

## MANIPAL ENTRANCE TEST (MET)

- Test Duration: 120 minutes
- Total Questions: 200 questions

Pharmaceutical Analysis (25 Qs), Pharmaceutical Chemistry (25 Qs), Pharmacology (25 Qs), Pharmacy Practice (25 Qs), Pharmacognosy (25 Qs), Pharmaceutics (25 Qs), Pharmaceutical Marketing, Management & Jurisprudence (25 Qs), Biochemistry, Microbiology and Biotechnology (25 Qs)

### SYLLABUS:

#### PHARMACEUTICAL ANALYSIS

Basics of Pharmaceutical Analysis: Different analytical techniques, concentration expression terms, preparation and standardisation of analytical solutions, errors in analysis and significant figures

1. Volumetric Analysis: Theory and practice of acid base, non-aqueous, redox, complexometric, precipitation titrations.
2. Gravimetry and Gasometry.
3. Quality Assurance: Basics of quality assurance, ICH guidelines, ISO guidelines, quality by design, calibration and validation. Good Manufacturing Practices, Good Laboratory Practices, Good Distribution Practices and Warehousing.
4. Advanced Analytical Techniques: (Theory, Practice, working and pharmaceutical applications of the following analytical techniques): UV Visible Spectroscopy, IR Spectroscopy, NMR Spectroscopy and other important absorption and emission spectroscopic techniques. Mass spectrometric technique. Conventional chromatographic techniques, Gas Chromatography, High Performance Thin Layer and Liquid Chromatographic techniques and recent advances in chromatography. potentiometry, polarography, amperometry and conductometry.

#### PHARMACEUTICAL CHEMISTRY

##### Organic Chemistry

General principles: a brief review of classification & sources of organic compounds,  $sp^3$ ,  $sp^2$ ,  $sp$  hybridization, sigma & pi- bonds, bond lengths, bond angles & bond energies along with their significance in reactions should be carried out. An overview of bond polarization, hydrogen bonds, inductive effects, resonance, and hyperconjugation be taken. Concept of homolytic & heterolytic bond fission, acidity & basicity with different theories should be covered briefly. Ease of formation & order of stabilities of electron deficient & electron rich species along with the reasons for the same should be covered. Relationships between energy content, stability, reactivity & their importance in chemical reactions should be covered. Calculations for determining empirical & molecular formula should be covered.

1. Different classes of compounds: The following classes of compounds should be taught in detail with respect to their IUPAC /systematic nomenclature, industrial [wherever applicable] & laboratory

methods of preparations, physical properties & chemical reactions with emphasis on reaction mechanisms [arrow based] & stereochemistry [wherever applicable], Alkanes [including cyclic compounds], Alkenes [including cyclic compounds], Alkynes [only open-chain compounds], Aliphatic hydroxyl compounds, Alkyl halides, Aldehydes & Ketones, Carboxylic acids, All functional derivatives of carboxylic acids.

2. Aromaticity & chemistry of aromatic compounds: Concept of aromaticity, Huckel's rule & its use in determining the aromatic/non-aromatic character of a compound. A brief coverage of structure of benzene. Detailed coverage of electrophilic & nucleophilic aromatic substitution reactions. Reactivity & orientation in these reactions. Reactivity & orientation in mono & disubstituted benzenes. Benzyne mechanism.

3. Different aromatic classes of compounds: The following classes of compounds with respect to their IUPAC / systematic nomenclature, industrial [wherever applicable] & laboratory methods of preparations, physical properties & chemical reactions with emphasis on reaction mechanisms [arrow based] & stereochemistry [wherever applicable].

4. Aromatic hydrocarbons: Phenolic compounds. Aromatic & aliphatic amines. Diazonium salts. Aromatic nitro - compounds, aryl halides, & ethers.

5. Polycyclic aromatic hydrocarbons: Syntheses & reactions with mechanisms of bi & tricyclic fused carbocyclic rings like naphthalene, anthracene, & phenanthrene.

