

**Syllabus of Subject for Part-C [50 questions].**

*Questions relevant to applied/analytical part of the biological processes from specific disciplines/subjects.*

**1. Biochemistry**

- *Molecules and their interaction relevant to biology:*  
Structure of atoms, molecules and chemical bonds, Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).  
Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.  
Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes, Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.
- *Introduction to biochemistry;*  
Biomolecules: structure and function  
Techniques in biochemistry: chromatography, electrophoresis, spectrophotometry, etc.
- *Cell Biology and Molecular Biology:*  
Cell structure and function and Cell signaling and communication: The Cell Theory of Life, Sub-cellular organelles, Cytoskeleton and Extracellular matrix, Cell cycle: Prokaryotic and Eukaryotic cells. Structure and function of subcellular organelles. Importance of cell shape, motility in intracellular transport. Structure and movement of cilia and flagella. Microtubules, structure and dynamics. Assembly of various extracellular matrix and their role in integrating cells into tissues and cell-cell interactions. Control of cell cycle in yeast and mammalian cells. Role of various cycle-CDK complexes in the transition of various checkpoint of cell cycle. Role of ubiquitin-protein ligase –SCF and APC/C in the control of cell cycle. Transport across cell membranes: Understanding membrane transport phenomenon, Passive and active transport, Symport, uniport and antiport. Overview of membrane structure and function. Endocytosis and endosome-endosome fusion, Classification of endocytosis, phagocytosis and pinocytosis, clathrin-independent endocytosis, receptor-mediated endocytosis. Overview of exocytosis. Transport of cholesterol and iron in mammalian cells. Identification and mechanism of action of various molecular factors (like Rab5, PI-3-Kinase) involved in endosome-endosome fusion. Protein sorting and targeting: Protein translocation across ER membrane, SRP. ER and Golgi vesicular traffic, Protein import in mitochondria, peroxisomes, chloroplasts. Signal for Import and Export of Macromolecules from Nucleus. Glycosylation in mammalian cells - types, role in protein stability and folding. General principles of signaling by cell surface receptors, endocrine, paracrine and autocrine signaling, types of cellular responses induced by signaling molecules, components of intracellular signal-transduction pathways. G-protein coupled receptor system, General mechanism of the activation of effectors molecules associated with GPCRs, GPCRs that activate or inhibit adenylatecyclase, activate phospholipase C, regulating ion channels. Signaling of growth factors (EGF and Insulin) via activation of receptor tyrosine kinases. Signaling of TGF $\beta$  by Smad proteins. Cytokine signaling via JAK/STAT pathway. Cell Survival and Death Signal: Programmed cell death and role of Caspase protein in apoptosis. Various pro-apoptotic and anti-apoptotic regulators and pathways. Various diseases associated with dysregulated signaling.

Molecular biology techniques: PCR, cloning, gene expression analysis, Electrophoresis – Principle, Polyacrylamide gel electrophoresis (native), SDS-PAGE, Agarose gel electrophoresis, Buffer systems, Detection, identification and staining and applications. Chromatography- Introduction to chromatography, Principle and applications of Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography, Molecular Sieve Chromatography and Affinity Chromatography. Reversed-phase chromatography;

FPLC, HPLC and their applications. DNA and RNA isolation; Northern Blot; Southern Blot; Western Blot; In situ hybridization; In vitro transcription assay; In vitro translation assay; Electrophoretic Mobility Shift Assay; DNA foot printing assay; RNase protection assay; Chromatin immunoprecipitation; Reporter assays, PCR, qPCR, Microarray, Sequencing, mammalian cell culture techniques; Immortalization of cells; Overexpression and Silencing of genes; Cell synchronization, Cell cycle analysis; Cytotoxicity and apoptosis tests; Cell staining techniques; Assays for cell proliferation, migration invasion of cells and cytotoxicity tests. Centrifugation - Principle of centrifugation, Sedimentation coefficient. Factors affecting sedimentation, Various types of centrifuges, Types of rotors. Differential centrifugation, Density gradient centrifugation - zonal and isopycnic. Spectroscopic methods -Absorbance, Beer's & Lambert's Law, Fluorescence, Chemiluminescence, Phosphorescence, Circular dichroism, IR, ESR, FRET, Biomolecular fluorescence complementation assay, FRAP (Fluorescence recovery after photobleaching); Differential Scanning Calorimetry and Isothermal titration Calorimetry. Structural methods - NMR; Xray crystallography; Cryo-EM, Imaging techniques and Microscopy. Protein purification - Gel filtration, ion-exchange, hydrophobic interaction chromatography, affinity chromatography, reversed-phase chromatography; FPLC, HPLC and their applications.

- *Enzymology and Metabolism:*

Enzyme kinetics and regulation

Metabolic pathways: glycolysis, TCA cycle, oxidative phosphorylation, etc.

Metabolic disorders and their biochemical basis

- *Biochemical Techniques and Instrumentation:*

Advanced chromatography techniques

Mass spectrometry

Nuclear magnetic resonance (NMR) spectroscopy

Immunology and Immunotechniques

- *Basics of immunology:*

Immunoassays: ELISA, western blotting, immunohistochemistry, etc.

