Syllabus for Bachelor of Pharmacy (B. Pharm.) Course
### SEMESTER IV

<table>
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<tr>
<th>Course code</th>
<th>Name of the course</th>
<th>No. of hours</th>
<th>Tutorial</th>
<th>Credit points</th>
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Scope: This subject imparts knowledge on stereo-chemical aspects of organic compounds and organic reactions, important named reactions, chemistry of important hetero cyclic compounds. It also emphasizes on medicinal and other uses of organic compounds.

Objectives: Upon completion of this course the student should be able to:
1. understand the methods of preparation and properties of organic compounds
2. explain the stereo chemical aspects of organic compounds and stereo chemical reactions
3. know the medicinal uses and other applications of organic compounds

Course Content

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

UNIT I

Stereo isomerism
Optical isomerism-
Optical activity, enantiomerism, diastereoisomerism, 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

Geometrical isomerism
Nomenclature of geometrical isomers (Cis Trans, EZ, 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  

Heterocyclic compounds: 
Nomenclature and classification 
Synthesis, reactions and medicinal uses of following compounds/derivatives 
Pyrrole, Furan, and Thiophene - Relative aromaticity, reactivity and Basicity of pyrrole

UNIT IV  

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  

Reactions of synthetic importance 
Metal hydride reduction (NaBH4 and LiAlH4), Clemmensen reduction, Birch reduction, Wolff Kishner reduction. 
Oppenauer-oxidation and Dakin reaction. 
Beckmanns rearrangement and Schmidt rearrangement. 
Claisen-Schmidt condensation

Recommended Books (Latest Editions) 
1. Organic chemistry by I.L. Finar, Volume-I & II. 
3. Heterocyclic Chemistry by Raj K. Bansal 
4. Organic Chemistry by Morrison and Boyd 
5. Heterocyclic Chemistry by T.L. Gilchrist
BP402T: MEDICINAL CHEMISTRY – I (Theory)

Scope: This subject is designed to impart fundamental knowledge on the structure, chemistry and therapeutic value of drugs. The subject emphasizes on structure activity relationships of drugs, importance of physicochemical properties and metabolism of drugs. The syllabus also emphasizes on chemical synthesis of important drugs under each class.

Objectives: Upon completion of the course student shall be able to
1. understand the chemistry of drugs with respect to their pharmacological activity
2. understand the drug metabolic pathways, adverse effect and therapeutic value of drugs
3. know the Structural Activity Relationship (SAR) of different class of drugs
4. write the chemical synthesis of some drugs

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
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
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, Methyldopa, Clonidine, Dobutamine, Isoproterenol, Terbutaline, Salbutamol*, Bitolterol, Naphazoline, Oxymetazoline and Xylometazoline.

Indirect acting agents: Hydroxyamphetamine, Pseudoephedrine, Propylhexedrine.

Agents with mixed mechanism: Ephedrine, Metaraminol.


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.


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
Barbiturtes: SAR of barbiturates, Barbital*, Phenobarbital, Mephobarbital, Amobarbital, Butabarbital, Pentobarbital, Secobarbital


B. Antipsychotics

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

Chlorprothixene: Thiothixene, Loxapine succinate, Clozapine.

Fluro buterophenones: Haloperidol, Droperidol, Risperidone.


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


Oxazolidine diones: Trimethadione, Paramethadione

Succinimides: Phensuximide, Methsuximide, Ethosuximide*

Urea and monoacylureas: Phencemide, 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*, Thiamylal sodium, Thiopental sodium.

Dissociative anesthetics: Ketamine hydrochloride.*

Narcotic and non-narcotic analgesics

**Narcotic antagonists:** Nalorphine hydrochloride, Levallorphan tartarate, 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)**

**I. Preparation of drugs/ intermediates**
- 1. 1,3-pyrazole
- 2. 1,3-oxazole
- 3. Benzimidazole
- 4. Benztriazole
- 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)**
2. Foye’s Principles of Medicinal Chemistry.
4. Introduction to principles of drug design- Smith and Williams.
5. Remington’s Pharmaceutical Sciences.
6. Martindale’s extra pharmacopoeia.
9. Indian Pharmacopoeia.
BP 403 T: PHYSICAL PHARMACEUTICS-II (Theory)

45 Hours

Scope: The course deals with the various physical, physicochemical properties and principle involved in dosage forms, formulations. Theory and practical components of the subject help the student to get a better insight in to various areas of formulation research and development and stability studies of pharmaceuticals.

Objectives: Upon completion of this course the student should be able to:
1. Understand various physicochemical properties of drug molecules in the designing the dosage form
2. Know the principles of chemical kinetics & to use them in assigning expiry date for Formulation
3. Demonstrate use of physicochemical properties in evaluation of dosage forms.
4. Appreciate physicochemical properties of drug molecules in formulation research and Development

Course Content

UNIT-I


UNIT-II

Rheology: Newtonian systems, law of flow, kinematic viscosity, effect of temperature, non-Newtonian systems, pseudoplastic, dilatants, 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 suspensions, emulsions and theories of emulsification. Physical stability of emulsions, preservation of emulsions, rheological properties of emulsions, phase equilibria and emulsion formulation.

UNIT-IV  
08 Hours
**Surface and interfacial phenomenon:** Liquid interface, surface & interfacial tensions, surface free energy, measurement of surface & interfacial tensions, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB Scale, solubilisation, detergency, adsorption at solid interface.

UNIT-V  
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.

