Department of Pharmaceutical Science and Drug Research,

Punjabi University, Patiala

Syllabus for Ph. D (Pharmaceutical Sciences) Entrance Test

Section A: Research Methodology

1. General Research Methodology: Research, objective, requirements, practical difficulties, review of literature, study design, types of studies, strategies to eliminate errors/bias, controls, randomization, crossover design, placebo, blinding techniques.
2. Definition, application, sample size, importance of sample size, factors influencing sample size, Central value, Measure of dispersion, Normal distribution curve and its properties, Deviations from normal distribution curve, Null hypothesis, degree of freedom, Level of significance, statistical tests of significance – parametric tests [Student t test, F test, one-way and two-way ANOVA, multiple comparison tests (*post hoc* analysis) – Dunnett's test, Fischer's LSD test, Studentized tukey's test and Student Newman Keul's test], non-parametric tests (Wilcoxan rank test and Kruskal Wallis test), Chi Square test, Correlation and Regression analysis
3. Medical Research: History, values in medical ethics, autonomy, beneficence, non-maleficence, double effect, conflicts between autonomy and beneficence/non-maleficence, euthanasia, informed consent, confidentiality, criticisms of orthodox medical ethics, importance of communication, control resolution, guidelines, ethics committees, cultural concerns, truth telling, online business practices, conflicts of interest, referral, vendor relationships, treatment of family members, sexual relationships, fatality.
4. CCSEA guidelines for laboratory animal facility: Goals, veterinary care, quarantine, surveillance, diagnosis, treatment and control of disease, personal hygiene, location of animal facilities to laboratories, anesthesia, euthanasia, physical facilities, environment, animal husbandry, record keeping, SOPs, personnel and training, transport of lab animals.
5. Declaration of Helsinki: History, introduction, basic principles for all medical research, and additional principles for medical research combined with medical care.
6. Intellectual property rights: Brief concept of IPR. Introduction to Indian, US and international patenting process. Regulatory requirements for preclinical and clinical testing of pharmaceuticals.

Section B: Pharmaceutical Sciences

PHARMACEUTICS

1. **Surface and Interfacial Phenomenon**: Liquid interface, surface and interfacial tensions, surface free energy, measurement of surface and interfacial tensions, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB classification, solubilization, detergency, adsorption at solid interfaces, solid-gas and solid-liquid interfaces, complex films, electrical properties of interface.
2. **Viscosity and Rheology**: Newtonian systems, Law of flow, kinematic viscosity, effect of temperature; non-Newtonian systems: pseudoplastic, dilatant, plastic; thixotropy, thixotropy in formulation, negative thixotropy
3. **Dispersion Systems** (Colloidal dispersions): Definition, types, properties of colloids, protective colloids, applications of colloids in pharmacy; Suspensions and Emulsions: Interfacial properties of suspended particles, settling in suspensions, theory of sedimentation, effect of Brownian motion, sedimentation of flocculated particles, sedimentation parameters, wetting of particles, controlled flocculation, flocculation in structured vehicles, rheological considerations; Emulsions-types, theories, physical stability
4. **Stability testing**: General considerations & concepts, half-life determination, Influence of temperature, light, solvent, catalytic species and other factors, Accelerated stability study, expiration dating
5. **Pharmaceutical Legislations:** Drugs & Pharmaceutical Industry - A brief review; Pharmaceutical Education, An elaborate study of the followings: Pharmaceutical Ethics; Pharmacy Act 1948; Drugs and Cosmetics Act 1940 and Rules 1945; Medicinal & Toilet Preparations (Excise Duties) Act 1955; Narcotic Drugs & Psychotropic Substances Act 1985 & Rules; Drugs Price Control Order. A brief study of the following Acts with special reference to the main provisions and the latest amendments: Poisons Act 1919; Drugs and Magic Remedies (Objectionable Advertisements) Act 1954; Medical Termination of Pregnancy Act 1970 & Rules 1975; Prevention of Cruelty to Animals Act 1960; States Shops & Establishments Act & Rules; Insecticides Act 1968; AICTE Act 1987; Factories Act 1948; Minimum Wages Act 1948; Patents Act 1970)
6. **Dosages Forms and Novel Drug Delivery Systems (NDDS): Formulation & evaluation:** Liquid Dosages Forms, Semisolid Dosage Forms, Suppositories, Pharmaceutical Aerosols, Capsules, Micro-encapsulation, Tablets, Parenteral Products, NDDS (Nanoparticles, vesicular drug delivery systems)

