



**JSPM UNIVERSITY PUNE**



# **SYLLABUS**



**Research Program Entrance Test**

**Subject Concerned Syllabus**

## Pharmacy

### **SYLLABUS FOR Ph.D ENTRANCE TEST FOR PHARMACEUTICAL SCIENCES**

The candidates appearing for Ph.D entrance test shall prepare all the four core subjects i.e., Pharmaceutics, Pharmaceutical Chemistry, Pharmacology and Pharmacognosy. The syllabus for JSPM University Ph.D Entrance Test (JSPMU-PET) for Pharmaceutical Sciences shall be as under:

#### **SUBJECT: PHARMACEUTICS**

##### **1. Pharmacy Profession & Introduction to Pharmaceutics**

Pharmacy as a career, evaluation of Pharmacy, earlier period middle to modern ages. Definition, importance of pharmaceuticals, areas concerned, scope of Pharmaceutics, history and development of the profession of Pharmacy and Pharmaceutical industry in India. A brief review of present Indian Pharma. Industry in global perspective.

##### **2. Introduction to dosage form**

Definition of the drug. New drug and dosage form. The desirable properties of a dosage form, the need of dosage form. Ideas about the available type of dosage forms and new drug delivery system.

##### **3. Sources of drug information**

Introduction to Pharmacopoeia with reference to IP, BP, USP and International Pharmacopoeia. Study of structure/features (index) general notice and compartment of monographs of excipients, drug and drug product. Other sources. Textbooks, journals, internet (drug information system, online database, patient/ consumer information and non- print material. Classification of information, primary, secondary and tertiary. Nomenclature of the drug.

##### **4. Allopathic dosage form**

Merits/demerits, importance, formulation development - vehicles/excipients with examples for the dosage form: liquid dosage form: monophasic liquid dosage form. Aromatic waters, syrup, elixir, linctus, lotion, liniment, glycerites, solutions, spirits, ENT preparations, mixtures, paints, mouthwash.

##### **5. Crude extract**

Infusion, decoction, maceration, percolation, tincture and extract. Methods of preparations of dry, soft and liquid extract.

##### **6. Allergenic extract**

Types of allergens, preparation of extract, testing and standardization of extracts.

## 7. Biological products

Absorbable and non-absorbable material types, sutures and ligatures, processing, manufacturing, sterilization, packing, QC tests of materials like catgut and nylon.

## 8. Pharmaceutical Plant, location, layout

**9. Plant location and layout of an industry. Various factors affecting locational aspects of chemical and pharmaceutical plants. The layout of plant building and importance of flow sheet, the difference between scientific process and technological process, the layout of various departments, equipment, and product layout v/s process layout. Dosage Form Necessities and Additives**

Antioxidants, preservatives, coloring agents, flavoring agents and diluting agents, emulsifying agents, suspending agents, ointment bases, solvents, and others.

## 10. Powders

Advantages and limitations as dosage form, manufacturing procedure and equipment, special care and problems in manufacturing powders, powders of IP, effervescent granules and salts.

## 11. Capsules

Hard gelatin capsules, shell formulation and manufacturing, capsule sizes, storage, filing, cleaning process general formulation contents and evaluation. Soft gelatin capsules, shell formulation, formulation contents, filing, sealing and storage. Microencapsulation, advantages, encapsulation materials, methods of microencapsulation, I.P. formulations

## 12. Tablets

Types, ideal requirement, classification, granulation methods, general formulation, compression machines, different types of tooling's, difficulties in tableting, troubleshooting aspects, evaluation, sugar coating, compression coating, film coating, problems in tablet coatings and their troubleshooting aspects. IP formulations.

## 13. Parenterals - product requiring sterile packaging

Definition, types advantages and limitations, general formulation, vehicles, production procedure, production facilities, controls, tests, selected IP injections, sterile powders, implants, emulsions, suspensions.

## 14. Suspensions

Formulation of deflocculated and flocculated suspension, manufacturing procedure, evaluation methods, IP suspensions.

### **15.Emulsions:**

Types, emulsifying agents, general formulation, manufacturing procedure, evaluation methods, IP emulsions.

### **16.Suppositories**

Ideal requirements, bases, manufacturing procedure, evaluation methods, IP products.

### **17.Semisolids**

Definitions, bases, general formulation, manufacturing procedure, evaluation methods, IP products.

**18.Liquids (solutions, syrups, elixirs, spirits, aromatic water, liquid for external uses)** Definition, types, general formulation, manufacturing procedure, evaluation methods, IP products.

### **19.Pharmaceutical Aerosols**

Definition, propellants, general formulation, manufacturing and packaging methods, pharmaceutical applications. Impacts of propellants on the environment.

### **20.Ophthalmic preparations**

Requirement, formulation, methods of preparation, containers, evaluation, IP products.

### **21.Preformulations**

Consideration of Importance, physical properties, physical forms, particle size, crystal forms, bulk control, solubility, wetting, flow cohesiveness, compressibility, organoleptic properties and its effect on final product consideration of Chemical properties, hydrolysis, oxidation, racemization, polymerization, isomerization, decarboxylation, enzymatic decomposition, formulation additives, stabilizers, suspending and dispersing agents dyes, solid excipients etc.and its effect on quality of finished product.

### **22.Stability of formulated products**

Requirements, drug regulatory aspects, pharmaceutical products stability, shelf life, overages, containers, closures.

Reaction rate and order, acid-base catalysis, destabilization and accelerated stability testing.

### **23.Physical Pharmacy**

#### **Matter, properties of matter**

States of matter, change in the state of matter, latent heat and vapor pressure, sublimation-critical point, eutectic mixtures, gases, aerosols- inhalers, relative humidity, liquid complexes, liquid crystals, glasses state, solid crystalline and amorphous

polymorphism.