Applications of immunology in research and diagnostics

Molecular Genetics and Genetic Engineering

DNA replication, transcription, and translation

Gene regulation

Recombinant DNA technology and its applications

- *Bioinformatics and Computational Biology:*

Introduction to bioinformatics

Sequence analysis

Structural bioinformatics

Advanced Topics in Biochemistry

- *Proteomics and systems biology:*

Neurochemistry

Biochemical pharmacology

Advanced enzymology

Cancer biology

Biochemical toxicology

Industrial biochemistry

- *Biochemical Techniques:*

Electrophoresis – Principle, Polyacrylamide gel electrophoresis (native), SDS PAGE, Agarose gel electrophoresis, Buffer systems, Detection, identification and staining and applications. Chromatography- Introduction to chromatography, Principle and applications of Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography, Molecular Sieve Chromatography and Affinity Chromatography. Reversed-phase chromatography; FPLC, HPLC and their applications. DNA and RNA isolation; Northern Blot; Southern Blot; Western Blot; In situ hybridization; In vitro transcription assay; In vitro translation assay; Electrophoretic Mobility Shift Assay; DNA foot printing assay; RNase protection assay; Chromatin immunoprecipitation; Reporter assays, PCR, qPCR, Microarray, Sequencing, mammalian cell culture techniques; Immortalization of

cells; Overexpression and Silencing of genes; Cell synchronization, Cell cycle analysis; Cytotoxicity and apoptosis tests; Cell staining techniques; Assays for cell proliferation, migration invasion of cells and cytotoxicity tests. Centrifugation - Principle of centrifugation, Sedimentation coefficient. Factors affecting sedimentation, Various types of centrifuges, Types of rotors. Differential centrifugation, Density gradient centrifugation - zonal and isopycnic. Spectroscopic methods -Absorbance, Beer's & Lambert's Law, Fluorescence, Chemiluminescence, Phosphorescence, Circular dichroism, IR, ESR, FRET, Biomolecular fluorescence complementation assay, FRAP (Fluorescence recovery after photobleaching); Differential Scanning Calorimetry and Isothermal titration Calorimetry. Structural methods - NMR; Xray crystallography; Cryo-EM, Imaging techniques and Microscopy. Protein purification - Gel filtration, ion-exchange, hydrophobic interaction chromatography, affinity chromatography, reversed-phase chromatography; FPLC, HPLC and their applications.

- ***Clinical Biochemistry***

Types of clinical samples, safety regulations, handling and storage of biological samples, types of vacutainers. Collection of blood and preparation of plasma and serum, Hemoglobin estimation by Sahli's method/ Drabkins's method, Types of Diabetes mellitus- IDDM, NIDDM, Estimation of Blood glucose by enzymatic method, Glucose Tolerance Test, Functions of liver, analysis of liver enzymes, Liver Function test, Estimation of Total protein and A:G ratio in serum. Functions of kidney, analysis of parameters related to kidney function, Kidney function test, Estimation of serum Urea (BUN) and serum Creatinine. Lipids of physiological importance (triglycerides, lipoproteins), Lipid Profile, Estimation of total blood cholesterol. Introduction to automation in clinical biochemistry labs, key Biomarkers used in preventive Health Checkups and their relevance

- ***Biochemical correlation of Diseases:***

Inherited Metabolic diseases and Hormonal disorders- Introduction to inherited Metabolic diseases. Alkaptonuria, Phenylketonuria; Glycogen storage diseases (Von Gierke disease, Cori disease); Lipid storage diseases: Gaucher's disease; SCID. Overview of the endocrine disorders: Cushing's disease, Diabetes insipidus.

Nutritional deficiency and lifestyle-based diseases - Concept of nutrition and balanced diet; Protein-energy malnutrition: Kwashiorkor and Marasmus; Vitamin deficiency diseases: Beri-Beri, Scurvy, Pellagra, Nutritional deficiency Anemia, Night blindness, Rickets. Lifestyle-based diseases: Atherosclerosis, Diabetes Mellitus-II.

Autoimmune diseases - Concepts in immune recognition-self and non-self-discrimination, organ specific autoimmune diseases- Hashimoto's thyroiditis, Graves' disease, Myasthenia Gravis, Diabetes Mellitus-I, Systemic diseases: Systemic lupus erythematosus (SLE), Rheumatoid arthritis.

Infectious diseases - Classification of infectious diseases; Role of sanitation, drugs and vaccines in prevention, transmission and treatment of infectious diseases. Diseases caused by viruses: Polio, Influenza, HIV and COVID. Diseases caused by bacteria: Tetanus, Tuberculosis. Protozoan infections: Malaria; Parasitic infections: Kala Azar.

## **2. Biological Sciences (Life Sciences, Human Biology, Botany)**

### **Life Sciences:**

- ***Developmental Biology and Physiology:***
  - Embryonic development and organogenesis
  - Stem cells and regeneration
  - Physiology of major organ systems (e.g., cardiovascular, respiratory, nervous)
  - Endocrine regulation and hormone signaling
  - Homeostasis and physiological adaptation
- ***Introduction to Applied Immunology:***
  - Overview of the immune system and its components

- Immune responses: innate and adaptive immunity
- Components of the innate immune system: barriers, cells, and soluble mediators
- Recognition of microbial pathogens by pattern recognition receptors
- Activation of innate immune responses: inflammation and phagocytosis
- Principles of adaptive immunity: antigen recognition and lymphocyte activation
- Humoral and cellular immune responses.
- *Principles of immunological techniques:*
  - ELISA, western blotting, immunofluorescence
  - Flow cytometry: principles and applications in immunology
  - Immunohistochemistry and immunocytochemistry
  - Immunoassays for infectious diseases and autoimmune disorders
  - Molecular techniques in immunology: PCR, gene cloning, and sequencing
- *Immunodiagnosics:*
  - Principles of immunodiagnosics
  - Serological tests for infectious diseases
  - Autoimmune disease diagnostics
  - Cancer biomarkers and immunodiagnosis
- *Immunotherapy and Vaccines:*
  - Principles of immunotherapy
  - Monoclonal antibodies in disease treatment
  - Immunotherapy in cancer and autoimmune diseases
  - Vaccine development and design
- *Immunoengineering and Biotechnology:*
  - Immunomodulatory drugs and their applications
  - Gene therapy and immunogenetics
  - Immunological approaches in regenerative medicine
  - Immunological considerations in bioprocessing and biomanufacturing
- *Ethical and Societal Implications:*
  - Ethical considerations in immunology research and application
  - Societal impact of immunological interventions
  - Access to immunotherapies and vaccines
  - Future perspectives and challenges in applied immunology.