7. **Biopharmaceutics & Pharmacokinetics** (Introduction to biopharmaceutics: Passage of drugs across biological barrier (passive diffusion, active transport, facilitated diffusion, ion-pair formation and pinocytosis; Pharmacokinetics: Significance of plasma drug concentration measurement. Compartment model- Definition and Scope. Pharmacokinetics of drug absorption - Zero order and first order absorption rate constant using Wagner-Nelson and residual methods. Volume of distribution and distribution coefficient. Clearance concept, mechanism of renal clearance, clearance ratio, determination of renal clearance; Bioavailability and bioequivalence: Measures of bioavailability, C_{max}, t_{max}, and Area Under the Curve (AUC); Design of single dose bioequivalence study and relevant statistics; Review of regulatory requirements for conducting bioequivalent studies. Biopharmaceutical Classification System (BCS) of drugs.

PHARMACEUTICAL CHEMISTRY

1. **Importance of fundamentals of organic chemistry in pharmaceutical sciences:** Molecular orbitals, Bonding and Anti-bonding orbitals, Covalent bond, Hybrid orbitals, Intramolecular forces, Polarity of bonds, Polarity of molecules, Intermolecular forces.
2. **Stereochemistry:** Nomenclature, isomerism, stereoisomerism, conformational and configurational isomerism, optical activity, specification of configuration, chirality, conformations, Stereoselective and stereospecific reactions;
3. **Structure, Nomenclature, Preparation and Reactions of:** Alkanes, Alkenes, Alkynes, Cyclic analogs, Dienes, Benzene, Polynuclear aromatic compounds, Arenes, Alkyl halides, Alcohols, Ethers, Epoxides, Amines, Phenols, Aldehydes and ketones, Carboxylic acids, Functional derivatives of' carboxylic acids, a,ß-Unsaturated carbonyl compounds, Reactive intermediates- carbocations, carbanions, carbenes and nitrenes.
4. **Nucleophilic and Electrophilic Aromatic Substitution Reactions:** Reactivity and orientation;
5. **Electrophilic and Nucleophilic Addition Reactions:** Rearrangements (Beckman, Hoffman, Benzilic acid, pinacole-pinacolone and Bayer-Villager); Elimination reactions; Electrocyclic, Cycloaddition and Sigmatropic reactions; Neighboring group effects.
6. **Heterocyclic Compounds:** Nomenclature, preparation, properties and reactions of 3-, 4-, 5-, 6- & 7-membered heterocycles with one or two heteroatoms like O, N, S. Chemistry of lipids, Carbohydrates and Proteins.
7. **Enzymes:** Nomenclature, enzyme kinetics and their mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis.
8. **Physico-chemical and stereoisomeric** (Optical, geometrical) aspects of drug molecules and biological action, Bioisosterism, Drug-receptor interactions including transduction mechanisms, Drug metabolism and Concept of Prodrugs.
9. **Principles of Drug Design:** Traditional analog and mechanism-based approaches, QSAR approaches, Applications of quantum mechanics, Computer Aided Drug Designing and molecular modeling.
