

SEMESTER IV

BP401T. PHARMACEUTICAL ORGANIC CHEMISTRY –III (Theory)

45 Hours

Course Content:

Note: To emphasize on definition, types, mechanisms, examples, uses/applications.

Unit-I

10 Hours

Stereo isomerism:

Optical isomerism– Optical activity, enantiomerism, diastereomerism, meso compounds.

Elements of symmetry, chiral and achiral molecules.

DL system of nomenclature of optical isomers, sequence rules, RS system of nomenclature of optical isomers.

Reactions of chiral molecules.

Racemic modification and resolution of racemic mixture.

Asymmetric synthesis: partial and absolute.

Unit-II

10 Hours

Geometrical isomerism- Nomenclature of geometrical isomers (Cis-Trans, E-Z, Syn-Anti systems). Methods of determination of configuration of geometrical isomers.

Conformational isomerism in Ethane, n-Butane and Cyclohexane.

Stereo isomerism in biphenyl compounds (Atropisomerism) and conditions for optical activity.

Stereospecific and stereoselective reactions.

Unit-III

10 Hours

Heterocyclic compounds:

Nomenclature and classification

Synthesis, reactions and medicinal uses of following compounds/derivatives:

Pyrrrole, Furan, and Thiophene.

Relative aromaticity and reactivity of Pyrrrole, Furan and Thiophene.

Unit-IV

8 Hours

Synthesis, reactions and medicinal uses of following compounds/derivatives:

Pyrazole, Imidazole, Oxazole and Thiazole.

Pyridine, Quinoline, Isoquinoline, Acridine and Indole.

Basicity of Pyridine.

Synthesis and medicinal uses of Pyrimidine, Purine, Azepines and their derivatives.

Unit-V**07 Hours****Reactions of synthetic importance**

Metal hydride reduction (NaBH_4 and LiAlH_4), Clemmensen reduction, Birch reduction, Wolff-Kishner reduction.

Oppenauer oxidation and Dakin reaction.

Beckmann rearrangement and Schmidt rearrangement.

Claisen-Schmidt condensation.

Recommended Books (Latest Editions)

- Organic Chemistry by Morrison R.T. and Boyd R.N., Bhattacharjee S.K., 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Organic Chemistry by Finar I.L., 6th Edition, Vol.-I, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- An Introduction to the Chemistry of Heterocyclic Compounds by Acheson R.M., 3rd Edition, Wiley (India) Pvt. Ltd.
- Organic Chemistry by Bruice P.Y., 3rd Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Organic Chemistry by Francis A. Carey and Robert M. Giuliano, Tata McGraw Hill Publishing Company Ltd., New Delhi.
- Strategic Applications of Named Reactions in Organic Chemistry by Laszlo Kurti and Barbara Czako, Elsevier Academic Press.
- Heterocyclic Chemistry by Gilchrist T.L., Pearson Education (Singapore) Ltd.
- Heterocyclic Chemistry by Bansal R.K., New Age International Publishers.
- A Textbook of Organic Chemistry by Jain M.K. and Sharma S.C., Shoban Lal and Co. Educational Publishers.
- The Chemistry of Organic Medicinal Products by Jenkins G.L., Hartung W.H., Hamlin K.E. and Data J.B., 4th Edition, PharmaMed Press, Hyderabad.

BP402T. MEDICINAL CHEMISTRY – I (Theory)

45 Hours

Course Content:

Study of the development of the following classes of drugs, Classification, mechanism of action, uses of drugs mentioned in the course, Structure activity relationship of selective class of drugs as specified in the course and synthesis of drugs superscripted (*).

Unit-I

10 Hours

Introduction to Medicinal Chemistry

History and development of medicinal chemistry

Physicochemical properties in relation to biological action

Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism.

Drug metabolism

Drug metabolism principles- Phase I and Phase II.

Factors affecting drug metabolism including stereo chemical aspects.

Unit-II

10 Hours

Drugs acting on Autonomic Nervous System

Adrenergic Neurotransmitters:

Biosynthesis and catabolism of catecholamine.

Adrenergic receptors (Alpha & Beta) and their distribution.

