DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY,
UTTAR PRADESH, LUCKNOW

EVALUATION SCHEME & SYLLABUS

BACHELOR OF PHARMACY
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>No. of Hours/week</th>
<th>Internal Assessment</th>
<th>End Semester Exams</th>
<th>Total Marks</th>
<th>Credit Points</th>
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<td>BP401T</td>
<td>Pharmaceutical Organic Chemistry III – Theory</td>
<td>4</td>
<td>10</td>
<td>15</td>
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<td>25</td>
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<td>BP402T</td>
<td>Medicinal Chemistry I – Theory</td>
<td>4</td>
<td>10</td>
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<td>36</td>
<td>70</td>
<td>115</td>
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*The lateral entry students taking admission directly to second year shall compulsorily appear for and pass the Computer Applications in Pharmacy Subject Examination in the Fourth Semester.
BP401T. PHARMACEUTICAL ORGANIC CHEMISTRY –III (Theory)

45 Hours

Course Content:

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

Unit-I
Stereo isomerism:
10 Hours
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
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
Heterocyclic compounds:
Nomenclature and classification
10 Hours
Synthesis, reactions and medicinal uses of following compounds/derivatives:
Pyrrole, Furan, and Thiophene.
Relative aromaticity and reactivity of Pyrrole, Furan and Thiophene.

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                                                                                                               07 Hours

Reactions of synthetic importance
Metal hydrid 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)
- 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.
BP402T. MEDICINAL CHEMISTRY – I (Theory)

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, Methyldopa, Clonidine, Dobutamine, Isoproterenol, Terbutaline, Salbutamol*, Bitolterol, Naphazoline, Oxymetazoline and Xylometazoline.
Adrenergic Antagonists:
Alpha adrenergic blockers: Tolazoline*, Phentolamine, Phenoxycybenzamine, Prazosin, Dihydroergotamine, Methysergide.
Unit-III

**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):** Phystostigmine, Neostigmine*, Pyridostigmine, Edrophonium chloride, Tacrine hydrochloride, Ambenonium chloride, Isofluorohate, Eclothiophate 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:** Tropicamid, Cyclopentolate hydrochloride, Clidinium bromide, Dicyclomine hydrochloride*, Glycoperolate, Methantheline bromide, Propantheline bromide, Benztropine mesylate, Orphenadrine citrate, Biperidine hydrochloride, Procyclidine hydrochloride*, Tridihexethyl chloride, Isopropamide iodide, Ethopropazine hydrochloride.

Unit-IV

**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, Barbital*, Phenobarbital, Meprobamatal, Amobarbital, Butabarbital, 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**: Phenytion*, Mephenytoin, Ethotoin.
- **Oxazolidine 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*, Thiamylal 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.
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. Phenytin
8. Phenothiazine
9. Barbital

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.
- An Introduction to Medicinal Chemistry by Patrick Graham L., Oxford University Press.
• 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.
• The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
• Pharmacopoeia of India, the Controller of Publications, Delhi.
BP403T. PHYSICAL PHARMACEUTICS-II (Theory)

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

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.
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.

**Recommended Books: (Latest Editions)**

- Physical Pharmacy by Alfred Martin, Lippincott Williams and Wilkins, USA.
- 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.
BP404T. PHARMACOLOGY-I (Theory)  
45 Hours

Unit-I  
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  
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 receptors 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  
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  
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**

**Pharmacology of drugs acting on central nervous system**

Psychopharmacological agents: antipsychotics, antidepressants, anti-anxiety agents, antimanics 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)  

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 software and videos.*

**Recommended Books (Latest Editions)**

- The Pharmacological Basis of Therapeutics by Goodman and Gilman’s, McGraw Hill, USA.
- Lippincott’s Illustrated Reviews- Pharmacology by Mycek M.J., Gelnet S.B. and Perper M.M.
- Principles of Pharmacology by Sharma H. L., Sharma K. K., Paras medical publisher
BP405T. PHARMACOGNOSY AND PHYTOCHEMISTRY I (Theory)

Course Content: 45 Hours

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

Polyploidy, 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)

- Practical Pharmacognosy: C.K. Kokate, Purohit, Gokhale, Vallabh Prakashan, Delhi.
- Pharmacognosy of Powdered Crude Drugs by M.A. Iyengar, PharmaMed Press, Hyderabad.