### **Micromeritics and powder rheology**

Particle size and distribution, average particle size number and weight distribution, particle number, methods of determining particle size and volume, optical microscopy, sieving, sedimentation, determining surface areas, permeability, adsorption, derived properties of powders, porosity, packing arrangement densities, bulkiness and flow properties.

### **Surface and interfacial phenomenon**

Liquid interface, surface and interfacial tensions, surface free energy, measurement of surface and interfacial tension, spreading coefficient, adsorption and liquid interfaces, surface active agents, HLB classification, solubilization, detergency, absorption at solid interfaces, solid gas and solid-liquid interfaces, complex films, electrical properties of interfaces.

### **Viscosity and rheology**

Newtonian systems, law of flow, kinematics viscosity, effect of temperature, non-Newtonian systems, pseudoplastics, dilatant, plastic, thixotropy in formulations, determination of viscosity and thixotropy by capillary, falling ball, rotational viscometer, application of rheology in pharmacy

### **Dispersion systems**

Colloidal dispersions: Definition, types, properties of colloids, protective colloids, application of colloids in pharmacy.

Suspensions and emulsions: Interfacial properties of suspended particles settling in suspension, theory of sedimentation, effect of Brownian movement, sedimentation of flocculated particles, sedimentation parameters, wetting of particles, significance of electrical properties in dispersions, controlled flocculation, flocculation in structured vehicles, rheological considerations, emulsions: types, theories, physical stability.

### **Complexation**

Classification of complexes, methods of preparations and analysis, applications.

### **Buffer**

Buffer equations and buffer capacity in general. Buffers in pharmaceutical systems, preparations and stability, buffered isotonic solutions. Measurements of tonicity calculations and methods of adjusting isotonicity.

### **Solubility**

Miscibility-influence of foreign substances three component systems; dielectric constant and solubility, solubility of solids in liquids

ideal and non-ideal solutions solvation and association in solutions solubility of salts in water

solubility of slightly soluble and weak electrolyte

calculating solubility of weak electrolytes as influenced by pH, influence of solvents on the solubility of drugs

combined effect of pH and solvents, distribution of solutes between immiscible solvents, effect of ionic dissociation and molecular association on partition, extraction, preservatives action of weak acids in emulsions, drug action and distribution coefficient.

Concepts of dissolution and diffusion.

## **Biopharmaceutics and Pharmacokinetics**

### **Bio-pharmaceutics**

The fate of drug after drug absorption, various mechanisms for drug absorption, drug concentration in blood, biological factors in drug absorption, physicochemical factors, dosage form consideration for gastrointestinal absorption.

Drug Absorption:

Gastrointestinal absorption-biological considerations.

Gastrointestinal absorption - physicochemical considerations.

Gastrointestinal absorption-role of the dosage form.

Pharmacokinetics. Compartmental and non-compartmental pharmacokinetics.

Biotransformation, drug disposition - distribution, drug disposition - elimination.

Variability-Body weight, age, sex and genetic factors. Pharmacokinetic variability-diseases. Pharmacokinetic variability-drug interactions. Individualization and optimization of drug dosing regimens.

### **Bio-availability & Bio-equivalence**

Quality parameters of dosage forms. Assay methods & its validation.

Physicochemical properties of drugs & added substances and its effect on preparations and biological availability of dosage forms. Pharmaceutical properties of dosage forms, disintegration, dissolution rate. Biological, pharmacological effects of dosage forms. Factors affecting Bioavailability, Determination of bioavailability.

Significance of bio-equivalence studies. Statistical analysis of bioequivalence studies. Development, scale up & post approval changes [SUPAC] & *in vitro* [dissolution] *in vivo* [plasma concentration profile] correlation or IV/IV correlation (IVIVC). Multi stage - Bioequivalence studies. Therapeutic equivalence. Titration design for clinical rationales. New Drug Application [NDA].

## **Bio- pharmaceutical statistics**

### **Post Marketing Surveillance. Process Validation Microbiology**

#### **Introduction to Microbiology**

Scope and application to pharmacy field. Whittaker's Five Kingdom concept, historical development - biogenesis Vs. abiogenesis, Germ theory of fermentation, Germ theory of disease, the contribution of Leeuwenhoek, Robert Koch, Jenner, Louis Pasteur and Ehrlich.

#### **Microscopy and staining technique**

The principle, ray diagram, construction, working and applications of light compound, darkfield, phase contrast, Fluorescence & electron microscope. The concept of resolving power, Magnification power, numerical aperture and angular aperture and working distance. The principle application of oil immersion microscopy. Theory of staining, principle and technique of staining procedure - Monochrome, Gram, acid-fast, negative, capsule, endospore.

#### **Biology of Microorganisms**

Cultural characteristics, pure culture techniques

Bacteria - Morphology and fine structure of bacteria, Nutritional requirement and type of culture media, growth and growth curve of bacteria, physical condition for growth, measurement of bacterial growth (Counting Methods), Reproduction in bacteria, genetic exchange - transformation, conjugation, and transduction, development of drug resistance by recombination and mutation, preservation of bacterial culture. Biochemical properties (sugar fermentation and IMVIC test). Pathogenesis of Staphylococcus, Mycobacterium.

Salmonella Introductory study of disease-causing rickettsia, the importance of actinomycetes in antibiotic production.

#### **Fungi and Viruses**

Fungi:- Introduction, general characteristics, morphology, the industrial and medical significance of *Saccharomyces Cerevisiae*, *Penicillium* and *Aspergillus*, *Candida*

Albicans, Epidermophyton, and trichophyta.

Viruses: - Introduction, structure and general properties Bacteriophages - Lytic and Lysogenic cycle, Epidemiological uses of Bacteriophages, human viruses - Cultivation and Multiplication virus-host cell interaction, Pathogenesis of HIV and Prions, types of Tumor viruses.