Sympathomimetic agents: SAR of sympathomimetic agents

Direct acting: Nor-epinephrine, Epinephrine, Phenylephrine*, Dopamine, Methyl dopa, Clonidine, Dobutamine, Isoproterenol, Terbutaline, Salbutamol*, Bitolterol, Naphazoline, Oxymetazoline and Xylometazoline.

Indirect acting agents: Hydroxyamphetamine, Pseudoephedrine, Propylhexedrine.

Agents with mixed mechanism: Ephedrine, Metaraminol.

Adrenergic Antagonists:

Alpha adrenergic blockers: Tolazoline*, Phentolamine, Phenoxybenzamine, Prazosin, Dihydroergotamine, Methysergide.

Beta adrenergic blockers: SAR of beta blockers, Propranolol*, Metipranolol, Atenolol, Betazolol, Bisoprolol, Esmolol, Metoprolol, Labetolol, Carvedilol.

Unit-III

10 Hours

Cholinergic neurotransmitters:

Biosynthesis and catabolism of acetylcholine.

Cholinergic receptors (Muscarinic & Nicotinic) and their distribution.

Parasympathomimetic agents: SAR of Parasympathomimetic agents

Direct acting agents: Acetylcholine, Carbachol*, Bethanechol, Methacholine, Pilocarpine.

Indirect acting/ Cholinesterase inhibitors (Reversible & Irreversible): Physostigmine, Neostigmine*, Pyridostigmine, Edrophonium chloride, Tacrine hydrochloride, Ambenonium chloride, Isoflurophate, Echothiophate iodide, Parathion, Malathion.

Cholinesterase reactivator: Pralidoxime chloride.

Cholinergic Blocking agents: SAR of cholinolytic agents

Solanaceous alkaloids and analogues: Atropine sulphate, Hyoscyamine sulphate, Scopolamine hydrobromide, Homatropine hydrobromide, Ipratropium bromide*.

Synthetic cholinergic blocking agents: Tropicamide, Cyclopentolate hydrochloride, Clidinium bromide, Dicyclomine hydrochloride*, Glycopyrrolate, Methantheline bromide, Propantheline bromide, Benztropine mesylate, Orphenadrine citrate, Biperidine hydrochloride, Procyclidine hydrochloride*, Tridihexethyl chloride, Isopropamide iodide, Ethopropazine hydrochloride.

Unit-IV

08 Hours

Drugs acting on Central Nervous System

A. Sedatives and Hypnotics:

Benzodiazepines: SAR of Benzodiazepines, Chlordiazepoxide, Diazepam*, Oxazepam, Chlorazepate, Lorazepam, Alprazolam, Zolpidem

Barbiturates: SAR of barbiturates, Barbitol*, Phenobarbital, Mephobarbital, Amobarbital, Butobarbital, Pentobarbital, Secobarbital.

Miscellaneous: Amides & imides: Glutethimide.

Alcohol & their carbamate derivatives: Meprobamate, Ethchlorvynol.

Aldehyde & their derivatives: Triclofos sodium, Paraldehyde.

B. Antipsychotics

Phenothiazines: SAR of Phenothiazines- Promazine hydrochloride, Chlorpromazine hydrochloride*, Triflupromazine, Thioridazine hydrochloride, Piperacetazine hydrochloride, Prochlorperazine maleate, Trifluoperazine hydrochloride.

Ring Analogues of Phenothiazines: Chlorprothixene, Thiothixene, Loxapine succinate, Clozapine.

Fluoro buterophenones: Haloperidol, Droperidol, Risperidone.

Beta amino ketones: Molindone hydrochloride.

Benzamides: Sulpiride.

C. Anticonvulsants: SAR of Anticonvulsants, mechanism of anticonvulsant action.

Barbiturates: Phenobarbitone, Metharbital.

Hydantoins: Phenytoin*, Mephenytoin, Ethotoin.

Oxazolindione diones: Trimethadione, Paramethadione.

Succinimides: Phensuximide, Methsuximide, Ethosuximide.*

Urea and monoacylureas: Phenacemide, Carbamazepine.*

Benzodiazepines: Clonazepam.

Miscellaneous: Primidone, Valproic acid, Gabapentin, Felbamate.

Unit-V

07 Hours

Drugs acting on Central Nervous System

General anesthetics:

Inhalation anesthetics: Halothane*, Methoxyflurane, Enflurane, Sevoflurane, Isoflurane, Desflurane.