#### **Human Biology:**

- Cancer genetics: Basics of DNA damage, underlying causes, genotoxic agents, repair mechanisms, carcinogenesis including defects in DNA repair and hereditary diseases, techniques in DNA damage analysis (DNA adduct analysis, comet assays, immunostaining tools), tumour progression and metastasis, tumour heterogeneity, familial and sporadic cancers and associated causes, cancer diagnostics, markers, treatment and prevention, delivery systems for targeted anti-cancer therapy.
- Human disease biology: Congenital and metabolic disorders of cardiovascular (emphasis on Atherosclerosis, diabetes, coronary artery disease, obesity etc.), skeletal and neuromuscular system (emphasis on Parkinson's, Alzheimer's, stroke etc.), immune system function during infectious diseases (including viral, bacterial and parasitic pathogens), Auto-immune and immuno-deficiency disorders, allergic and rare diseases such as muscular dystrophies.
- Human clinical genetics: Patterns of inheritance in human diseases, genetic basis of inborn errors and monogenic diseases, Genome-wide association studies, genetics of well-known cases of genetic disorders including neuromuscular pathologies, multi-factorial syndromes, male and female infertility, mosaicism and uniparental disomy etc.
- Regenerative Medicine: Principles of regeneration, types of stem cells and their developmental origin, concept of cell and gene therapy and potential applications, intellectual property rights and production practices (GMP, GLP etc.)
- Personalised medicine: Human genome project, importance of genetic variation in human health and disease (including disease penetrance and drug response), potential clinical applications of next-gen and single cell sequencing, genome guided therapy for cancer.

- Molecular basis of genetic testing: Principles of types of PCR amplification.
- Management of genetic disorders: Topics covered under genetic inheritance patterns and risk assessment, pharmacological interventions, potential of gene and cell therapy, clinical applications of gene editing tools.
- Techniques in human genetics: Prenatal diagnosis, chromosomal testing, invasive and non-invasive methods of genetic testing.
- Aging: Concepts of age-associated functional decline in various physiological systems, molecular mechanisms underlying cellular senescence, DNA damage and repair pathways in aging, mitochondrial dysfunction, immune system function during aging, Management: caloric restriction, dietary intervention, exercise and pharmacological intervention etc.

#### **Botany:**

- Photosynthesis & Respiration: Light harvesting complexes, mechanisms of electron transport, CO<sub>2</sub> fixation-C<sub>3</sub>, C<sub>4</sub>, and CAM pathways, Citric acid cycle, plant mitochondrial electron transport and ATP synthesis.
  - Plant hormones: Biosynthesis, storage, breakdown and transport, physiological effects, mechanisms of action.
  - Secondary metabolites: Biosynthesis of terpenes, phenols, nitrogenous compounds and their roles.
  - Principles and methods of taxonomy: Concepts of species and hierarchical taxa, Biological nomenclature, Criteria for classification of taxon, Major classification of plants
  - Economic Botany & Ethnobotany: Production, uses and general account of Cereals and Millets (wheat, paddy, and maize), Legumes (Pea, Gram and Lentil), Fibres (Cotton, jute and coir), Timbers (Teak, Shisham and Sal), Medicinal plants (*Aconitum*, *Cinchona* and *Rauwolfia*), Oils (Castor, mustard and groundnut) and Beverages (Tea, coffee and cocoa); Concept and history of ethnobotany, Ethnobotany and conservation of natural resources, Ethnobotanical plants as leads for drug development.
  - Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses, mechanisms of stress resistance.
  - Ecosystem: Structure and function, energy flow and mineral cycling, Food chain and trophic levels, Effects of pollution and phytoremediation.
- Economic Botany
  - Genetics
  - Plant molecular biology
  - Plant Physiology and Development

- *Ecology and Environmental Sciences*

- Ecosystem structure and function
- Population dynamics and community ecology
- Biodiversity and conservation biology
- Environmental pollution and toxicology
- Climate change and global warming

### **3. Biostatistics**

- Basic biostatistics: Types of data, measurement, descriptive statistics
- Probability concepts
- Probability distributions: Binomial, Poisson, Normal, Chisquare, t, F
- Sampling distributions
- Estimation and hypothesis testing
- Analysis of variance
- Simple linear regression and correlation
- Multiple regression and correlation
- Multivariable regression techniques
- Categorical data analysis
- Non parametric distribution
- Survival analysis methods
- Vital statistics

- Study designs
- Quantifying the extent of disease in different study designs
- Sample size and power

#### 4. Biotechnology

- *Proteins:*

Primary structure of a protein: methods of sequencing, forces stabilizing protein structure, secondary and super secondary structures of a protein, tertiary structure of globular and fibrous proteins, quaternary structure of a protein, post-translational modifications, G-proteins and G-protein coupled receptors (GPCRs), structure and function, proteins in inherited syndromes.

- *Protein folding:*

Introduction: Genes and Proteins, Protein structural organization, Protein folding, Anfinsen's experiments and lessons, Levinthal's paradox, Energy minima and stability of protein folds, protein evolution, protein conformational diseases, Methods of determining protein structures: Basic principles and drawbacks, Protein structure prediction: Principles and advantages, Protein structure prediction: Uses and Applications.