10. **Structures, Chemical names, Mode of action, Uses,** Structure-Activity Relationships including Physicochemical Properties of the following classes of drugs: Cholinergics, anti-cholinergics and cholinesterase inhibitors, Adrenergic drugs, Antispasmodic and anti-ulcer drugs, Local Anesthetics, Neuromuscular blocking agents, Antihistamines, Eicosanoids, Analgesic-antipyretics, NSAIDS, Steroidal Drugs (stereochemistry, Androgens and anabolic agents, Estrogens and Progestational agents, Oral contraceptives, Adrenocorticoids), General Anesthetics, Hypnotics and Sedatives, Anticonvulsants, Anti-Parkinsonian drugs, Psychopharmacological agents (Neuroleptics, Anti-depressants, Anxiolytics), Opioid analgesics, Anti-tussives, CNS stimulants, Diuretics, Anti-hypertensives, Anti-arrhythmic agents, anti-anginal agents, Cardiotonics, Anti-hyperlipidemic agents, Anticoagulants, Anti-platelet drugs, Thyroid and Anti-thyroid drugs, Insulin and oral hypoglycemic agents, Chemotherapeutic Agents used in bacterial, fungal, viral, protozoal, parasitic and other infections, Antibiotics (ß-Lactam, macrolides, tetracyclines, aminoglycosides, polypeptide antibiotics, fluoroquinolones), Anti-metabolites (including sulfonamides), Anti-neoplastic agents, Anti-viral agents (including anti–HIV), Immunosuppressives and immunostimulants, Diagnostic agents, Pharmaceutical Aids.
11. **Pharmaceutical Analysis**
    - Different techniques of pharmaceutical analysis, Significant figures, Rules for retaining significant digits, Types of errors, Mean deviation, Standard deviation, Statistical treatment of small data sets, Selection of sample, Precision and accuracy, Methods of expressing concentration, primary and secondary standards.
    - Volumetric analysis including Acid-Base Titrations (Relative strengths of acids and bases, Law of mass action, Common ion effect, Ionic product of water, pH, Hydrolysis of salts, Henderson-Hasselbach equation, Buffer solutions, Neutralization curves, Theory of indicators), Oxidation Reduction Titrations (Concepts of oxidation and reduction, Redox reactions, Strengths and equivalent weights of oxidizing and reducing agents, Theory of redox titrations, Redox indicators, Iodimetry, Iodometry, Cerrimetry, potassium iodate titrations, potassium bromate titrations), Precipitation Titrations (Solubility product, Argentometric titrations, Gay-Lussac method, Mohr's method, Volhard's method and Fajan's method); Gravimetric Analysis (Colloidal state, Co-precipitation, Post precipitation, Digestion, washing of the precipitate, Filter papers and crucibles, Ignition, Thermogravimetric curves, Specific examples like barium sulphate, aluminium as aluminium oxide and calcium as calcium oxalate); Non-aqueous titrations (Solvents, Indicators, applications); and Complexometric titrations (Complexing agents used as titrants, Sequestering agents, Indicators, Masking and demasking).
    - Chromatography: General principle, plate theory, Factors affecting resolution, Van Deemter equation. Instrumentation and applications of TLC, HPLC, GLC, HPTLC, Paper Chromatography and Column Chromatography.

- Instrumental methods: Principle, theoretical considerations, instrumentation, quantitative and qualitative applications of UV-VIS, IR (Dispersive IR, FT-IR and ATR) and H-NMR spectroscopy, Spectrofluorimetry, Mass Spectrometry (Rules governing fragmentation, Ionization modes - EI, CI, ESI and MALDI, Analysers - magnetic sector, quadrupole, TOF); Flame Photometry, Atomic Absorption Spectroscopy, and X-ray Diffraction Analysis. Interpretation of Spectra.
- Quality assurance: GLP, ISO 9000, TQM, Quality Review and Quality documentation, Regulatory control, regulatory drug analysis, interpretation of analytical data, Validation, quality audit: quality of equipment, validation of equipment, validation of analytical procedures.