Ultra-short acting barbiturates: Methohexital sodium*, Thiopental sodium, Thiopental sodium.

Dissociative anesthetics: Ketamine hydrochloride. *

Narcotic and non-narcotic analgesics

Morphine and related drugs: SAR of Morphine analogues, Morphine sulphate, Codeine, Meperidine hydrochloride, Anileridine hydrochloride, Diphenoxylate hydrochloride, Loperamide hydrochloride, Fentanyl citrate*, Methadone hydrochloride*, Propoxyphene hydrochloride, Pentazocine, Levorphanol tartrate.

Narcotic antagonists: Nalorphine hydrochloride, Levallorphan tartrate, Naloxone hydrochloride.

Anti-inflammatory agents: Sodium salicylate, Aspirin, Mefenamic acid*, Meclofenamate, Indomethacin, Sulindac, Tolmetin, Zomepirac, Diclofenac, Ketorolac, Ibuprofen*, Naproxen, Piroxicam, Phenacetin, Acetaminophen, Antipyrine, Phenylbutazone.

BP406P. MEDICINAL CHEMISTRY – I (Practical)

4 Hours/week

I. Preparation of drugs/ intermediates

- 1 1,3-pyrazole
- 2 1,3-oxazole
- 3 Benzimidazole
- 4 Benzotriazole
- 5 2,3- diphenyl quinoxaline
- 6 Benzocaine
- 7 Phenytoin
- 8 Phenothiazine
- 9 Barbiturate

II. Assay of drugs

- 1 Chlorpromazine
- 2 Phenobarbitone
- 3 Atropine
- 4 Ibuprofen
- 5 Aspirin
- 6 Furosemide

III Determination of Partition coefficient for any two drugs

Recommended Books (Latest Editions)

- Wilson and Gisvold's Organic Medicinal and Pharmaceutical Chemistry by Block J.H. and Beale J.M., Lippincott Williams and Wilkins.
- Foye's Principles of Medicinal Chemistry by Lemke T.L., Williams D.A., Roche V.F. and Zito S.W., Lippincott Williams and Wilkins.
- Burger's Medicinal Chemistry and Drug Discovery by Abraham D.J., Vol I to IV. John Wiley and Sons Inc., New York.
- Synthesis of Essential Drugs by Vardanyan R.S. and Hruby V.J., Elsevier.
- Medicinal and Pharmaceutical Chemistry by Singh H. and Kapoor V.K., Vallabh Prakashan, Delhi.
- An Introduction to Medicinal Chemistry by Patrick Graham L., Oxford University Press.
- Medicinal Chemistry: A Biochemical Approach by Nogrady T., Oxford University Press, New York.
- The Organic Chemistry of Drug Design and Drug Action by Silverman R.B., Elsevier.
- Essentials of Medicinal Chemistry by Korolkovas A., John Wiley and Sons Inc., New York.

- Textbook of Drug Design and Discovery by Larsen P.K., Liljefors T. and Madsen U., Taylor and Francis Inc.
- Practical Organic Chemistry by Mann F.G. and Saunders B.C., Orient Longman Limited.
- Vogel's Textbook of Practical Organic Chemistry by Furniss B.S., Hannaford A.J., Smith P.W.G. and Tatchell A. R., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.).
- The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
- Pharmacopoeia of India, the Controller of Publications, Delhi.
- The Chemistry of Organic Medicinal Products by Jenkins G.L., Hartung W.H., Hamlin K.E. and Data J.B., PharmaMed Press Hyderabad.

BP403T. PHYSICAL PHARMACEUTICS-II (Theory)

45 Hours

Course Content:

Unit-I

07 Hours

Colloidal dispersions: Classification of dispersed systems & their general characteristics, size & shapes of colloidal particles, classification of colloids & comparative account of their general properties. Optical, kinetic & electrical properties. Effect of electrolytes, coacervation, peptization & protective action.

Unit-II

10 Hour

Rheology: Newtonian systems, law of flow, kinematic viscosity, effect of temperature, non-Newtonian systems, pseudoplastic, dilatant, plastic, thixotropy, thixotropy in formulation, determination of viscosity, capillary, falling Sphere, rotational viscometers.