### **Aseptic Technique**

The omnipresence of microorganisms, the importance of asepsis, sources of contamination and methods of prevention, Principle, construction & working of laminar airflow bench.

### **Sterilization & Disinfection**

Concept and classification, principle and methods of sterilization, Mechanisms of cell injury.

Construction working & applications of moist heat & dry heat sterilizer, gamma radiation sterilizer, filtration sterilizer. Indicators of sterilization, microbial death, kinetic terms- D value, z value.

**Terminology of chemical antimicrobial Agents, Chemical classification of different disinfectants, characteristics of ideal disinfectants, factors affecting the action of disinfectants, evaluation methods (RW Coeff.), Kelsey Sykes test, Chick Martin test. Microbial spoilage**

Types of spoilage, factors affecting spoilage of pharmaceutical products.

### **Vaccines & Sera**

Manufacturing (seed lot system) and quality control of bacterial vaccines & Toxoids (Tetanus, TAB, Cholera, BCG, DPT), Viral vaccine (Polio- Salk Sabin, Rabies, MMR, Hepatitis, Chickenpox, influenza), Antisera (diphtheria, tetanus), antiviral Antisera (rabies). Preparation of allergenic extracts & diagnostics.

### **Microbial Assay**

Importance, general methods of assay of antibiotics (Cup & plate method, paper disc method, turbidometry, dilution method), methods for fungicidal & antiviral compounds, assay, microbial limit tests.

### **Pharmaceutical Engineering**

#### **Fluid flow**

Type of flow, Reynold's number, viscosity, the concept of the boundary layer, basic

equation of fluid flow, the study of valves, flow meters, manometers and measurement of flow and pressure including mathematical problems.

### **Heat transfer**

Source of heat, mechanism of heat transfer, the laws of heat transfer, steam and electricity as heating media, determination of requirement of the amount of steam/electrical energy, steam pressure, boiler capacity, mathematical problems on heat transfer, steam traps and reducing valve, lagging etc.

### **Evaporation**

The basic concept of phase equilibrium, factors affecting evaporation, evaporators, film evaporators, single effect and multiple effect evaporators, mathematical problems on evaporation.

### **Distillation**

Raoult's law, phase diagram, volatility: simple steam and flash distillation, principles of rectification, Mc-Cabe Thiele method for calculations of a number of theoretical plates, azeotropic and extractive distillation, mathematical problems on distillation.

### **Drying**

Moisture content and mechanism of drying, the rate of drying and time of drying calculations, classifications and types of dryers, dryers used in pharmaceutical industries and special drying methods like freeze drying and lyophilization, mathematical problems in drying.

### **Size reduction and size separation**

Definition, objectives of size reduction, factors affecting size reduction, laws governing in energy and power requirement of a mill, types of mills including ball mill, hammer mill, fluid energy mill, micronizer, Quadro co-mil, multi mill etc.

### **Extraction**

Theory of extraction, extraction methods, equipment for various types of the extraction process.

### **Mixing**

Theory of mixing, solid-solid, solid-liquid and liquid-liquid mixing equipment.

### **Crystallization**

Characteristics of crystals like purity, size, shape, geometry, habit, forms, size and factors affecting them. Solubility curves and calculation curves and calculations of heat balance around S Swanson's Walker crystallizer , supersaturation theory and its

limitations, Nucleation mechanism, crystal growth, study of various types of crystallizers, tanks, agitated batch, Swanson's Walker, single vacuums, circulating magma and crystal crystallizers, cracking of crystals and its prevention. Numerical problems on yields. Introduction to polymorphism.

### **Filtration and Centrifugation**

Theory of filtrations, filter aids, filter media, industrial filters, including filter press, rotary filter, edge filters, filter leaf and laboratory filtration equipment etc., Factors affecting filtration, mathematical problems on filtrations, optimum cleaning cycle in batch filters. Principles of centrifugation, industrial centrifugal filters and centrifugal sedimentars.

### **Dehumidification and humidity control**

Basic concept and definition, wet bulb and adiabatic saturation temperatures, psychometric count and measurement of humidity, application of humidity measurement in pharmacy, equipment for humidification and dehumidification operations

### **Automated process control systems**

A process variable, temperature, pressure, flow level and vacuum and their measurement. Elements of automatic process control and introduction to automatic process control. Elements of computer-aided manufacturing (CAM).

### **Industrial hazards & safety precautions**

Mechanical, chemical, electrical, fire, dust, noise hazards, Industrial dermatitis, accident, records, safety requirements/equipment etc.

## **SUBJECT: 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. 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.

### **Protection & deprotection of groups**

Introduction to protection & deprotection of functional groups. Two examples each for amino, hydroxyl, & carbonyl groups. The significance of these in syntheses should be explained.

### **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.

### **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].

Aromatic hydrocarbons.

Phenolic compounds.

Aromatic & aliphatic amines. Diazonium salts.

Aromatic nitro- compounds, aryl halides, & ethers.

### **Polycyclic Aromatic Hydrocarbons**

Syntheses & reactions with mechanisms of bi & tricyclic fused carbocyclic rings like naphthalene, anthracene, & phenanthrene.

### **Carbonyl Chemistry**

Carbonyl chemistry involving group conversions & their reaction mechanisms along with stereochemistry wherever applicable.

- Wolf-Kishner reduction & Huang-Minlong modification.
- Reduction of arylsulfonyl hydrazine/hydrazones to alkanes.
- Bamford Steven reaction.
- DCC Oxidation of alcohol.
- Michael addition / 1,4-addition / conjugate addition.
- Mannich condensation / reaction.
- Robinson annulation.
- Stobbe condensation.
- Darzen's glycidic ester synthesis.
- Beckmann rearrangement.
- Baeyer Villiger rearrangement.
- Curtius, Wolff, & Lossen rearrangements.
- Willgerodt rearrangement.
- Pinacol-pinacolone rearrangement
- Methylene transfer reactions. Use of diazomethane & sulphur ylides in the same.
- Mono- & dialkylations in 1,3-dicarbonyl compounds.
- Formation & use of enol ethers, enol acetates & enamines as protective groups & in regiospecific alkylations.