6. Carbonyl chemistry: Carbonyl chemistry involving group conversions & their reaction mechanisms along with stereochemistry

wherever applicable: Wolf-Kishner reduction, Michael addition / 1,4-addition / conjugate addition, Mannich condensation /

reaction, Beckmann rearrangement, Baeyer Villiger rearrangement, Curtius, Wolff, & Lossen rearrangements, Pinacolpinacolone rearrangement etc

7. Heterocyclic chemistry; IUPAC Nomenclature of heterocyclic rings [3-10 membered] containing O, S, & N atoms. Nomenclature of above rings containing mono-, di-, & multiple [same or different] heteroatoms should also be covered. Nomenclature of 2 & 3 fused rings containing mono-, di-, & multiple heteroatoms [same or different] should also be covered. Syntheses & reactions of three to six- membered rings in detail. Syntheses of five & six-membered rings containing mono- or any di-heteroatoms [O,S, & N]. Syntheses of quinoline, isoquinoline, benzoxazole, benzothiazole, & benzimidazole, benzotriazole, and benzothiazole.

8. Stereochemistry: Stereochemistry definition, Chirality & asymmetry [introduction of the same to S, P, & N]. Definition & classification [different types of isomerisms]. Enantiomers, diastereomers. Enantiomerism & diastereomerism. Meso compounds & their optical activity. Stereochemistry in acyclic compounds. Newman projection formulae & their significance. Conformational analysis of n-butane. Absolute & relative configuration. Assigning R & S configuration based on Cahn Ingold &

Prelog system. Racemic mixture- its definition & resolution. Definitions of terms stereoselective, stereospecific, Enantiomeric excess & diastereomeric excess. Stereochemistry in cyclic systems.

Conformations of cyclohexane. Cis-trans relationship in cyclohexane. Prediction of stability of different conformations of 1, 2- 1,3- & 1,4- disubstituted cyclohexanes. Effect of multiple substitutions on the stability of cyclohexane conformations. Chair conformations of cis-, & trans-decalins, perhydrophenanthrenes, & a tetracyclic steroidal nucleus. An introduction to atropisomerism.

9. Carbohydrates: Definition & classification. D & L nomenclature in sugars. Different ways of drawing / representing a sugar molecule [including cyclic Structure], interconversion of these representations. Anomers & epimers. Mutarotation. Reactions of glucose. Chain extension & chain reduction of a sugar.

10. Amino acids & proteins: Amino acids & proteins. Definition & classification. D & L Amino acids, natural, essential, & nonessential amino acids. Denaturation, Strecker, Gabriel phthalimide methods for the preparation of amino acids. Peptide bond & its formation. Two protective groups each, for -NH<sub>2</sub> & -COOH functionalities during protein synthesis. Sequencing of a protein by chemical & enzymatic methods.

11. Pericyclic reactions: Pericyclic reactions. Concept of HOMO & LUMO. Drawing of HOMO & LUMO of 1, 3-butadiene, allylic cation, radical & anion, & 1, 3, 5-hexatriene, Diel's-Alder & retro Diel's Alder reaction.

## Inorganic Chemistry

1. Pharmaceutical impurities: Impurities in pharmaceutical substances, sources, types & effects of impurities. Limit tests for heavy metals like lead, iron, arsenic, mercury & for chloride & sulphate as per Indian Pharmacopoeia [I. P.].

2. Monographs: Monograph & its importance, various tests included in monographs as per I. P. A study of the following compounds with respect to their methods of preparation, assay, & pharmaceutical uses of sodium citrate, calcium carbonate, copper sulphate, light & heavy kaolin, ammonium chloride & ferrous gluconate.

3. Isotopes: Isotopes - stable & radioactive, mode & rate of decay. Types & measurement of radioactivity. Radiopharmaceuticals & their diagnostic & therapeutic applications in pharmacy & medicine - such as <sup>125</sup>I, <sup>32</sup>P, <sup>51</sup>Cr, <sup>60</sup>Co, <sup>59</sup>Fe, <sup>99</sup>Tc-M. Radiocontrast media, use of BaSO<sub>4</sub> in medicine.

## 4. Dentifrices, desensitizing agents, & anticaries agents edicinal Chemistry

1. Therapeutic classes of drugs: The following topics should be dealt with covering nomenclature [including stereochemical aspects], biological activity [including side & toxic effects], mode of action, structure-activity relationship [where ever applicable] & syntheses of reasonable molecules, 1. General anesthetics, 2. Local anesthetics, 3. Diagnostic agents. 4. Coagulants, anticoagulants & plasma expanders. 5. Antiseptics, disinfectants, sterilants, & astringents. 6. Purgatives, laxatives & antidiarrhoeal agents.