- *Bioinformatics:*

Sequence analysis - pair wise & multiple sequence alignment & phylogenetic, Biological softwares & tools: ExpASy & BLAST, Biological databases of genes, proteins & structures: NCBI, UniProt & PDB

- *Structural Bioinformatics, Molecular Modeling & Simulations:*

Secondary structure prediction of protein, Tertiary structure prediction of protein: Homology Modeling, Threading & *Ab initio*, Modeling of protein-ligand interactions: Molecular Docking, Molecular mechanics force field, Energy Minimization, Molecular Dynamics Simulation.

- *Drug discovery & CADD:*

Drug target identification & validation, Lead compound identification & optimization, Preclinical development & Clinical trials, Receptor based drug design – Molecular docking & *de novo* design

Ligand based drug design – QSAR & pharmacophore modeling,

- *Enzyme Kinetics:*

General principles, Enzyme assays, Single substrate reaction, Michaelis- Menten kinetics, Multi substrate reaction, NonMichaelis - Menten kinetics, Enzyme inhibition and activation, allosteric mechanism, control of enzyme activity, Bimolecular interactions analyzers, Principles and applications of Surface Plasmon Resonance, ELISA and Western blot.

- *Elementary spectroscopy: Principles and applications:*

Introduction to spectroscopy, basic principles, instrumentation and applications of UV-VIS absorption, infrared, Raman Spectroscopy Atomic Force Microscopy, Circular dichroism. Fluorescence spectroscopy, Mass spectroscopy for small molecules, nuclear magnetic resonance, Electron microscopy.

- *Basic and Applied Molecular biology:*

Nucleotides and Nucleic Acids, Structure of DNA and RNA, Forces stabilizing nucleic acid structure, DNA replication and structural mechanisms of DNA polymerase, Mutations and DNA repair, transcription and RNA polymerase, Genetic code, Structure of acyl tRNA and amino-acylation, Prokaryotic and eukaryotic translation, Post translational modifications.

Basic principle of cloning, Primer design, Polymerase chain reaction, Vectors, Chromosomal and Plasmid DNA isolation from *E. coli*, Protein expression in bacterial and mammalian systems, Cell free translation, Northern, southern and western blotting, Genomic and cDNA library preparation, Basics of Sanger and Next generation sequencing, Genome editing (CRISPR-Cas) systems. Gene therapy, Micro array analysis, Protein-nucleic acid

interaction, siRNA and their applications.

- **Cell biology:**

Organization and structure of prokaryotes and eukaryotes. How cells are studied: Microscopy, Light and Electron Microscopy, principles, techniques and sample preparations. Nucleus, cytoplasm, plasma membrane, mitochondria-structure, function respiratory chain and ATP synthesis, endoplasmic reticulum, golgi apparatus, peroxisomes, lysosomes, protein modifications, glycosylation. Intracellular transport of proteins, vesicular transport, receptor mediated endocytosis. Cell contractibility and Mobility, cytoskeletal motility, dynamics of Aqua and aero motions.

- **Membrane Biophysics:**

Membrane Structure, Lipid structure and their organization, comparison of different membrane models, diffusions and permeability, different types of transport system across membranes, Passive Membrane Properties, electrical equivalent circuit of membrane, membrane resistance Nernst Equation, Ion Pump, Goldman's Equation, Methods to record membrane potential, Current-voltage relation, Ion Channels – Structure and Types, Ion Permeability, ion selectivity, Channel Gating, Gating Current

- **Analytical techniques and separation methods:**

Protein salting in, salting out, Basic principle and application: Principle of centrifugation-sedimentation, sedimentation coefficient, Preparative centrifugation and analytical centrifugation, sedimentation velocity method and equilibrium method; molecular weight, size and shape determination.

- **Principle of chromatography:** capacity factor, distribution coefficient; retention factor, selectivity factor, Chromatographic techniques- ion exchange chromatography, Gel filtration chromatography, Affinity chromatography, hydroxyapatite chromatography, hydrophobic interaction chromatography for separation of proteins. HPLC, FPLC and UPLC: principle and its applications, SDS PAGE, Native PAGE, Isoelectric focusing: principle and procedure, 2D Electrophoresis, preparative electrophoresis, estimation of relative molecular weight of proteins, Dynamic light scattering principle and application.

## 5. Microbiology (Bacteriology, Virology, Parasitology)

- **Bacteriology:**

- Bacterial cell structure and appendages: Overview of eubacterial cell organization: nucleoid, ribosomes, intracytoplasmic membranes and cell inclusions. Detailed account of biogenesis and function of various cell structure appendages: flagella- structure, assembly and mechanism of movement; pili and fimbriae- types, structure and their role. External cell surface structures: capsule, glycocalyx, slime layer and S-layer.
- Bacterial cell wall and cell membrane: Overview of gram negative and gram positive bacterial cell wall, outer membrane lipopolysaccharide (LPS). Detailed account of cell wall synthesis and its inhibitors including different antibiotics.
- Bacterial cell division and reproduction: Binary fission and other forms of reproduction in bacteria, bacterial cell cycle, assembly, maintenance and disassembly of Z ring, endospore structure and stages involved in endospore development in *Bacillus subtilis*
- Bacterial genome: Genome organization of *E.coli* and salient features of genomes of *Deinococcus radiodurans*, *Azotobacter vinelandii*, *Buchnera sp.*, *Agrobacterium tumefaciens* and *Eupulopiscium sp.*
- Bacterial secretion system: Introduction. Sec secretion pathway, SecB secretion pathway, SRP pathway, Tat pathway. Protein secretion in Gram-negative bacteria: Type I-Type VII. Protein secretion in Gram-positive bacteria: Type VII, Sec A2, Sortases and Injectosome. Introduction to Type VIII and Type IX secretion systems.