### **i. 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.

### **ii. Bridged Rings**

Bridged ring systems & their nomenclature. C<sub>8</sub>, C<sub>9</sub>, C<sub>11</sub> bridged bicyclic alkanes. Chemistry of hexamine, morphan, biperiden, amantadine, diazabicyclo[2.2.2] octane

### **iii. Kinetic & Thermodynamic Control**

Kinetic & thermodynamic control of sulfonation, enolate anion formation & alkylation of enamine reactions

### **iv. Stereochemistry**

Stereochemistry. 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.

## **v. Carbohydrates**

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.

## **vi. Amino acids and proteins**

Amino acids & proteins. Definition & classification. D & L Amino acids, natural, essential, & non-essential 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.

## **vii. 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.

## **A. PHARMACEUTICAL INORGANIC CHEMISTRY**

### **i. 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.]

### **ii. Monographs**

**iii. 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.**

### **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. Radiocontrast

media, use of BaSO<sub>4</sub> in medicine.

#### iv. Dentifrices, desensitizing agents, & anticaries agents

### B. MEDICINAL CHEMISTRY

#### i. 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.

- a. General anesthetics.
- b. Local anesthetics.
- c. Diagnostic agents.
- d. Coagulants, anticoagulants & plasma expanders.
- e. Antiseptics, disinfectants, sterilants, & astringents.
- f. Purgatives, laxatives & antidiarrhoeal agents.

#### ii. 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.

- a. Antimalarials
- b. Antiamoebic agents.
- c. Anthelmintic agents.
- d. Antibacterial sulpham drugs [only].
- e. Quinolone antibacterials.
- f. Antimycobacterial drugs.
- g. Antifungal agents.
- h. Antiviral agents including HIV & anti-HIV drugs.
- i. Thyroid & antithyroid drugs.

- j. Antiallergic agents.
- k. Antiulcer agents & Proton Pump Inhibitors.
- l. Hypoglycemic agents.

Different 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.

A. 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.

C. Steroids. Corticosteroids [gluco- & mineralocorticoids] & anti-inflammatory steroids. Sex steroids. Male & female contraceptive agents. Anabolic steroids. Anticancer agents.

### **iii. Different classes of therapeutic drugs**

A detailed study of the following classes with respect to drug nomenclature, classification, physicochemical properties, mode of action [MOA], biosynthesis, structure-activity relationships [SAR], wherever applicable, synthesis of simple & prototype molecules, drug metabolism, therapeutic uses & side effects. Drug resistance, wherever applicable, in respective classes of drugs.

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

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

C. Cholinergic agents. Muscarinic & nicotinic cholinergic agonists & antagonists [up to

M2 & N2]. Neuronal [transmission] blockers.

D. Drugs used in neuromuscular disorders. Drugs used in the treatment of Parkinson's disease. Central & peripheral muscle relaxants.

E. Hypertensive, antihypertensive, & antianginal agents.

F. Diuretics.

G. Eicosanoids. Prostaglandins, prostacyclins, & thromboxanes. Their biochemical role, biosynthesis, & inhibitors.

iv.

v. 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  $pK_a$ , 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.

vi. Asymmetric synthesis. Chirality, chiral pool, sources of various naturally available chiral compounds. Eutomers, distomers, eudismic ratio. Enantioselectivity & enantiospecificity. Enantiomeric & diastereomeric excess. Prochiral molecules. Asymmetric synthesis of captopril & propranolol.

vii. Combinatorial chemistry. Introduction & basic terminology. Databases & libraries. Solid phase synthesis technique. Types of supports & linkers, Wang, Rink, & dihydropyran derivatized linkers. Reactions involving these linkers. Manual parallel & automated parallel synthesis. Houghton's tea bag method, micromanipulation, recursive deconvolution. Mix & split method for the synthesis of tripeptides. Limitations of combinatorial synthesis. Introduction to throughput screening.

## **D. PHARMACEUTICAL ANALYSIS**

**i. Importance of quality control in pharmacy**

**ii. Acid-Base Titrations**

Definitions of acids & bases according to Arrhenius & Lewis theory. Definitions of normality, molarity, molality, & equivalent weight. Primary & secondary standards with examples & differences between them. Standardization of strong acids & bases using primary & secondary standards. Preparation of standard solutions of & calculations of equivalent weights of oxalic acid, potassium acid phthalate, calcium chloride dihydrate, & sodium carbonate. Calculation of factors involved in standardization of sodium hydroxide, hydrochloric acid, & oxalic acid. Direct, back & differential titrations. Application of direct & back titrations to preparations like boric acid & borax in a mixture, ammoniated mercury, milk of magnesia, & zinc oxide ointment.

Law of mass action, acid-base equilibria, pH scale, pH & hydronium ion concentrations in aqueous systems, calculations of pH for weak acids & weak bases. Use & applications of pH meter. Hydrolysis of salts. Strengths of acids & bases, dissociation constant.

Theory of acid-base indicators. Neutralization [titration] curves.