Deformation of solids: Plastic and elastic deformation, Heckel equation, Stress, Strain, Elastic Modulus.

Unit-III

10 Hours

Coarse dispersion: Suspension, interfacial properties of suspended particles, settling in suspensions, formulation of flocculated and deflocculated suspensions. Emulsions and theories of emulsification, microemulsion and multiple emulsions. Stability of emulsions, preservation of emulsions, rheological properties of emulsions and emulsion formulation by HLB method.

Unit-IV

10 Hours

Micromeritics: Particle size and distribution, mean particle size, number and weight distribution, particle number, methods for determining particle size by different methods, counting and separation method, particle shape, specific surface, methods for determining surface area, permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness & flow properties.

Unit-V

8 Hours

Drug stability: Reaction kinetics: zero, pseudo-zero, first & second order, units of basic rate constants, determination of reaction order.

Physical and chemical factors influencing the chemical degradation of pharmaceutical product: temperature, solvent, ionic strength, dielectric constant, specific & general acid base catalysis, Simple numerical problems. Stabilization of medicinal agents against common reactions like hydrolysis & oxidation. Accelerated stability testing in expiration dating of pharmaceutical dosage forms. Photolytic degradation and its prevention.

BP407P. PHYSICAL PHARMACEUTICS-II (Practical)

3 Hrs/week

1. Determination of particle size, particle size distribution using sieving method.
2. Determination of particle size, particle size distribution using Microscopic method.
3. Determination of bulk density, true density and porosity.
4. Determine the angle of repose and influence of lubricant on angle of repose.
5. Determination of viscosity of liquid using Ostwald's viscometer.
6. Determination sedimentation volume with effect of different suspending agent.
7. Determination sedimentation volume with effect of different concentration of single suspending agent.
8. Determination of viscosity of semisolid by using Brookfield viscometer.
9. Determination of reaction rate constant first order.
10. Determination of reaction rate constant second order.
11. Accelerated stability studies.

Recommended Books: (Latest Editions)

- Physical Pharmacy by Alfred Martin, Lippincott Williams and Wilkins, USA.
- Experimental Pharmaceutics by Eugene, Parott, Burgess Pub. Co., UK.
- Pharmaceutical dosage forms: Disperse systems by Liberman H.A., Lachman C., Volume 1-3. Marcel Dekker Inc.
- Bentley's Textbook of Pharmaceutics edited by E.A. Rawlins, Reed Elsevier India Pvt. Ltd., New Delhi.
- Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems by Loyd V. Allen, Jr., N.G. Popovich and H. C. Ansel, Lippincott Williams & Wilkins, USA.
- Lachman/Lieberman's Theory and practice of industrial pharmacy by Roop K. Khar, S.P. Vyas, F.J. Ahmad and G.K. Jain, CBS Publishers & Distributors Pvt. Ltd., New Delhi.
- Cooper and Gunn's Tutorial Pharmacy edited by S.J. Carter, CBS Publishers & Distributors Pvt. Ltd., New Delhi.

BP404T. PHARMACOLOGY-I(Theory)

45 Hours

Course Content:

Unit-I

08 hours

General Pharmacology

Introduction to Pharmacology- Definition, historical landmarks and scope of pharmacology, nature and source of drugs, essential drugs concept and routes of drug administration, Agonists, antagonists (competitive and noncompetitive), spare receptors, addiction, tolerance, dependence, tachyphylaxis, idiosyncrasy, allergy.

Pharmacokinetics- Membrane transport, absorption, distribution, metabolism and excretion of drugs. Enzyme induction, enzyme inhibition, kinetics of elimination.

Unit-II

12 Hours

General Pharmacology

Pharmacodynamics- Principles and mechanisms of drug action. Receptor theories and classification of receptors, regulation of receptors. drug receptors interactions signal transduction mechanisms, G-protein-coupled receptors, ion channel receptor, transmembrane enzyme linked receptors, transmembrane JAK-STAT binding receptor and receptors that regulate transcription factors, dose response relationship, therapeutic index, combined effects of drugs and factors modifying drug action.

Adverse drug reactions.

Drug interactions (pharmacokinetic and pharmacodynamic).