- **Virology:**

- Introduction to Virology: The big picture of all viruses using a common strategy, virus classification, the infectious cycle, studying virus infection. Koch's Postulates for viruses,

virus genome types, double stranded DNA (dsDNA), gapped DNA genomes, single-stranded (ssDNA) genomes, double stranded RNA (dsRNA), single stranded RNA (ssRNA), (+) strand RNA, single stranded (+) sense RNA with DNA intermediate, single stranded RNA (-) sense, ambisense RNA genomes.

- Virus Structure and Assembly: Meta stability, the tools for viral structural biology. Helical symmetry, Icosahedral symmetry, Triangulation number, Quasi-equivalence. Virus attachment and entry, Initiation of infection, Affinity, Avidity, cellular receptor for viruses. Getting into the nucleus, virus disassembly, metastable structures, concentrating components for assembly, getting things to the right place. How do viruses make sub-assemblies, sequential and concerted assembly. Packaging signals, packaging of segmented genome, acquisition of an envelope, budding strategies.
  - RNA directed RNA synthesis, Reverse Transcription and Integration, Translation and genome replication of DNA viruses: Identification of RNA polymerase, how RNA synthesis occurs in viruses? Reverse transcriptase, retrovirus genome organization, steps of DNA synthesis in retroviruses. Regulation of translation in virus infected cells. Basic rules of genome replication in DNA viruses, viral origins of DNA replication. Generic steps in transcription, host polymerases, initiation, splicing, alternate splicing, promoter structure, steps in regulation of transcription, enhancers, virus coded transcriptional regulators, transcriptional cascade, export.
  - Virus Infections basics, interaction with host, acute and persistent infections: Fundamental questions of viral pathogenesis. Virion defenses to hostile environment, viral spread, viremia, determinants of tissue tropism. Virus shedding, transmission of infection, host defense, innate immune response, virus virulence, identifying virulence genes. Toxic viral proteins, cellular virulence genes, immunopathology, systemic inflammatory response syndrome. Immune complexes, virus induced auto-immunity, general pattern of infection. In apparent acute infections, defense against the acute infection. Influenza, Polio, Measles, Rotavirus, persistent infections, chronic and latent Infections.
  - Vaccines and anti-Viral drugs, virus evolution and emerging viruses: Herd immunity, requirement of an effective vaccine, different ways of making vaccine. Inactivated vaccine, subunit vaccines, subunit vaccines, live attenuated vaccines, polio eradication. Anti-viral drugs, search for anti-viral drugs, the path for drug discovery, mechanism based screens, cell based screen, antiviral screening. Resistance to antiviral drugs, main drivers of virus evolution, the quasi-species concept, error threshold, genetic bottlenecks, Muller ratchet, genetic shift and drift. Theories on origin of virus, evolution of new viruses, emerging viruses, Factors that drive viral emergence, evolving host-virus relationship.
  - Unusual Infectious Agents, viral cancer, transformation and oncogenesis: Viroids, origin of viroids, Satellites, Prions, Transmissible spongiform encephalopathy (TSE) caused by prions, Prion hypothesis, Prion species barrier. Virus-induced cancer, Avian leucosis retroviruses, Proviral DNA sequences, Proto-oncogenes, DNA tumor Viruses, the link between DNA virus biology and transformation.
  - Virus Evasion strategies and investigation of virus outbreak: Strategies for evasion, Translational regulation, Innate defense targets, Viral modulators of interferon, Autophagy, Apoptosis, Apoptotic pathway and viruses, Immune modulation, Immune modulation strategies. Case study of health risk associated with a virus epidemic, the origin of outbreak, the spread, the intervention strategies, public health response.
- *Parasitology:*
    - *General Parasitology*
      - Scope and historical landmarks in Parasitology. Basic principles and nomenclature aspects of parasites. Parasitology as an academic and applied science. Parasite fauna of hosts belonging to different groups. Zoogeography of parasites. Host parasite inter-relationship.
      - Properties of parasites. Host specificity. Kinds of parasites. Hyperparasitism. Parasitoids. Relation of parasite fauna with the food, age and migration of the host and season of the year.

*Molecular Parasitology:*



- Virus: Introduction and molecular characteristics, mode of transmission, clinical presentation and control measures of human viral diseases (Hepatitis A, B & C, Dengue, Mumps, Influenza and HIV). General introduction to bird flu (avian influenza). Bacteria: General characteristics, culture characters, pathogenesis, laboratory diagnosis and control measures of human bacterial diseases (Meningitis, Tuberculosis, Typhoid and Leprosy). Bacteriology of water, milk and air. Biological warfare: Bioterrorism. Fungi: Opportunistic mycoses: define and list; Candidiasis (*Candida albicans*). Biochemical and molecular techniques and their application: Concept of centrifugation, spectrophotometry, electrophoresis, chromatography, Western blotting, Southern and Northern blotting, ELISA, PCR and RFLP.