**iii. Definition, different types of buffers [chemical & biological], & their composition. Buffer capacity, buffered isotonic solutions. Calculations involving preparation of various buffer capacity solutions. Biological & pharmaceutical applications of buffers. Non-aqueous titrations**

Acid-base definitions according to Lowry-Bronsted, Lewis & Arrhenius concept. Factors affecting strengths of acids & bases. Intrinsic structure & surrounding environment. Protophilic, protogenic, amphiprotic & aprotic solvents. Acid-base equilibria in non-aqueous media. Titrants & indicators used for the assay of acidic & basic substances. Preparation of perchloric acid, formation of onium ion. Assay of 1<sup>0</sup>, 2<sup>0</sup>, 3<sup>0</sup> amines & amine hydrochlorides using perchloric acid & the reactions involved in it. Standardization of sodium ethoxide solution. Assay of phenols & phenobarbitone. General applications of non-aqueous titrations

**iv. Oxidation-reduction titrations**

Definition of oxidation, reduction, oxidizing & reducing agent. Equivalent weight, the concept of half reactions. Systematic balancing of half reactions with respect to:

- a. Oxalic acid-KMnO<sub>4</sub>,
- b. FeSO<sub>4</sub>-ceric nitrate, &

c. I<sub>2</sub>-sodium thiosulphate solution titrations.

Calculation of equivalent weight of oxalic acid, KMnO<sub>4</sub>, FeSO<sub>4</sub>, permanganate & I<sub>2</sub> from half- reactions. Calculation of factors for titrations mentioned in a, b & c.

a) Redox titrations:

KMnO<sub>4</sub> as a self indicator, its preparation, standardization, & use in the assay of ferrous gluconate tablets, H<sub>2</sub>O<sub>2</sub>, & NaNO<sub>2</sub> solution.

b) Iodimetric & iodometric titrations. Definitions & difference between iodimetry & iodometry. Preparation, standardization of iodine solution. Assay of ascorbic acid & sulphurointment by iodimetry. Assay of copper sulphate & ferric chloride by iodometry.

c) Bromometric titrations.

d) Iodate titrations. Definition. Preparation, standardization & use of KIO<sub>3</sub> in the assay of ascorbic acid & KI.

e) Cerimetric titrations. Preparation, standardization & use of ceric solutions in the assay of paracetamol tablets. Its advantages over permanganate solutions.

f) Bromine titrations. Preparation, standardization & use of bromine solution in the assay of phenol & isoniazid tablets.

g) Potassium dichromate titrations. Preparation, standardization & use of potassium dichromate solution in the assay of ferrous ammonium sulphate.

## **v. Precipitation titrations**

The principle of solubility product & sparingly soluble salts.

Titrants & indicators used in Mohr's, Volhard's, & Fajan's methods. Preparation & standardization of silver nitrate & ammonium thiocyanate solutions. Assay of sodium chloride by Mohr's method, use of nitrobenzene in the assay of halides, ammonium chloride, & thiourea by Volhard's method. Calculation of factors in argentometric titrations. Titration curve method. General applications of precipitation titrations.

## **vi. Complexometric titrations**

Difference between double salts & co-ordinate compounds. Definitions of coordination number of metal ions, ligands- uni-, bi-, & multidentate. Complexing, chelating, & sequestering agents with respective examples. Structure of complexes of platinum with ammonia. Ethylenediamine tetraacetate [EDTA] as a multidentate ligand in

complexometry. Coordinate compounds of EDTA with bi-, tri-, & tetravalent metal ions. Stability of complexes & factors affecting it, use of buffers in EDTA titrations. Selective analysis of ions based on pH adjustments, use of masking & demasking agents, pM or metalion indicators. Standardization of EDTA solution, titration curves, and examples of assays carried out by direct & back titrations & by replacement of one complex by the other. Applications of complexometry in the assays of calcium gluconate, milk of magnesia, zinc undecenoate ointment, & aluminium hydroxide gel. Assay of NaF by indirect titration.

#### **vii. Gravimetry**

Principles of gravimetry. Factors affecting precipitation, formation, & properties of the precipitate. Colloidal state. Impurities in the precipitate, conditions of precipitation. Precipitation from homogenous solutions, washing, drying, & ignition of the precipitate. Experimental techniques of drying & ignition. Applications of gravimetry in pharmacy.

#### **viii. Extraction techniques**

Liquid-liquid extraction, separation of mixtures by extraction. Distribution law. Successive & multiple extraction [Craig method], continuous counter-current extraction. Effect of temperature & pH on extraction. Inert solute, associate ion pair formation, emulsion problem in extractions. Applications in pharmacy.

#### **ix. Potentiometry**

Theory, ion-selective electrodes, measurement of potential, red-ox titration curve, pH measurement, the relation of pH to potential. Applications in pharmacy.

#### **x. Miscellaneous methods of analysis**

Diazotization titrations. Kjeldahl nitrogen estimation. Karl Fisher titrations. Liquid gelenicals. Oxygen flask Determination of alcohol content in liquid gelenicals. Oxygen flask combustion method.

#### **xi. Calibration: Calibration of Instruments**

#### **xii. General principles of spectroscopy**

Wave-particle duality, wave properties, particulate properties. Line & band spectrum. Electromagnetic spectrum. Absorption & emission spectroscopy. Understanding of

terms such as absorbance, transmittance, absorptivities, molar absorptivity,  $E_{1\text{cm } 1\%}$ ,  $\lambda_{\text{max}}$ , the effect of solvent & pH on  $\lambda_{\text{max}}$ .

### **xiii. Ultraviolet-visible Spectrometry**

Different electronic transitions. Auxochromes & their effects, auxochromic, bathochromic & hypsochromic shifts [red & blue shifts]. Beer-Lambert law, its derivation, deviations in Beer's law. Single & double beam spectrophotometers covering sources of radiations, different monochromators, detectors such as barrier cell, photocell, photomultiplier tube. Photodiode array detector. Applications of this technique in qualitative & quantitative estimations giving emphasis on problem-solving. Fieser-Woodward rules for calculations of theoretical  $\lambda_{\text{max}}$  values.

### **xiv. Spectrofluorimetry**

Principle, definitions & types of luminescence. Mechanism of fluorescence & phosphorescence. Singlet & triplet states & intersystem crossing. Fluorescence yield & factors affecting it. Quenching of fluorescence & fluorescence quenchers. Structure & fluorescence. A brief discussion of instrumentation. Applications of fluorimetry in pharmacy.