2. Various classes of therapeutic agents: A detailed study of the following classes with respect to drug nomenclature, classification, physicochemical properties, mode of action [MOA], structure-

activity relationships [SAR], wherever applicable, synthesis of simple & prototype molecules, drug metabolism, therapeutic uses & side effects. Drug resistance, wherever applicable, should be covered in respective classes of drugs: Antimalarials, Antiamoebic agents, Anthelmintic agents, Antibacterial sulpha drugs [only], Quinolone antibacterials, Antimycobacterial drugs, Antifungal agents, Antiviral agents including HIV & anti-HIV drugs, Thyroid & antithyroid drugs, Antiallergic agents, Antiulcer agents & Proton Pump Inhibitors, Hypoglycemic agents etc

3. Different classes of therapeutic drugs: A detailed study of the following classes with respect to drug nomenclature, classification, physicochemical properties, mode of action [MOA], structure-activity relationships [SAR], wherever applicable,

synthesis/biosynthesis of simple & prototype molecules, drug metabolism, therapeutic uses & side effects. Drug resistance, wherever applicable, in respective classes of drugs.

a) Sedative-hypnotics b. Antiepileptic agents. c. Neuroleptics. d. Anti-anxiety drugs.

b) Antibiotics. Penicillins, cephalosporins & other beta-lactam antibiotics like imipenem & aztreonam. Beta-lactamase inhibitors such as clavulanic acid & sulbactam. Chloramphenicol. Tetracyclines. Aminoglycoside antibiotics. Macrolide antibiotics. Lincomycins. Polypeptide antibiotics. Anticancer antibiotics. III. Steroids. Corticosteroids [gluco- & mineralocorticoids] & anti-inflammatory steroids. Sex steroids. Male & female contraceptive agents. Anabolic steroids. Anticancer agents.

c) Narcotic [centrally acting] analgesics [analgetics]. Morphine & all its structural modifications [peripheral & nuclear]. Narcotic agonists & antagonists [dual & pure]. Non-narcotic analgesics [NSAIDS]. Difference between narcotic & nonnarcotic agents

d) Adrenergic drugs. Neurotransmitters & their role. General & specific adrenergic agonists & antagonists [up to alpha-2 & beta-2 only]

e) Cholinergic agents. Muscarinic & nicotinic cholinergic agonists & antagonists [up to M2 & N2]. Neuronal [transmission] blockers.

f) Drugs used in neuromuscular disorders. Drugs used in the treatment of Parkinson's disease. Central & peripheral muscle relaxants g) Hypertensive, antihypertensive, & antianginal agents.

h) Diuretics.i) Eicosanoids. Prostaglandins, prostacyclins, & thromboxanes. Their biochemical role, biosynthesis, & inhibitors.

4. Introduction to quantitative structure-activity relationship. [QSAR]: Linear free energy relationship. Hammett's equation. Use of substituent constants such as  $\pi$ ,  $\sigma$ ,  $E_s$ , & physicochemical parameters such as pKa, partition coefficient,  $R_m$ , chemical shifts, molar refractivity, simple & valance molecular connectivity to indicate electronic effects, lipophilic effects, & steric effects.

Introduction, methodology, advantages & disadvantages/limitations of Hansch analysis.

5. Combinatorial chemistry: Introduction & basic terminology, methods and applications. Limitations of combinatorial synthesis. Introduction to throughput screening.