## 6. Nursing

- *Nursing management:*
  - Infection Control in Clinical Settings
  - Nursing Management of Respiratory and Cardiovascular Problems
  - Nursing Management of Digestive System Problems
  - Nursing Management of Genito-Urinary Problems
  - Nursing Management of Endocrine System Disorders
  - Nursing Management of Musculoskeletal Problems
  - Nursing Management of Neurological Disorders
  - Nursing Management of Reproductive System Disorders
  - Nursing Management in Critical Care Units
  - Nursing Care of Neonates and Children
  - Assessment and Nursing Management of Eye Disorders
  - Assessment and Nursing Management of Ear, Nose & Throat Disorders
  - Nursing Care of the Elderly
  - Nursing Management of Psychiatric Disorders
  - Assessment and Nursing Management of Pregnancy, Labor, and Puerperium
  - Community Health Nursing
- *Nursing education:*
  - Aims and Philosophies of Education
  - Teaching-Learning Process and Strategies
  - Instructional Media and Aids
  - Development and Trends in Nursing Education
  - Overview of Nursing Educational Programs in India
  - Continuing Education in Nursing
  - Curriculum Development
  - Teacher Education for Nursing Profession
  - Evaluation and Assessment
  - Guidance and Counseling
  - Administration of Nursing Curriculum
  - Development of Standards and Accreditation in Nursing Education
  - Ethics and Evidence-Based Teaching in Nursing Education
- *Nursing research:*
  - Introduction to Management
  - Organization of Nursing and Health Delivery System
  - Roles and Functions of Nurse Managers in Planning, Organizing, Personnel Management, Directing, and Controlling
  - Organizational Behavior
  - Financial Management in Nursing
  - Management Information System
  - Material Management
  - Legal and Ethical Issues in Nursing Management
  - Professionalism and Professional Advancement

- *Research Methodology and Statistics:*
  - Fundamentals of Nursing Research
  - Ethics in Nursing Research
  - Research Problem and Literature Review
  - Theoretical and Conceptual Framework in Nursing Research
  - Planning of Research and Research Designs
  - Tools of Data Collection and Sampling
  - Methods of Data Collection and Analysis
  - Communication and Critiquing of Research Findings
  - Descriptive and Inferential Statistics
  - Measures of Relationship and Designs
  - Tests of Significance
  - Application of Statistics in Health
  - Use of Computers for Data Analysis
- *Clinical specialty (all five core specialties: medical surgical, pediatric Nursing, mental health nursing, OBG and community Health Nursing) including advanced nsg.*

## **7. Nutrition**

- *Food Science & Analysis*
  - Cereals, millets, pulses, vegetables, fruits, milk, eggs, meat & other animal food and oilseeds.
  - Composition and nutritive value of these food groups.
  - Processing, preservation and storage of these food groups.
  - Principles and methods of proximate analysis.
- *Food Microbiology & Food Safety*
  - Food-borne diseases and their prevention.
  - Food spoilage
  - Food packaging, packaging material, labeling, food laws and regulations.
  - International food standards, codex alimentarius and FSSAI.
  - Food additives & Food adulterants.
  - Natural toxicants and pesticide residues.
  - Food safety hazards and risks.
  - HACCP.
  - Food security.
- *Nutritional Biochemistry, Nutrient Requirements & Dietary Guidelines*
  - Carbohydrates, proteins, lipids, vitamins and minerals.
  - Metabolism of these macronutrients and micronutrients and their functions.
  - Fiber, glycemic index and load.
  - Water and electrolyte balance.
  - Enzymes and hormones.
  - Nutrient and drug interactions.
  - ICMR-NIN, Recommended Dietary Allowances (RDA 2020).
  - ICMR-NIN, Dietary guidelines.
- *Clinical Therapeutic Nutrition & Food Service Management*
  - Nutrition during lifecycle.
  - Clinical signs and symptoms of macronutrient and micronutrient deficiencies and their sources.
  - Nutritional Risk Screening (NRS) and Subjective Global Assessment (SGA).
  - Therapeutic modification of normal diets and their use in treating communicable and non-communicable diseases.
  - Nutrition in geriatrics.
  - Menu planning for industrial/institutional canteen, hospital canteen, snack bar, residential hostel, fast food outlets and cafeteria.
- *Community Nutrition*
  - Major public health nutrition programs in India.
  - Nutritional problems of vulnerable segments.
  - Assessment of community nutritional status – ABCD approach.
  - Indicators/parameters and standards used for assessment of different methods.

- Infant and child feeding practices (IYCF).
- Nutrition in emergencies and disasters.

## 8. Pharmacology

### • *Pharmaceutics*

- Pre formulation Studies: solid-state properties, partition coefficient, solubility, dissolution of drug substance, crystal form and stability, compatibility tests.
- Optimization techniques in pharmaceutics, formulation and processing
- Validation: Regulatory basis, validation of sterile products, solid dosage forms, process validation and non-sterile analytical method validation.
- Advances of pharmacotherapeutics in drug delivery.
- Polymers and their applications: Polymer classification, physico-chemical properties, blend of polymer and properties of blends, mechanism of drug release from polymers, applications of polymers in controlled release and in other formulations.
- Fundamental, design and fabrication of controlled release drug delivery system: factor influencing the design and performance of sustained/controlled drug delivery system, drug targeting, pharmacokinetics/ pharmacodynamics basis of controlled drug delivery system, regulatory requirements.
- Biochemical and molecular biology approaches in controlled drug delivery: Novel chemical approaches for sustained drug delivery system, design and fabrication of oral controlled release drug delivery system, parenteral products, implantable systems, transdermal patches, ocular, intravaginal, intrauterine system, cardiovascular drug delivery system-coated balloon catheters and coated stents.
- Intelligent drug delivery system: Micro particulate drug carriers, liposome, microspheres, selective endocytosis of macromolecular drug carriers, antibodies for drug delivery.
- Nano pharmaceuticals- Method of preparation, characterization and application of nano emulsion, nano suspension, solid lipid nanoparticles (SLN) and self-nanoemulsifying drug delivery (SNEDDS)