### **xv. Flame photometry & atomic absorption spectrometry**

Principle & instrumentation with emphasis on working & importance of different components. Temperature, flame absorption & emission profiles. Interferences & their avoidance. Quantitative estimations & applications.

### **xvi. Infrared spectrometry**

Infrared region in EM spectrum. The principle, different stretching & bending vibrations. Components [& their working] of a dispersive instrument. Fourier transform [FT] technique, FT instruments & their comparison with dispersive instruments. Sample handling techniques. Functional group & fingerprint regions in the spectrum. Functional groups identification & their use in the characterization of compounds. Problems based on the identification of functional groups from spectra of unknown compounds.

### **xvii. Proton nuclear magnetic resonance spectrometry**

The principle involved in the technique. Knowledge about fundamental terms involved such as quantized absorption, flipping of nucleus, spin number, magnetic

moment, magnetogyric ratio, relaxation, etc. Equations relating these terms to the frequency of radiation & magnetic field [without derivation of the equations]. Types of relaxation processes. Low & high-resolution instruments. A brief discussion on the low-resolution instrumentation [60 MHz]. Quantitative knowledge of the relationship between MHz & magnetic field. An introduction to superconductivity magnets. Solvents & reference standards used. Setting up of NMR scale. Sample preparation. Shielding & deshielding of a proton & its effect on chemical shifts. Discussion on & importance of equivalent & non equivalent protons [number of signals], chemical shifts [position of signal] & their calculation from the spectrum, chemical shifts of different H's, splitting [multiplicity] of a signal, coupling constants [J values] , integration [area under the signal]. Importance of these terms in identification [or confirmation] of different functional groups. Significance & contribution of J value in stereochemistry. Prediction [expected theoretical values] of chemical shifts & multiplicities for all protons from simple structures containing up to 12-15 carbons. An introduction to FT-technique & its significance in  $^{13}\text{C}$ -NMR Spectrometry.

#### **xviii. Mass spectrometry**

Principle. Low & high-resolution instruments. Components & importance of each in brief. Different types of mass spectrometric techniques. Brief knowledge of Chemical Ionization mass spectrometry. Calculations of hydrogen deficiency index [HDI] or unsaturation index [UI]. Base or parent peak, molecular ion,  $M + 1$ ,  $M + 2$  peaks. Calculations of molecular weight based on  $M + 1$  &  $M + 2$  peaks. Formation of molecular ion & further fragmentation. Rearrangements in mass spectrometry. Major modes of fragmentations of hydrocarbons, hydroxyl compounds, halogen compounds, aldehydes, ketones, carboxylic acids, and amines. Introduction [only] to recent advances in MS.

#### **xix. Polarography**

Principle & instrumentation. Ilkovich equation [no derivation] & its importance. Dropping mercury electrode [DME], saturated calomel electrode. Liquid-liquid junction potential, polarographic cell. Explanation of origin of the S-shaped C-V curve. Applications of this technique. Amperometric titrations, principles, instrumentation, & applications.

## **xx. Nephelometry & Turbidimetry**

Principles, Tyndall effect. Duboscq turbidimeter. Eeel's nephelometer. Applications.

## **xxi. Chromatography**

Principle, rate & plate theory, Van Deemter equation & the parameters affecting separation/band broadening. Classification of chromatography, retention factor. A detailed study of thin layer chromatography [TLC], preparative TLC, paper chromatography [PC], column chromatography, gas chromatography [GC / GLC].

Qualitative & quantitative applications of the above techniques. An introduction to high performance TLC [HPTLC], comparison of TLC & HPTLC. A brief introduction to high pressure / performance liquid chromatography [HPLC].

## **xxii. Miscellaneous**

An introduction to electrophoresis. An introduction to lasers & masers.

Statistical treatment to experimental data. Sampling techniques & applications in pharmaceutical industry.

## **SUBJECT: PHARMACOLOGY**

### **i. General Pharmacology**

Introduction to Pharmacology- Definition, scope and source of drugs, dosage forms and routes of drug administration. Pharmacodynamics-Mechanism of drug action, Receptors, classification and drug-receptor interactions, combined effects of drugs, factors modifying drug actions.

Pharmacokinetics-Mechanism and principle of absorption, distribution, metabolism and excretion of drugs. Principles of basic and clinical pharmacokinetics. Pharmacogenetics. Adverse drug reactions.

Discovery and development of new drugs-Preclinical and clinical studies.

**Detailed pharmacology including classification, mechanism of action and therapeutic uses of following classes:**

### **ii. Neurohumoral transmission in autonomic and central nervous system:**

Neurohumoral transmission (Autonomic and somatic). Neurohumoral transmission in the

C.N.S with special emphasis on Pharmacology of various neurotransmitters. Nitric oxide: Biosynthesis of nitric oxide and its physiological role. Therapeutic use of nitric oxide and nitric oxide donors. Clinical condition in which nitric oxide may play a part.

### **Peptides and proteins as mediators:**

General Principal of peptide pharmacology Biosynthesis and regulation of peptides Peptide antagonists. Protein and peptide as drugs.

### **iii. Pharmacology of peripheral nervous system**

Parasympathomimetics, Parasympatholytics, Sympathomimetics, Sympatholytics, Ganglionic stimulants and blockers. Neuromuscular blocking agents and skeletal muscle relaxants (peripheral).

Local anesthetic agents. Drugs used in Myasthenia Gravis.

#### **iv. Pharmacology of central nervous System**

General anesthetics. Alcohols and disulfiram. Sedatives, hypnotics and centrally acting muscle relaxants, Psychopharmacological agents: Antipsychotics, antidepressants, anti-anxiety agents, anti-manics and hallucinogens.

Anti-epileptic drugs. Anti-parkinsonism drugs. Nootropics.

Narcotic analgesics, drug addiction, drug abuse, tolerance and dependence.