## PHARMACOLOGY

1. General Pharmacology: Routes of drug administration.
2. Pharmacokinetics: Mechanisms and principles of absorption, distribution, biotransformation and excretion of drugs. Pharmacodynamics: Principles of drug action, concept of receptors, theories of drug receptor interaction, agonist, partial agonist, inverse agonist, antagonist, a brief description of cellular signaling systems, dose response relationship. Synergism, various types of antagonism, and other factors modifying drug action
3. Pharmacology of drugs acting on the autonomic nervous system; Organization and function of autonomic nervous system, autonomic transmission and co-transmission; Cholinergic system and drugs: Cholinergic transmission, cholinergic receptors, parasympathomimetic agents, anticholinesterases and anticholinergic drugs; Adrenergic system and drugs: Adrenergic transmission, biosynthesis, storage, release, re-uptake and metabolism of endogenous catecholamines, adrenergic receptors, adrenergic drugs, alpha and beta blockers and adrenergic neuron blockers
4. Pharmacology of drugs acting on cardiovascular system, Cardiac glycosides and antiarrhythmics, antianginal agents, antihypertensives and hypolipidemics
5. Drugs acting on haemopoietic system, Antianaemic agents, coagulants and anticoagulants, fibrinolytic agents and antiplatelet drugs
6. Pharmacology of hormones and related drugs: Introduction to endocrine Pharmacology, pituitary hormones, oxytocic and tocolytic agents, thyroid hormones and antithyroid agents, hormones of pancreas and hypoglycaemic agents, adrenal corticosteroids and corticosteroid antagonists, gonadal hormones and their inhibitors, oral contraceptives and drugs regulating calcium homeostasis
7. Drugs acting on the respiratory system: Drugs for bronchial asthma and cough.
8. Drugs acting on the kidney: Diuretics and antidiuretics
9. Autacoids: Histamine, 5-hydroxytryptamine and their antagonists, plasma kinins and angiotensin, pentagastrin, substance P, cholecystokinin and eicosanoids
10. Pharmacology of drugs acting on the central nervous system, Synaptic transmission in central nervous system, General anaesthetics: Theories of general anaesthesia, stages of anaesthesia, inhalation anaesthetics, intravenous anaesthetics and preanaesthetic medication, Alcohol: Pharmacological actions, toxic effects, addiction, treatment and rehabilitation, Sedatives and hypnotics: Barbiturates, benzodiazepines and non-barbiturate hypnotics; antiepileptics, Local anaesthetics: Definition, classification, general mechanisms of action, uses and different methods of local anaesthesia Psychopharmacological agents: Antipsychotics, antianxiety, antidepressants, antimanic drugs and hallucinogens; Drugs for Neurodegenerative disorders: Antiparkinsonism drugs and Drugs for Alzheimer's disease; Analgesics: Opioid analgesics and antagonists, NSAIDs and other drugs used in arthritis and gout.

11. Drugs acting on gastrointestinal tract: Drugs for the treatment of peptic ulcer, emetics, antiemetics, prokinetics, purgatives and anti-diarrhoeal agents

12. Chemotherapy: General chemotherapy: Basic principles of chemotherapy, sulphonamides, trimethoprim, quinolones, urinary antiseptics, b-lactam antibiotics, aminoglycosides, tetracyclines, chloramphenicol, macrolides and miscellaneous agents; Specific chemotherapy: Drugs for tuberculosis and leprosy, antiviral and antifungal agents, antiprotozoals (antimalarial, antiamebic and miscellaneous), anthelmintics and anticancer agents

13. Immunopharmacology: General immune responses, immunosuppressants and stimulants.

14. Toxicology: Acute and sub-acute toxicity studies, general principles of management of poisoning, toxicities and management of poisonings with heavy metals (Pb, Hg, As, Fe).

#### PHARMACY PRACTICE

1. Hospital pharmacy: Hospital and its organization, Hospital pharmacy and its organization, Pharmacy and therapeutic committee, Hospital formulary, Drug distribution system in a hospital, Purchase and inventory control.

2. Community pharmacy: Community pharmacy and its legal requirement and management, OTC, prescription and prescription medications, Medication adherence and communication skills, Education and training program for the pharmacists.

3. Clinical pharmacy: Clinical pharmacy and various clinical pharmacy services, Adverse drug reaction, Therapeutic drug monitoring, Patient medication history interview, Drug information services, Patient counselling, Interpretation of Clinical laboratory tests, Hematological tests, cardiac function tests, pulmonary function tests, liver function tests and Renal function tests.

4. Pharmacotherapeutics of following diseases: Hypertension, myocardial infarction, diabetes mellitus, asthma, anemia, epilepsy, stroke rheumatoid arthritis, alcoholic liver diseases. Urinary tract infections, tuberculosis and HIV infection.

#### PHARMACOGNOSY

1. Cultivation, collection and post-harvest technology of crude drugs: Introduction, cultivation, collection, drying storage and preservation of crude drugs of natural origin, factors influencing cultivation, plant hormones and their applications.

2. Adulteration and evaluation of crude drugs: Methods of adulteration and evaluation - Organoleptic, Microscopical, Physical, Chemical and Biological methods.