### • *Pharmacology*

- Basic Principles in Drug Therapy: Drug-receptor interaction, Cellular Transduction Mechanisms, Adverse Drug Reactions, Drug therapy in elderly, Drug Therapy during pregnancy and lactation, Gene therapy, Chiral Pharmacology.
- Drugs acting on the Autonomic Nervous System and Central Nervous System: Neurotransmitter in ANS and CNS, Muscarinic Receptor (Agonists and Antagonists), Cholinesterase Inhibitors, Agents acting at the skeletal muscle and autonomic ganglia, Sympathomimetic Drugs and Adrenergic receptor antagonists. Drugs in the treatment of Anxiety, Depression, Psychosis, Mania, Epilepsy and Parkinsonism, Opioid analgesics and antagonists, Drug addiction and drug abuse.
- Drugs effecting Cardiovascular function and Digestive System: Diuretics, Congestive heart failure and its treatment, Pharmacotherapy of hypertension, Drugs used in the treatment of coronary artery diseases, Arrhythmia and its management, Drugs used in the treatment of Hyperlipoproteinemias, Anticoagulant, thrombolytic and antiplatelet drugs.
- Pharmacotherapy of peptic ulcer, ulcerative colitis, Irritable Bowel Syndrome, Diarrhoea, Constipation, Emetics & antiemetics.
- Therapy of Infectious diseases and Endocrinology: General Principles, Antibacterial drugs (Sulphonamides, Penicillins, Cephalosporins, Tetracyclines, Chloramphenicol, Aminoglycosides, Quinolones), Drugs used in the chemotherapy of Protozoal infections, Leprosy, Tuberculosis, Fungal infections, Viral infections, Drugs used in the Chemotherapy of Neoplastic diseases and Immuno modulators, Hormones of anterior and posterior pituitary

- gland. Insulin, oral hypoglycemic agents, Adrenocorticotrophic hormones, Anti thyroid drugs, Androgens and Anabolics. Agents affecting Calcification and bone turnover.
- Screening methods in Pharmacology and Toxicology: Basic principles, methods of bioassay and important bioassay of drugs, Pharmacological Screening Techniques to evaluate drugs belonging to following categories:
    - Analgesics, anti-inflammatory agents and local anaesthetics.
    - Antihypertensives, antianginals, diuretic and saluretic activity.
    - Antiulcer drugs, antidiabetics, hepato protective, nephron protective and anti obesity activity.
    - Effects on behavior and muscle coordination, antiepileptics, anti-Parkinsonism, drug effects on learning and memory.
    - Anticancer activity (*In vitro* and *In vivo*)
    - Evaluation of antioxidants (*In vitro* and *In vivo*)
    - Drug Toxicity, Safety Evaluation of new drugs. Regulations for Laboratory animal care and ethical requirements.
  - *Pharmaceutical chemistry*
    - Physicochemical properties in relation to drug action; metabolic transformation of drugs and its role in development of new drug molecules; metabolic antagonism.
    - Stereo chemical aspects of drug receptor interactions and mechanism of drug interaction. Isosterism and bio isosterism as guides to structural variations; Concepts of conformational analysis and its role in design and development of new drug molecules.
    - Principle of drug design: Analogue synthesis versus rational design; discovery of lead compounds, Pharmacophoric identification, Prodrugs and soft drug.
    - QSAR and introduction to molecular modeling.
    - Following name reactions and their application in the synthesis of some medicinal agents: Claisen- Schmidt reaction, Perkins reaction, Friedal Craft Reaction, Aldol condensation, Mannich reactions, Beckmann's rearrangement, Wagner-Meerwein rearrangement, Wittig Reaction, Oppenaur oxidation, (Meervein- pondroff-verley) M.P.V. Reduction.
    - Cardiovascular Agents: Anti-hypertensive agents, antiarrhythmic agents, antihyper lipidemic agents, antianginal agents.
    - Psychopharmacological agents: Antipsychotic Agents: Introduction, Biochemical basis of mental disorders, Development of antipsychotic agents: Phenothiazines, Butyrophenones: Atypical antipsychotic agents. Antidepressant Drugs: Introduction, Development of tricyclic antidepressants, Monoamine oxidase inhibitors; Selective serotonin-reuptake inhibitors; Atypical antidepressants, Lithium salts. Antianxiety Agents: Introduction, medicinal Chemistry of benzodiazepines; SAR of benzodiazepine derivatives, medicinal chemistry of non-benzodiazepines; serotonin-reuptake inhibitors, development of meprobamate and analogues; atypical anxiolytic agents.
    - Chemotherapy: Antiviral agents including the development in chemotherapy of AIDS.
    - Drugs for neoplastic diseases, Drug affecting immune responses, Radioprotective drugs.
    - Analgesics and anti-inflammatory agents, Prostaglandins, Non-steroidal drugs, Steroidal drugs, Endorphins, Diuretic agents.
    - Chemistry of cell membrane; Signal transduction and G. Proteins.
  - *Pharmacognosy & phytochemistry*
    - Plant Tissue Culture techniques and its application in relation to Phytopharmaceuticals: Introduction, techniques of initiation and maintenance of various types of cultures. Immobilized cell techniques, Biotransformation studies including recent developments in production of biological active constituents in static, suspension and hairy root cultures, Bioreactors for production of biologically active constituents and other applications of plant tissue culture techniques.
    - General methods of phytochemical & biological screening, isolation and purification of plant constituents.