#### **v. Pharmacology of cardiovascular system**

Introduction of hemodynamics and Electrophysiology of heart.

Anti-hypertensive drugs, Anti-anginal agents, Anti-arrhythmic drugs. Drugs used in congestive heart failure. Anti-hyperlipidemic drugs. Drugs used in the therapy of antiplatelet drugs. Blood and plasma volume expanders.

**vi. Drugs Acting on Urinary System:** Diuretics and anti-diuretics.

#### **vii. Drugs acting on Respiratory system**

Anti-asthmatic drugs, Mucolytics and nasal decongestants, Anti-tussives and expectorants. Respiratory stimulants.

#### **viii. Pharmacology of Endocrine system**

**ix.** shock. Haematinics, anticoagulants and haemostatic agents. Fibrinolytics and

Basic concepts in endocrine pharmacology. Hypothalamic and pituitary hormones. Thyroid hormones and antithyroid drugs, Parathormone, Calcitonin and vitamin-D. Insulin, oral hypoglycemic agents and glucagon. ACTH and corticosteroids. Androgens and anabolic steroids. Estrogens, progesterone and oral contraceptives. Drugs acting on the uterus.

#### **x. Chemotherapy**

General principles of chemotherapy. Sulphonamides and co-trimoxazole. Antibiotics- Penicillins, cephalosporins, chloramphenicol, Macrolides, quinolones and fluoroquinolones, Tetracyclines. Aminoglycosides and miscellaneous antibiotics. Chemotherapy of tuberculosis, leprosy, fungal diseases, viral diseases, AIDS, protozoal diseases, worm infections, urinary tract infections and sexually transmitted diseases. Chemotherapy of malignancy.

### **xi. Autacoids and their Antagonists**

Histamine, 5-HT and their agonists and antagonists.

Prostaglandins, thromboxanes and leukotrienes. pentagastrin, cholecystokinin, angiotensin, bradykinin and substance P., Analgesic, anti-pyretic, anti-inflammatory and anti-gout drugs.

### **xii. Pharmacology of drug acting on the gastrointestinal tract**

Antacids, anti-secretary and antiulcer drugs.

Laxatives and antidiarrheal drugs. Appetite stimulants and suppressants. Digestants and carminatives. Emetics and anti-emetics.

### **xiii. Chronopharmacology**

Definition of rhythm and cycles. Biological clocks and their significance leading to chronotherapy.

**xiv. Immunopharmacology:** Immunostimulants and immunosuppressants.

**xv. Vitamins & Minerals:** Vitamin deficiency diseases and their management. Role of minerals in health & diseases.

### **xvi. Principles of toxicology**

Definition of poison. General principles of treatment of Poisoning. Treatment of poisoning due to Heavy metals, insecticides, opioids and other addict forming drugs. Study of acute, sub acute and chronic toxicity as per OECD guidelines (guidelines 420,423,425,407,408,451/452; only names and significance, detailed procedures and minute details are not expected).

## **SUBJECT: PHARMACOGNOSY**

### **i. Introductory Pharmacognosy**

Historical development, modern concept and scope of Pharmacognosy. The significance of Pharmacognosy in various systems of medicine practiced in India viz: Ayurveda, Unani, Homeopathic and Siddha.

### **ii. Classification of crude drugs**

Based on alphabetical, morphological, pharmacological, chemical, taxonomical and chemotaxonomic methods: organized and unorganized drugs: official and unofficial drugs. Plants, animals and minerals: marine products: plant tissue culture.

#### **i. Factors influencing quality of crude drugs**

Exogenous factors: temperature, rainfall, daylight, altitude and soil. Endogenous factors: Mutation, polyploidy, & hybridization in medicinal plants. Production factors including collection, drying, storage and transport methods.

Study of morphological and histological characters of crude drugs, Ergastic cell inclusions, anatomical structures of both monocot and dicot stems, leaves and roots: barks, fruits and seeds.

**ii. Techniques in microscopy:** Details of mountants, clearing agents, chemomicroscopic (microchemical) reagents.

#### **iii. Introduction to phytoconstituents**

Definition, classification, chemical tests and pharmaceutical importance of: carbohydrates and their derivatives, fats and proteins, alkaloids, glycosides, flavonoids, steroids, saponins, tannins, resins, lipids and volatile oils.

#### **iv. Principles of plant classification**

Diagnostic features and medicinal significance of important plants with special reference to: **Algae:** Rhodophyceae (Agar, Alginic acid, Diatoms). **Fungi:** Ergot, Yeast and penicillium. **Gymnosperm:** Pinaceae (Turpentine, Colophony), Gnetaceae (Ephedra). **Angiosperm:** Apocynaceae, Asteraceae, Lamiaceae, Rubiaceae, Rutaceae, Solanaceae, Scrophulariaceae, Leguminosae, Papaveraceae, Acanthaceae and Apiaceae. **Pteridophytes:** Male fern.

#### **v. Pharmaceutical aids**

Biological sources, chemical constituents, adulterants and uses of: Starches, acacia gum, tragacanth, sterculia, guar gum, pectin, arachis oil, castor oil, sesame oil, cottonseed oil, olive oil, cotton, silk, wool, regenerated fibers, asbestos, kaolin, prepared chalk, kieselguhr.

**vi. Animal products:** Biological sources, chemical constituents, adulterants and uses

of: Shellac, cochineal, cantharides, woolfat, lard, beeswax, honey, musk, lanolin, gelatin.

**vii. Plant products:** Introduction to plant bitters, sweeteners, nutraceuticals, cosmeceuticals and photosensitizing agents.

**viii. Toxic drugs:** Study of allergens, hallucinogens, narcotics.

**ix. Enzymes:** Biological sources, preparation, characters, and uses of: diastase, papain bromelain, ficin, yeast, pancreatin, urokinase, pepsin, trypsin, penicillinase, hyaluronidase and streptokinase.

