast, insect and mammalian cells; Baculovirus expression systems; Expression of heterologous genes; Factors affecting the expression of cloned genes; Codon bias; Vector engineering and codon optimization;

Transgenic and gene knockout technologies: Transgenic methodology; Transgenic animals and plants; Targeted gene replacement; chromosome engineering.

Studying gene expression and function: Studying the transcript of a cloned gene; Identifying protein binding sites on a DNA molecule; Identifying control sequences by deletion analysis; Identifying and studying the translation product of a cloned gene by HRT & HART. Studying protein-protein interactions (Phage display and the yeast two hybrid systems). Production of Proteins from cloned genes: Expression in E-coli (Vectors for expression of foreign genes in E-coli, promoters used in expression vectors, general problems with the production of recombinant protein in E. coli); Production of recombinant protein by eukaryotic cells (Recombinant protein production in yeast, insect cells and mammalian cells; Pharming-recombinant protein production from live animals and plants); Recombinant protein purification using His-tag. Importance of gene cloning in medicine for the production of recombinant pharmaceuticals

Intellectual Property Rights: Introduction to IPR, Types of IPR - Patents, Trademarks, Copyright and Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR - patentable and nonpatentable, IPR and WTO regime - consumer protectionand plant genetics resources. Bioethics: Introduction to ethics and bioethics; Ethical and socioeconomic aspects of gene therapy, germline, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMOs, human genome project, human cloning and bio-weapons.

Basics of Microbiology

Members of the microbial world; Impact of microorganisms on humans; Gram+veandGram–vebacteria;Controlof microorganisms by physical & chemical agents; Nutritional types of microorganisms; Culture media; Pure culture techniques; Microbial Growth curve, Continuous culture of microorganisms; influence of environmental factors on growth: solutes and water activity, pH, temperature, oxygen concentration, pressure and radiations; Biofilms

Bacterial Genetics: Transformation, Transduction &Conjugation

Fermentations: Lactic and mixed acid fermentations; Amino acid fermentation by Clostridium species and the Strickland reaction; fermentations without substrate level phosphorylation; Fermenters; Characteristics of large-scale fermentations; Major products of industrial microbiology: Antibiotics (penicillin and tetracyclines), Alcohol and alcoholic beverages, Organic compounds (citric acid); Yeast as a food and food supplement; Microbes as products: Biosensors and Bioinsecticides

Methods of food preservation; Food born infection and intoxications (Salmonella & Staphylococcus)

Biochemical activities of Microorganisms: Extracellular enzymatic activities of microorganisms, Carbohydrate fermentation, Triple sugar-iron agar test, IMViC test, Hydrogen sulphide test, Urease test, Litmus milk reactions, Nitrate reduction test, Catalase test, Oxidase test, Utilization of amino acids, Acetogenesis; Methanogenesis; Microbial Biodegradation of Petroleum and Xenobiotics; Biodegradable plastics, Virus: Structure and general characteristics; cultivation of viruses; Viroid’s and Prions.

Microbial diseases and their control:

Pathogenicity of microorganisms: Host-parasite interactions; pathogenesis of viral diseases; Bacterial pathogenesis; pathogenicity islands; Toxigenicity: General characteristics of Exotoxins and Endotoxins

Antimicrobial chemotherapy: General Characteristics of antimicrobial drugs, Mechanism of action of antibacterial drugs: inhibitors of cell wall synthesis, protein synthesis inhibitors, metabolic antagonists, nucleic acid synthesis inhibitors; factors influencing antimicrobial dug effectiveness, Mechanisms of drug resistance; Mechanism of action of Antifungal drugs and Antiviral drugs

Genetics and Evolution

Inheritance: Mendelian principles; extensions of Mendelian principles (codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance, expressivity and phenocopy); cytoplasmic inheritance; concept of gene; allele (multiple and pseudo); linkage; sex linked inheritance, mutations and recombination.

Human Genetics: Human karyotype: banding and nomenclature of banding and aberrant karyotypes; Common syndromes due to numerical chromosome changes (triploidy, trisomy, monosomy) and structural alterations (translocation, duplications, deletions and fragile sites); Linkage map and Pedigree analysis; Identification of human genetic diseases- positional cloning illustrated using examples- Duchenne muscular dystrophy, cystic fibrosis, Huntington's disease.

Evolutionary Thoughts and History: Lamarckism and Darwinism; Adaption, Struggle, Fitness and natural selection; The evolutionary synthesis; The evolutionary time scales; Eras, periods and epoch; Origins of unicellular and multicellular organism; Major groups of plants and animals; Stages in primate evolution including Homo.

Molecular Evolution: Concept of neutral evolution, origin of new genes and proteins (by gene disruption and exon shuffling); gene duplication and divergence; variation (phenotypes, chromosome structure, protein structure and nucleotide sequences); speciation, allopatry and sympatry; isolating mechanisms; convergent evolution; co-evolution; adaptive radiation. Population Genetics: Populations, Gene pool, Gene and allele frequency; Conservation of gene frequency; Hardy Weinberg Law; concepts of rate of change in gene frequency through natural selection; random genetic drift

Important Note: The Weightage as mentioned against the syllabus is tentative & may vary.