3. Plant secondary metabolites: Introduction, definition, distribution, properties, classification, extraction, chemistry and tests for identification of Carbohydrates, Tannins, Lipids, Proteins, Essential oils, Resins, Alkaloids and Glycosides. Systematic Pharmacognostic studies of following drugs: Carbohydrates: Acacia, Tragacanth, Sterculia, Guar gum, Agar, Starch, Cellulose, Honey Alginate, carrageenan, Isapgol; Tannins: Catechu (pale & black), Nutgall, Asoka, Arjuna, Kino; Lipids: Castor oil, Cocoa Butter, Olive oil, Shark liver oil, Wool fat, Beeswax, Spermaceti, Chaulmoogra oil, Linseed oil, Arachis oil, Sesame oil, Kokum butter; Proteins: Gelatin and its products, Collagen;

Essential oils: Fennel, Mentha, Cinnamon, Lemon grass, Clove, Nutmeg, Cardamom, Eucalyptus, Coriander, Caraway, Dill, Ajowan, Valerian, Jatamansi, Rasna, Garlic, Acorous, Lemon and Orange peel, Musk, Gaultheria, Sandal wood, Tulsi, Lavender, Artemisia, Coleus, Crocus; Resins: Cannabis, Podophyllum, Ginger, Capsicum, Colophony, Asafoetida, Benzoin Myrrh, Guggul, Turmeric, Boswellia; Alkaloids: Datura, Belladonna, Hyoscyamus, Coca, Rauwolfia, Nux vomica, Ergot, Catharanthus, Aswagandha, Cinchona, Ipecac, Opium, Vasaka, Pepper, Lobelia, Tobacco, Kurchi,

Tea, Aconite, Ephedra, Colchicum; Glycosides: Digitalis, Squill, Strophanthus, Aloe, Senna, Rhubarb, Cascara, Licorice, Ginseng, Dioscorea, Gokhru, Senega, Wild cherry bark, Bitter almond, Mustard, Linseed, Citrus peel, Milk thistle, Psoralea, Gingko, Ammi, Gentian, Chirata, Quassia, Kalmegh, Hypericum, Artichoke.

4. Introduction to phytochemistry: Preliminary phytochemical screening of natural products. General methods used for the extraction, isolation and purification of phytoconstituents. A brief account of spectroscopic and chromatographic methods used for evaluation of Phytoconstituents.

5. Plant biosynthesis: Introduction, Techniques employed for the elucidation of biosynthetic pathways. Study of basic metabolic pathways - Shikimic acid, Isoprenoid and Acetate pathway. Biosynthesis of Tropane (Hyoscyamine/Hyoscine), Quinoline (Cinchona alkaloids), Isoquinoline (Papaverine), Phenanthrene (Morphine) and Indole alkaloids (Lysergic acid derivatives), Biosynthesis of Steroidal glycosides (C-23 and C-24) digitoxin.

6. Natural pesticides of plant origin: Introduction, classification of pests, methods of pest control, classification of pesticides based on mode of action. Natural drugs used as Pesticides-Pyrethrum, Neem, Tobacco, Red Squill.

7. Enzyme biotechnology: Introduction, classification, general methods of isolation and purification of enzymes, enzyme reactors and applications of immobilized enzymes in drug analysis. Source, methods of preparation, chemical nature and uses of the Papain, Bromelain, Streptokinase, Urokinase, Asparaginase, Diastase, Pepsin, Trypsin, Pancreatin.

8. Plant tissue culture: Introduction, types of culture, methods and their application. Callus and suspension culture, protoplast isolation and fusion, Biotransformation and immobilization, Production of secondary metabolites, transgenic plants and their applications.

9. Herbal formulations and standardization: Introduction and classification, General considerations, Selection of dosage form, Stages of herbal formulation, Herbal dosage forms, Formulation and standardization, WHO guidelines for the assessment of herbal medicine, Marker based standardization of herbal drugs by HPLC and HPTLC.

10. Nutraceuticals and cosmeceuticals: Introduction, classification with examples and importance. Natural products used as nutraceuticals: Antioxidants, PUFA, probiotics, prebiotics, dietary fibers. Natural products used as cosmeceuticals: Skin care, hair care products, source, active constituents and uses of Soy bean, Spirulina, Garlic, Aloes, Tea, Turmeric.