Drug discovery and clinical evaluation of new drugs -Drug discovery phase, preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance.

Unit-III

10 Hours

Pharmacology of drugs acting on peripheral nervous system

Organization and function of ANS.

Neurohumoral transmission, co-transmission and classification of neurotransmitters.

Parasympathomimetic, Parasympatholytic, Sympathomimetics, sympatholytic.

Neuromuscular blocking agents and skeletal muscle relaxants (peripheral).

Local anesthetic agents.

Drugs used in myasthenia gravis and glaucoma.

Unit-IV

08 Hours

Pharmacology of drugs acting on central nervous system

Neurohumoral transmission in the CNS special emphasis on importance of various neurotransmitters like with GABA, Glutamate, Glycine, serotonin, dopamine.

General anesthetics and pre-anesthetics.
Sedatives, hypnotics and centrally acting muscle relaxants.
Anti-epileptics.
Alcohols and disulfiram.

Unit-V

07 Hours

Pharmacology of drugs acting on central nervous system

Psychopharmacological agents: antipsychotics, antidepressants, anti-anxiety agents, antimaniacs and hallucinogens.

Drugs used in Parkinson's disease and Alzheimer's disease.

CNS stimulants and nootropics.

Opioid analgesics and antagonists.

Drug addiction, drug abuse, tolerance and dependence.

BP408P. PHARMACOLOGY-I (Practical)

4Hours/Week

1. Introduction to experimental pharmacology.
2. Commonly used instruments in experimental pharmacology.
3. Study of common laboratory animals.
4. Maintenance of laboratory animals as per CPCSEA guidelines.
5. Common laboratory techniques. Blood withdrawal, serum and plasma separation, anesthetics and euthanasia used for animal studies.
6. Study of different routes of drugs administration in mice/rats.
7. Study of effect of hepatic microsomal enzyme inducers on the phenobarbitone sleeping time in mice.
8. Effect of drugs on ciliary motility of frog oesophagus.
9. Effect of drugs on rabbit eye.
10. Effects of skeletal muscle relaxants using Rota-rod apparatus.
11. Effect of drugs on locomotor activity using Actophotometer.
12. Anticonvulsant effect of drugs by MES and PTZ method.
13. Study of stereotype and anti-catatonic activity of drugs on rats/mice.
14. Study of anxiolytic activity of drugs using rats/mice.
15. Study of local anesthetics by different methods.

Note: All laboratory techniques and animal experiments are demonstrated by simulated experiments by software and videos.

Recommended Books (Latest Editions)

- Rang and Dale's Pharmacology by Rang H. P., Dale M. M., Ritter J. M., Flower R. J., Churchill Livingstone Elsevier.
- Basic and Clinical Pharmacology by Katzung B. G., Masters S. B., Trevor A. J., Tata McGraw-Hill.
- The Pharmacological Basis of Therapeutics by Goodman and Gilman's, McGraw Hill, USA.
- Applied Therapeutics: The Clinical use of Drugs by Marry Anne K. K., Lloyd Yee Y., Brian K. A., Robbin L.C., Joseph G. B., Wayne A.K., Bradley R.W., the Point Lippincott Williams & Wilkins.
- Lippincott's Illustrated Reviews- Pharmacology by Mycek M.J., Gelnet S.B. and Perper M.M.
- Essentials of Medical Pharmacology by K.D. Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.
- Principles of Pharmacology by Sharma H. L., Sharma K. K., Paras medical publisher
- Modern Pharmacology with Clinical Applications, by Charles R. Craig & Robert.
- Fundamentals of Experimental Pharmacology by Ghosh M.N., Hilton & Company, Kolkata.
- Handbook of Experimental Pharmacology by Kulkarni S.K., Vallabh Prakashan.

BP405T. PHARMACOGNOSY AND PHYTOCHEMISTRY I (Theory)

45 Hours

Course Content:

Unit-I

10 Hours

Introduction to Pharmacognosy:

Definition, history, scope and development of Pharmacognosy.

Sources of Drugs – Plants, Animals, Marine & Tissue culture.

Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilage, oleoresins and oleo- gum -resins).

Classification of drugs:

Alphabetical, morphological, taxonomical, chemical, pharmacological, chemo and sero taxonomical classification of drugs.