PHARMACOLOGY

1. **Basic Principles of Cell Injury and Adaptations:** Causes of Cellular injury, pathogenesis, morphology of cell injury, adaptations and cell death.
2. **Basic Mechanisms involved in the process of inflammation and repair:** Vascular and cellular events of acute inflammation, chemical mediators of inflammation, pathogenesis of chronic inflammation, brief outline of the process of repair.
3. **Immunopathophysiology:** T and B cells, MHC proteins, antigen presenting cells, immune tolerance, pathogenesis of hypersensitivity reactions, autoimmune diseases, AIDS, Amyloidosis.
4. **Fundamentals of general pharmacology:** Dosage forms and routes of administration, mechanism of action, combined effect of drugs, factors modifying drug action, tolerance and dependence; Pharmacogenetics; Principles of Basic and Clinical pharmacokinetics, absorption, Distribution, Metabolism and Excretion of drugs, Adverse Drug Reactions; Bioassay of Drugs and Biological Standardization; Discovery and development of new drugs, Bioavailability and bioequivalence studies;
5. **Pharmacology of Peripheral Nervous System:** Neurohumoral transmission (autonomic and somatic), Parasympathomimetics, Parasympatholytics, Sympathomimetics, Adrenergic receptor and neuron blocking agents, Ganglion stimulants and blocking agents, Neuromuscular blocking Agents, Local anesthetic Agents.
6. **Pharmacology of Central Nervous System:** Neurohumoral transmission in CNS, General Anesthetics, Alcohols and disulfiram, Sedatives, Hypnotics, Anti-anxiety agents and centrally acting muscle relaxants, Psychopharmacological agents (anti-psychotics), anti-maniacs, and hallucinogens, Antidepressants, Anti-epileptics drugs, Anti-Parkinsonian drugs, Analgesics, Antipyretics, Narcotic analgesics and antagonists, C.N.S. stimulants, Drug Addiction and Drug Abuse.
7. **Pharmacology of Cardiovascular System:** Drugs used in the management of congestive cardiac failure, Antihypertensive drugs, Anti-anginal and Vasodilator drugs, including calcium channel blockers and beta adrenergic antagonists, Anti arrhythmic drugs, Anti-hyperlipedemic drugs, Drugs used in the therapy of shock.
8. **Drugs Acting on the Hemopoietic System:** Hematinics, Anticoagulants, Vitamin K and hemostatic agents, Fibrinolytic and anti-platelet drugs, Blood and plasma volume expanders.
9. **Drugs acting on urinary system:** Fluid and electrolyte balance, Diuretics.
10. **Autacoids:** Histamine, Antihistaminic drugs, 5-HT agonists and antagonists, Prostaglandins, thromboxanes and leukotrienes, Angiotensin, Bradykinin and Substance P and other vasoactive peptides, nonsteroidal anti-inflammatory and anti-gout agents.
11. **Drugs Acting on the Respiratory System:** Anti-asthmatic drugs including bronchodilators, Anti-tussives and expectorants, Respiratory stimulants.
12. **Drugs acting on the Gastrointestinal Tract:** Antacids, Anti-secretory and Anti-ulcer drugs, Laxatives and anti-diarrhoeal drugs, Appetite Stimulants and Suppressants, Emetics and anti-emetics, Miscellaneous: Carminatives, demulcents, protectives, adsorbents, astringents, digestants, enzymes and mucolytics.
13. **Pharmacology of Endocrine System:** Hypothalamic and pituitary hormones, Thyroid hormones and anti-thyroid drugs, parathormone, calcitonin and Vitamin D, Insulin, glucagons, incretins, oral hypoglycemic agents and insulin analogs, ACTH and corticosteroids, Androgens and anabolic steroids, Estrogens, progesterone and oral contraceptives, Drugs acting on the uterus.
14. **Chemotherapy:** General Principles of Chemotherapy, Bacterial resistance; Sulfonamides and cotrimoxazole, Antibiotics-Penicillins, Cephalosporins, Aminoglycosides, Chloramphenicol, Macrolides, Tetracyclines, Quinolones, fluoroquinolones and Miscellaneous antibiotics; Chemotherapy of tuberculosis, leprosy, fungal diseases, viral diseases, HIV and AIDS, urinary tract infections and sexually transmitted diseases, malaria, amoebiasis and other protozoal infections and anthelmentics. Chemotherapy of malignancy and immunosuppressive agents.
15. **Principles of Toxicology:** Definition of poison, general principles of treatment of poisoning with particular reference to barbiturates, opioids, organophosphorous and atropine poisoning, Heavy metals and heavy metal antagonists.