**BP 407P: PHYSICAL PHARMACEUTICS- II (Practical)**

4 Hours / week
1. Determination of surface tension of given liquids by drop count and drop weight method
2. Determination of HLB number of a surfactant by saponification method
3. Determination of Freundlich and Langmuir constants using activated char coal
4. Determination of critical micellar concentration of surfactants
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)
1. Physical Pharmacy by Alfred Martin, Sixth edition
2. Experimental pharmaceutics by Eugene, Parott.
3. Tutorial pharmacy by Cooper and Gunn.
5. Liberman H.A, Lachman C., Pharmaceutical Dosage forms, Tablets, Volume-1 to 3, Marcel Dekkar Inc.
7. Physical Pharmaceutics by Ramasamy C, and Manavalan R.
Scope: The main purpose of the subject is to understand what drugs do to the living organisms and how their effects can be applied to therapeutics. The subject covers the information about the drugs like, mechanism of action, physiological and biochemical effects (pharmacodynamics) as well as absorption, distribution, metabolism and excretion (pharmacokinetics) along with the adverse effects, clinical uses, interactions, doses, contraindications and routes of administration of different classes of drugs.

Objectives: Upon completion of course student shall be able to

1. Understand the pharmacological actions of different categories of drugs
2. Explain the mechanism of drug action at organ system/sub cellular/ macromolecular levels.
3. Apply the basic pharmacological knowledge in the prevention and treatment of various diseases.
4. Observe the effect of drugs on animals by simulated experiments
5. Appreciate correlation of pharmacology with other bio medical sciences

Course Content

UNIT-I 10 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 non competitive), 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 10 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 peripheral nervous system
Organization and function of ANS.
Neurohumoral transmission, co-transmission and classification of neurotransmitters.
Parasympathomimetics, Parasympatholytics, Sympathomimetics, sympatholytics.
Neuromuscular blocking agents and skeletal muscle relaxants (peripheral).
Local anesthetic agents.
Drugs used in myasthenia gravis and glaucoma

UNIT-IV 08 Hours
Pharmacology of central nervous system
Neurohumoral transmission in the C.N.S. 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 central nervous system
Psychopharmacological agents: Antipsychotics, antidepressants, anti-anxiety agents, anti-manics 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)

4 Hours / 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.
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.
15. Study of local anesthetics by different methods

Note: All laboratory techniques and animal experiments are demonstrated by simulated experiments by softwares and videos
Recommended Books (Latest Editions)

3. Goodman and Gilman’s, The Pharmacological Basis of Therapeutics
5. Mycek M.J, Gelnet S.B and Perper M.M. Lippincott’s Illustrated Reviews- Pharmacology
7. Sharma H. L., Sharma K. K., Principles of Pharmacology, Paras medical publisher
8. Modern Pharmacology with clinical Applications, by Charles R.Craig& Robert,
Scope: The subject involves the fundamentals of Pharmacognosy like scope, classification of crude drugs, their identification and evaluation, phytochemicals present in them and their medicinal properties.

Objectives: Upon completion of course student shall be able to
1. to know the techniques in cultivation and production of crude drugs
2. to know the crude drugs, their uses and chemical nature
3. know the evaluation techniques for the herbal drugs
4. to carryout the microscopical and morphological evaluation of crude drugs

Course Content

UNIT-I 10 Hours
Introduction to Pharmacognosy:
(a) Definition, history, scope and development of Pharmacognosy
(b) Sources of Drugs – Plants, Animals and Marine
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 and their evaluation by organoleptic, microscopic, physical, chemical and biological methods and properties.

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.
Polyploidy, mutation and hybridization with reference to medicinal plants
Conservation of medicinal plants
UNIT-III
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-IV
Study of biological source, chemical nature and uses of drugs of natural origin containing following drugs
Plant Products: Fiber - Cotton, Jute, Hemp
Plant bitters & sweeteners
Primary metabolites: Carbohydrates: Acacia, Agar, Tragacanth, Honey
Proteins: Gelatin
Lipids: Castor oil, Chaulmoogra oil, Wool Fat, Bees Wax
Marine Pharmacognosy
Novel medicinal agents from marine sources

UNIT-V
Study of biological source, chemical nature and uses of drugs of natural origin containing following drugs
Secondary metabolites
Flavonoids – Tea, Ruta
Saponins – Liquorice, Dioscorea
Alkaloids-Vinca, Rauwolfia, Bellodonna, Opium
Tannins – Catechu, Pterocarpus
Terpenoids - Mentha, Clove, Nutmeg
Resins: Benzoin, Guggul, Ginger, Asafoetida
Glycosides –Senna, Arjuna, Digitalis
1. Macroscopical and microscopical characters (T.S and powder) of the following drugs: Cinchona, Cinnamon, Senna, Clove, Ephedra, Fennel and Coriander.
2. Analysis of crude drugs by chemical tests:
   i) Asafoetida (ii) Benzoin (iii) Acacia (iv) Agar (v) Gelatin (vi) starch
   (vi) Aloes (vii) Honey (viii) Castor oil
3. Determination of stomatal number and index
4. Determination of vein islet number, vein islet termination and paliside ratio.
5. Determination of size of starch grains, calcium oxalate crystals by eye piece micrometer
6. Determination of fiber length and width
7. Determination of number of starch grains by Lycopodium spore method

**Recommended Books (Latest Editions)**

3. Text Book of Pharmacognosy by T.E. Wallis
7. Essentials of Pharmacognosy, Dr.SH.Ansari, IInd edition, Birla publications, New Delhi, 2007
8. Practical Pharmacognosy: C.K. Kokate, Purohit, Gokhlae