Quality control of Drugs of Natural Origin:

Adulteration of drugs of natural origin. Evaluation by organoleptic, microscopic, physical, chemical and biological methods and properties.

Quantitative microscopy of crude drugs including lycopodium spore method, leaf constant, camera lucida and diagrams of microscopic objects to scale with camera lucida.

Unit-II

10 Hours

Cultivation, Collection, Processing and storage of drugs of natural origin: Cultivation and Collection of drugs of natural origin. Factors influencing cultivation of medicinal plants. Plant hormones and their applications.

Ployploidy, mutation and hybridization with reference to medicinal plants.

Conservation of medicinal plants.

Unit-III

07 Hours

Plant tissue culture:

Historical development of plant tissue culture, types of cultures, Nutritional requirements, growth and their maintenance.

Applications of plant tissue culture in pharmacognosy.

Edible vaccines.

Unit-IV

10 Hours

Pharmacognosy in various systems of medicine:

Role of Pharmacognosy in allopathy and traditional systems of medicine namely, Ayurveda, Unani, Siddha, Homeopathy and Chinese systems of medicine.

Introduction to secondary metabolites:

Definition, classification, properties and test for identification of Alkaloids, Glycosides, Flavonoids, Tannins, Volatile oil and Resins.

Unit-V**08 Hours**

Study of biological source, chemical nature and uses of drugs of natural origin containing following drugs.

Plant Products:

Fibers - Cotton, Jute, Hemp.

Hallucinogens, Teratogens, Natural allergens.

Primary metabolites:

General introduction, detailed study with respect to chemistry, sources, preparation, evaluation, preservation, storage, therapeutic used and commercial utility as Pharmaceutical Aids and/or Medicines for the following primary metabolites:

Carbohydrates: Acacia, Agar, Tragacanth, Honey.

Proteins and Enzymes: Gelatin, casein, proteolytic enzymes (Papain, bromelain, serratiopeptidase, urokinase, streptokinase, pepsin).

Lipids (Waxes, fats, fixed oils): Castor oil, Chaulmoogra oil, Wool Fat, Bees Wax.

Marine Drugs: Novel medicinal agents from marine sources.

BP408P. PHARMACOGNOSY AND PHYTOCHEMISTRY I (Practical)

4 Hours/Week

1. Analysis of crude drugs by chemical tests:
 - (i) Tragacanth.
 - (ii) Acacia.
 - (iii) Gelatin.
 - (iv) Starch.
 - (v) Honey.
 - (vi) Castor oil.
 - (vii) Agar.
2. Determination of stomatal number and index.
3. Determination of vein islet number, vein islet termination and palisade ratio.
4. Determination of size of starch grains, calcium oxalate crystals by eye piece micrometer.
5. Determination of Fiber length and width.
6. Determination of number of starch grains by Lycopodium spore method.
7. Determination of Ash value.
8. Determination of Extractive values of crude drugs.
9. Determination of moisture content of crude drugs.
10. Determination of swelling index and foaming.

Recommended Books: (Latest Editions)

- Trease and Evans Pharmacognosy by W.C. Evans, 16th edition, W.B. Saunders & Co., London.
- Pharmacognosy by Tyler V.E., Brady L.R. and Robbers J.E., 9th Ed., Lea and Febiger, Philadelphia.
- Textbook of Pharmacognosy by Wallis T.E., CBS Publishers & Distributers Pvt. Ltd., New Delhi.
- Pharmacognosy and Phytochemistry by Mohammad Ali, CBS Publishers & Distribution, New Delhi.
- Textbook of Pharmacognosy by C.K. Kokate, Purohit, Gokhale (2007), 37th Edition, Nirali Prakashan, New Delhi.
- Herbal Drug Industry by R.D. Choudhary (1996), 1st Ed., Eastern Publisher, New Delhi.
- Essentials of Pharmacognosy, Dr. S.H. Ansari, 2nd Ed., Birla publications, New Delhi.
- Practical Pharmacognosy: C.K. Kokate, Purohit, Gokhale, Vallabh Prakashan, Delhi.
- Pharmacognosy of Powdered Crude Drugs by M.A. Iyengar, PharmaMed Press, Hyderabad.