**x. Natural pesticides and insecticides:** Introduction to herbicides, fungicides, fumigants and rodenticides tobacco, pyrethrum, & neem.

**a. Adulteration and evaluation of crude drugs:** Different methods of adulteration: Evaluation of drugs by organoleptic, microscopic, physical, chemical and biological methods. Deterioration of herbal drugs by insects.

**b. Quantitative microscopy**

Definition and determination of stomatal index, stomatal number, palisade ratio, vein islet number, vein termination number, lycopodium spore method. Micrometers and measurement of microscopic characters.

**c. Biogenetic pathways**

Formation of primary and secondary metabolites. Study of Calvin cycle, TCA cycle, Shikimic acid pathway, Embden-Mayerhoff pathway, acetate hypothesis, isoprenoid pathway. Biosynthesis of carbohydrates, lipids and volatile oils.

**d. Carbohydrates & lipids**

Biological sources, salient morphological features, chemical constituents, and uses of: Plantago, bael, chaulmoogra oil, neem oil, shark liver oil, cod liver oil, guggul lipids.

**e. Tannins**

Biological sources, morphology, chemical constituents, chemical test and uses of: Pale catechu, black catechu, nutgalls, *Terminalia belerica*, *Terminalia chebula*, *Terminalia arjuna*.

**f. Volatile oils**

Biological sources, morphology, chemical constituents, adulterants and uses of: Black pepper, turpentine, mentha, coriander, cardamom, cinnamon, cassia, lemon peel, orange peel, lemongrass, citronella, cumin, caraway, dill, spearmint, clove, anise, star anise, fennel, nutmeg, eucalyptus, chenopodium, ajowan, sandalwood.

**g. Resinous drugs**

Classification, formation, sources, chemical constituents, identification test, adulterants and uses of: benzoin, Peru balsam, tolu balsam, colophony, myrrh, asafoetida, jalap, colocynth, ginger, turmeric, capsicum, cannabis, podophyllum.

#### **h. Glycosides**

Nature and classification. Biological sources, morphology, chemical constituents, adulterants and uses of: Digitalis, strophanthus, squill, thevetia, oleander, cascara, aloe, rhubarb, senna, quassia, dioscorea, quillaia, glycyrrhiza, ginseng, gentian, wild cherry, withania, bitter almond. Biosynthesis of cardiac and anthraquinone glycosides.

#### **i. Alkaloids**

Nature, classification, biological sources, morphology, chemical constituents, adulterants and uses of: Areca nut, belladonna, hyoscyamus, stramonium, duboisea, coca, coffee, tea, cinchona, opium, ipecac, nux vomica, ergot, rauwolfia, vinca, kurchi, ephedra, colchicum, vasaca, pilocarpus, aconite, Solanum xanthocarpum. Biosynthesis of tropane, cinchona and opium alkaloids.

#### **j. Extraction and Isolation Techniques**

General methods used for the extraction, isolation and identification of alkaloids, lipids, glycosides, flavonoids, saponins, volatile oils and resins. Application of column, paper and thin layer chromatographic techniques, for the isolation of phytopharmaceuticals.

#### **k. Phytopharmaceuticals**

Isolation, identification and estimation of: caffeine, eugenol, digoxin, piperine, tannic acid, diosgenin, hesperidin, berberine, calcium sennosides, rutin, glycyrrhizin, menthol, ephedrine, quinine, andrographolides and guggul lipids.

#### **iii. Quality control and Standardization of herbal drugs**

Quality control of herbal drugs as per WHO, AYUSH and Pharmacopoeial guidelines- Extractive values, ash values, chromatographic techniques (TLC, HPTLC and HPLC) for determination of chromatographic markers. Determination of heavy metals, insecticides, pesticides and microbial load in herbal preparations.

#### **iv. Herbal formulations**

Principals involved in Ayurveda, Sidha, Unani, Chinese and Homeopathic systems of medicines. Preparation of Ayurvedic formulations like aristas, asava, ghutika, tailia, churna, avaleha, ghrita and bhasmas: Unani formulations like majooms, Safoofs.

Determination of alcohol contents in arishtas & asavas.

#### **v. Worldwide trade of crude drugs and volatile oils: Study of drugs having high**

commercial value and their regulations pertaining to trade.

#### **vi. Herbal cosmetics**

Importance of herbals as shampoos (soapnut), conditioners and hair darkeners, (amla, henna, hibiscus, tea), skin care (aloe, turmeric, lemon peel, vetiver).

#### **vii. Traditional herbal drugs**

Common names, sources, morphology, active constituents and uses (traditional, folklore), pharmacological and clinical uses of: *punarnava* (*Boerhaviadiffusa*), shankhpushpi (*Convolvulus microphylla*), lehsun (*Allium sativum*), guggul (*Commiphora mukul*), kalmegh (*Andrographis peniculata*), tulsi (*Ocimum sanctum*), valerian (*Valerian officinalis*), artemisia (*Artemisia annua*), chirata (*Swertia chirata*), ashoka (*Saraca indica*).

#### **viii. Plants based industries and research institutes in India**

Knowledge about the herbal products being manufactured by premier herbal industries and thrust area of the institutes involved in plant research.

#### **ix. Patents**

Indian and International patent laws, proposed amendments as applicable to herbal/natural products and processes: Intellectual Property Rights with special reference to phytoconstituents.

#### **x. Ayurvedic system of medicine**

Theory, basic concept, diagnosis, various branches of treatment in ayurveda, types of the drug formulation in Ayurveda and important Ayurvedic drugs and their uses, formulation of asavas, arishtas, watika, churna, tailas, ghruta, lep.

#### **xi. Homeopathic system of medicine**

Theory, basic concept, diagnosis, treatment, source of homeopathic medicines and important homeopathic drugs and their uses.