- Natural sources, extraction, purification, isolation and characterization of the following Phytopharmaceuticals.
- Alkaloids: Morphine, Quinine, reserpine
- Glycosides/flavanoids: Sennosides, Glycyrrhizine, Asiaticosides, Diosgenin, Solarodine, Rutin, quercitin
- Industrially important volatile oils: occurrence, chemistry, ontogenic variation and trade.
- Methods of investigation of biogenetic pathways.
- Biogenetic pathways for the production of phytopharmaceuticals, such as Alkylamine (Ephedra), Pyridine, Piperidine (Lobelia), Tropane (Belladonna), Quinoline (Cinchona), Isoquinoline (Opium), Diterpene (Cannabinoids), Indole (Ergot), Cardiac glycosides, Coumarins and Flavones.

## 9. Public Health

- *Epidemiology:*
  - Basic epidemiological measures
  - Study designs in epidemiology (Observational/Experimental)
  - Validity of epidemiologic studies
- *Biostatistics:*
  - Probability and distributions
  - Descriptive statistics
  - Inferential statistics
- *Research methods in public health:*
  - Quantitative research methods
  - Qualitative research methods
  - Study design and sampling techniques
- *Disease epidemiology:*
  - Burden of infectious diseases and non-communicable diseases
  - Transmission dynamics and risk factors
  - Control and prevention strategies
  - Disease surveillance and outbreak investigation
  - Contemporary issues
- *Social and behavioural sciences in public health:*
  - Social determinants of health
  - Health behaviour theories
  - Community interventions and health promotion
  - Contemporary issues
- *Health policy and management:*
  - Health systems and policy analysis
  - Healthcare financing
  - Healthcare quality and management
  - Economic evaluation in public health
  - Contemporary issues
- *Public health programs:*
  - National health programs
  - Planning and evaluation
  - Health information systems
  - Health promotion/communication
  - Contemporary issues
- *Environmental and occupational health:*
  - Environmental risk factors and health effects
  - Environmental policy and regulation
  - Workplace hazards and occupational diseases
  - Occupational health policies and regulations
  - Contemporary issues
- *Public health nutrition:*
  - Malnutrition

- Anthropometric indices
- Contemporary issues
- *Ethics and laws in public health:*
  - Ethical considerations in research
  - Ethical considerations in public health practice
  - Public health laws and regulations
  - Contemporary issues
- Consumer behaviour, Demand and supply of healthcare and elasticities, Grossman model and health disparities
- Features of health care markets – imperfections – Government interventions
- Efficiency and equity in health care
- Building blocks of health system, health care financing and insurance
- Economic evaluation methods (cost minimisation, cost-effectiveness, and cost-benefit analysis)
- Indian Health system- Reforms and challenges

## 10. Social Behavioral Sciences

- *Introduction:*
  - Language behaviour as human instinct.
  - Core properties of human communication and behaviour vs. animal communication and animal behaviour.
- *Brain and Mind in Human Communication and Behaviour:*
  - Structure of the brain.
  - Lateralization and localization hypothesis.
  - Linguistic and cognitive functions' localization.
- *Development of Cognitive Competence:*
  - Understanding cognitive competence, capacity, and potential.
  - Development in human babies: Acquisition process.
- *Social, Emotional, and Linguistic Cognition:*
  - Definitions and significance.
  - Theories of early development of social-emotional-linguistic behaviour and cognition.
- *Theoretical Perspectives: Behaviourism vs Cognitivism:*
  - Behaviourism: B.F. Skinner's Verbal Behaviour as representative of the behaviouristic paradigm.
  - Cognitivism: Noam Chomsky's review of Verbal Behaviour (1959) and mid-century Cognitive revolution; the new Chomskyan Cognitive paradigm.
  - Innate Hypothesis and Language Development: The role of innate factors in language development.
  - Critical Period Hypothesis: Language, Mind, and Brain development.
- *Research Methodology for Social and Behavioral Sciences:*
  - Theories, models, and methods for studying human behaviour, language, and cognition.
  - Qualitative and Quantitative approaches.
  - Inductive vs Deductive reasoning.
  - Empirical vs Subjective/interpretative studies.
  - Eclectic interdisciplinary approaches.
- *Ethical Issues in Social, Behavioral, and Cognitive Research:*
  - Concerns and considerations in research involving human participants.

## 11. Veterinary Science/Medicine

- *Fundamentals of Veterinary Sciences:*
  - Introduction to veterinary science
  - Basic anatomy and physiology of domestic animals
  - Principles of animal nutrition
  - Introduction to veterinary microbiology and immunology
  - Animal Husbandry and Management

- *Principles of livestock management:*
  - Breeds and breeding techniques
  - Livestock housing and welfare
  - Introduction to veterinary extension education
  - Veterinary Pathology
- *General pathology:*
  - Systemic pathology
  - Pathogenesis of common diseases in animals
  - Diagnostic techniques in veterinary pathology
  - Veterinary Pharmacology and Toxicology
- *Principles of pharmacology:*
  - Drug administration and dosage calculations
  - Veterinary pharmacokinetics and pharmacodynamics
  - Toxicology and drug interactions
  - Veterinary Parasitology
- *Identification and classification of animal parasites:*
  - Parasitic diseases of domestic animals
  - Diagnosis and control of parasitic infections
  - Zoonotic aspects of parasitology
  - Veterinary Epidemiology
- *Principles of veterinary epidemiology:*
  - Disease surveillance and monitoring
  - Epidemiological study designs
  - Outbreak investigation and control measures
- *Veterinary Medicine:*
  - Principles of veterinary medicine
  - Infectious and non-infectious diseases of animals
  - Clinical diagnosis and treatment strategies
  - Preventive medicine and herd health management
  - Veterinary Surgery and Anesthesiology
- *Principles of veterinary surgery:*
  - Surgical techniques in domestic animals
  - Anesthesia protocols and monitoring
  - Post-operative care and complications