PHARMACEUTICS

Physical Pharmacy: Buffers, Solubility, Viscosity and rheology, Surface and interfacial phenomenon, Dispersion systems, Complexation, Micromeritics and Powder rheology. Dispensing Pharmacy: Introduction to laboratory equipment, weighing methodology, handling of prescriptions, labelling instructions for dispensed products, Posological calculations, Available dosage forms and packing, Compounding and dispensing of prescriptions, Enlarging and reducing formula, Displacement value, Preparations of formulations involving allegation, alcohol dilution and isotonic solution. pharmaceutical Technology: Pharmacy Profession & Introduction to Pharmaceuticals, Introduction to dosage forms, Pharmaceutical Plant, Location and layout, Ophthalmic preparations, Preformulations, Packaging materials, Cosmetics, Pilot plant scale-up techniques, Dosage form necessities and additives, Powders, Sources of drug information, Tablets, Parenterals, Suspensions, Emulsions,

Suppositories, Stability of formulated products, Prolonged action pharmaceuticals, Novel drug delivery systems, Semisolids, Allergenic extract, Capsules, Liquids (syrups, elixirs, spirits, aromatic water, liquid for external uses), Pharmaceutical aerosols. Pharmaceutical Engineering: Material of constructions, Drying, Size reduction and Size separation, Extraction, Mixing, Crystallization, Industrial hazards & safety precautions, Evaporation, Distillation, Filtration and Centrifugation. Biopharmaceutics and Pharmacokinetics: Biopharmaceutics, Bio-pharmaceutical statistics and Bio-availability & Bio-equivalence.

#### PHARMACEUTICAL MANAGEMENT AND JURISPRUDENCE

1. Introduction to management, Types of management. Basic concepts of management, management process, function and principles. Levels of management, pharmaceutical management art, science or profession, Social responsibilities of management, functions of management.
2. Planning and Forecasting Planning: Nature, process and types of planning, steps in planning process, planning premises. Advantages and limitations of planning. Management by objective, meaning, objective features, advantages and limitations. Forecasting: meaning, nature, importance, limitations. Techniques of forecasting.
3. Organization Definition, nature, theories, functions, line and staff organization concepts.
4. Research Management R & D organizations and research categories. Elements needed for an R & D organization. Technology transfer.
5. Inventory Management Objective and functions of inventory control. Types of inventories. Requirements of effective inventory control.
6. Communication Nature, types of communication, process, channels and barriers of communication. Limitations of communications. Importance in pharmaceutical industries.
7. Marketing Research New product selection, product management, advertising.
8. Leadership and motivation Leadership: meaning, nature, leadership styles. Theories of leadership. Motivation: meaning, nature, importance. Theories of motivation.
9. Human resource and development (HRD) Definition, HRD methods, HRD process, HRD in Indian industry.



10. Standard institutions and regulatory authorities: Bureau of Indian standards (BIS), International Organization for Standardization (ISO), United States of Food and Drug Administration (USFDA), Central Drug Standard Control Organization (CDSCO), International Conference on Harmonization (ICH), World Health Organization (WHO).

#### PHARMACEUTICAL JURISPRUDENCE

1. Historical background Drug legislation in India, Code of Ethics for Pharmacists.
2. The Pharmacy Act 1948 (inclusive of recent amendments).
3. Drugs and Cosmetics Act 1940, Rules 1945, including New Drug applications.
4. Narcotic Drugs and Psychotropic Substances Act, and Rules there under.
5. Drugs and Magic Remedies (Objectionable Advertisements) Act 1954.
6. Medicinal and Toilet Preparations (Excise Duties) Act 1955, Rules 1976.
7. Medical Termination of Pregnancy Act 1970 and Rules 1975.
8. Prevention of Cruelty to Animals Act 1960.
9. Drug (Price Control) Order.
10. Shops and Establishment Act.
11. Indian Pharmaceutical Industry- An Overview.
12. Introduction to Intellectual Property Rights and Indian Patent Act 1970.
13. An Introduction to Standard Institutions and Regulatory Authorities such as BIS, ASTM, ISO, TGA, USFDA, MHRA, ICH, WHO.

#### BIOCHEMISTRY, MICROBIOLOGY and BIOTECHNOLOGY

Biochemistry: Cell, Lipids, Enzymes, Nucleic acids, Biological oxidations & reductions, Carbohydrates, Proteins

Microbiology: Introduction to Microbiology, Microscopy and staining technique, Biology of Microorganisms, Bacteria, Fungi and Viruses, Aseptic Technique, Sterilization & Disinfection, Microbial Assay

Biotechnology: Fermentation Technology and Industrial Microbiology, Recombinant DNA Technology, Animal Cell Culture, Stem cell culture, Biotechnology-Derived Products. Vaccines and Sera preparations