PHARMACOGNOSY

1. **Sources of drugs studied in pharmacognosy**: Plants, animals, microorganisms, marine, mineral and plant tissue cultures.
2. **Classification of Drugs**: Morphological, taxonomical, chemical, pharmacological and chemo-taxonomical classification of drugs; Importance of chemotaxonomy in drug discovery
3. **Cultivation of Crude Drugs**: Need for cultivation of medicinal plants. Intrinsic and extrinsic (both biotic and abiotic) factors influencing quality of medicinal plants during their growth / cultivation, collection and post-harvest stage. Importance of GACP. Methods for conservation of plants.
4. **Plant drug standardization:** Need for quality control of crude drugs and medicinal plant preparations. Techniques used for plant drug standardization (organoleptic, microscopic, physical, chromatographic, chemical and biological methods).

Significance of chromatographic fingerprinting and marker(s) determination in plant extracts. WHO and AYUSH guidelines for the standardization of herbal drugs.

5. **Importance of phytoconstituents**: Study of their properties, chemistry, isolation, identification tests, classification and commercial/medicinal uses:
   - CARBOHYDRATES: Emphasis on pharmaceutical and medicinal importance of gums and mucilages.
   - LIPIDS: Importance of fixed oils and waxes in drug and cosmetic formulations.
   - RESINS: Study of chemical and physical properties of Resins and Resin Combinations. Application of podophyllum, cannabis, capsicum, turmeric, ginger in modern medicine.
   - TERPENOIDS: Study of general properties and uses. Importance of the following in pharmacy:
     - Volatile oils: Chemical complexity of volatile oils.
     - Triterpenoids
     - Carotenoids
   - PHENOLIC COMPOUNDS: Introduction to properties and biological significance of various classes like phenolic acids, coumarins, flavonoids, lignans and tannins
   - GLYCOSIDES: Study of general properties and uses. Special emphasis on the following:
     - Saponin glycosides: Liquorice, ginseng, dioscorea
     - Cardioactive glycosides: Digitalis, strophanthus and thevetia,
     - Anthraquinone glycosides: Aloe, senna, rhubarb
     - Others: Psoralea, gentian, chirata, quassia.
   - ALKALOIDS: Study of general properties and uses. Special emphasis on the following:
     - Tropane: Belladonna, datura, duboisia, and withania.
     - Quinoline and Isoquinoline: Cinchona, ipecac, opium.
     - Indole: Ergot, rauwolfia, catharanthus.
     - Steroidal: Veratrum and kurchi.
     - Alkaloidal Amine: Ephedra and colchicum.
     - Purines: Coffee, tea.
6. **Phytochemical screening**: Preparation of different extracts; factors influencing choice of extraction methods. Screening of different phytochemical groups (general and specific tests) in plant extracts.
7. **Biosynthesis of phytoconstituents**: General Techniques to study biosynthetic pathways. Study of pathways involved in biosynthesis of aromatic compounds and terpenoids.
8. **Traditional medicine:** Introduction to principles of different Indian systems of medicine (AYUSH medicine). Need for evidence based clinical practice of traditional medicine
9. **Medicinal plant biotechnology**: Importance of polyploidy, mutation and hybridization for plant improvement. Requirements and techniques involved in plant tissue culture (micropropagation, hairy root culture, protoplast fusion, somatic embryogenesis). Applications of plant tissue culture for increasing secondary metabolite production.
10. **Role of plant-based products in national economy**: Utilization of aromatic plants and derived products with special reference to sandalwood oil, mentha oil, lemon grass oil, vetiver oil, and eucalyptus oil. World-wide trade in medicinal plants and derived products with special reference to diosgenin, taxol, tropane alkaloid containing plants, Papain, Ginseng, Aloe, plants containing laxatives, plant sweeteners.
11. **Importance of Marine pharmacognosy for discovery of novel bioactive agents.**