### SEMESTER-V

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<th>S. No.</th>
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CA = Class Attendance, TA = Teacher Assessment.
### SEMESTER-VI

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FIFTH SEMESTER

BOP-351

PHARMACEUTICAL CHEMISTRY-VI
(MEDICINAL CHEMISTRY-I)

Unit I

Basic principles of medicinal chemistry: Physicochemical parameters in relation to biological activity, Stereochemical (Geometrical, Optical and Conformational) aspects of drug design, Bioisosterism. Drug-receptor interaction (forces), Concept of pro-drugs (Bio-precursor and Carrier linked).

Classification, mode of action, uses, recent advances and structure activity relationship of the following classes of drugs (Synthetic procedures of individually mentioned drugs only).

Unit II

Drugs acting at autonomic nervous system

Cholinergic drugs: Methacholine, Pilocarpine.

Anticholinergic drugs: Atropine.

Anticholinesterases: Neostigmine, Physostigmine.

Adrenergic drugs: Ephedrine, Adrenaline, Salbutamol.

Unit III

Drugs acting at central nervous system

General anaesthetics: Methohexital, Ketamine.

Local anaesthetics: Benzocaine, Lignocaine.

Skeletal muscle relaxants: Succinylcholine, Pancuronium.

Opioid analgesics: Pethidine, Pentazocine.

Antitussives: Cramiphen, Dextromethorphen.

Unit IV

Anxiolytics: Diazepam.

Sedatives and hypnotics: Phenobarbitone, Alprazolam.

Anticonvulsants: Phenytoin, Ethosuximide, Valproic Acid, Vigabatrin.

Drugs for neurodegenerative disorders: Alzheimer’s disease (Tacrine), Parkinson’s disease (Levodopa).
Unit V

Antidepressants: Imipramine, Amitriptyline, Fluoxetine.

Antipsychotic: Chlorpromazine, Haloperidol.

CNS Stimulants and psychedelics: Amphetamine, Caffeine.

Antispasmodics: Dicyclomine.

BOP-351P

PHARMACEUTICAL CHEMISTRY-VI
(MEDICINAL CHEMISTRY-I) PRACTICAL

Synthesis of selected drugs from the course content involving two or more steps and characterize/evaluate their Pharmacopoeial standards (if available).

2. To evaluate the Pharmacopoeial standards of Phenytoin.
4. To evaluate Pharmacopoeial standards of Benzocaine.
5. Synthesis of Benzamide.
6. To evaluate the synthesized Benzamide.
7. Synthesis of Caffeine.
8. To evaluate the synthesized Caffeine.
10. To evaluate the Pharmacopoeial standards of Phenobarbitone.
12. To evaluate the synthesized Thiobarbituric acid derivatives.
14. To evaluate the synthesized Piperazin-2,5-dione derivatives.

BOOKS RECOMMENDED

2. Block J.H. and Beale J.M., Wilson and Gisvold’s Textbook of Organic Medicinal and
Pharmaceutical Chemistry, Lippincott Williams and Wilkins.


Unit I

Preformulation studies: Significance of physical form, particle size, shape, density, wetting, dielectric constant, solubility, dissolution and stability on formulation development. Brief introduction to ICH guidelines for stability.

Unit II

Biphasic liquid dosage forms (suspensions and emulsions): Vehicles, additives, stabilizers, preservatives, suspending agents, emulsifying agents, colors and flavors; manufacturing, packaging and evaluation. Brief introduction to multiple emulsion, microemulsion, nanoemulsion and nanosuspension.

Unit III

Semisolid dosage forms: Classification, skin permeation enhancement methods, semisolid bases and their selection, general formulation of semisolids and clear gel manufacturing procedures, packaging and evaluation. Introduction to in situ gels and hydrogels.

Suppositories: Bases, manufacturing procedures, packaging and evaluation. Introduction to liquid suppositories.

Unit IV

Ophthalmic, nasal, otic and parenteral products: Significance and formulation details, equipment for large scale manufacturing, in-vitro methods of evaluation, containers and closures, prefilling treatments. Ophthalmic, nasal, otic and parenteral preparations (Sterile water for injection, water for injection, suspension and sterile powder).

Unit V

Pharmaceutical aerosols: Definition, propellants, general formulation, manufacturing, packaging, evaluation and pharmaceutical applications.

Veterinary dosage forms: Animal dosage forms like solid, liquid oral, parenteral, pastes, pellets and implants; regulatory requirements for approval of animal drugs.
BOP-352P

PHARMACEUTICS-VI
(PHARMACEUTICAL TECHNOLOGY-I) PRACTICAL

1. Formulation and evaluation of the following dosage forms containing drugs mentioned in IP.
   a. Suspensions.
   b. Emulsions.
   c. Ear drops.
   d. Eye drops.
   e. Nasal drops.
   f. Topical gels.
   g. Ointments.
   h. Pastes.
   i. Suppositories.

2. Formulation and evaluation of disodium EDTA injection IP (vials).

3. Formulation and evaluation of water for infection IP (ampoules).

4. To perform tip or bead and pull sealing of ampoules.

BOOKS RECOMMENDED

5. Ansel, H.C., Introduction to Pharmaceutical Dosage Forms, Lea and Febiger, Philadelphia, U.S.A.
8. Turco S. J., Sterile Dosage Form-Their Preparation and Clinical Application, LWW.
PHARMACEUTICS-VII
(Pharmaceutical & Food Microbiology)

Unit I
A. Introduction to scope of food and pharmaceutical microbiology.
B. Optical microscopy and electron microscopy.
C. Identification of microbes: Structure of bacterial cell, stains and types of staining techniques.
D. Classification of bacteria based on temperature, pH and oxygen requirements.

Unit II
A. Nutrition, cultivation and isolation of bacteria and viruses.
B. Factory and hospital hygiene—control of microbial contamination during manufacture, concept and design of clean and aseptic areas, nosocomial infections and their control.

Unit III
Control of microbes
A. Disinfection, factors influencing disinfectants, dynamics of disinfection, disinfectants and antiseptics and their evaluation.
B. Methods of sterilization, validation of sterilization methods and equipments.

Unit IV
Food Microbiology
A. Microbial flora of fresh food: egg, meat, fruits and vegetables.
B. Microbial spoilage of foods.
C. Elementary techniques of industrial food preservation—radiation, low and high temperatures.
D. Probiotics in food: Benefits of probiotic foods, brief introduction to probiotic milk, yogurt and ice-cream.

Unit V
A. Sterility testing as per I.P.
B. Preservative efficacy.
C. Microbial assays of antibiotics: Oxytetracycline and Erythromycin.
D. Microbial assays of Vitamin B₁₂.
PHARMACEUTICS-VII
(PHARMACEUTICAL & FOOD MICROBIOLOGY) PRACTICAL

1. Study of sterilization methods and equipments
   • Dry heat
   • Moist heat.
2. Preparation of various types of culture media.
3. Isolation of bacteria.
4. Sub-culturing of common bacteria, fungi and yeast.
5. Identification and staining of bacteria
   • Simple staining
   • Gram staining
   • Acid fast staining
   • Hanging drop preparation.
6. Microbial examination of foods.
7. Evaluation of disinfectants and antiseptics.
8. Phenol coefficient test, minimum inhibitory concentration.
9. Test for sterility of pharmaceutical products as per IP.
10. Microbial assay of antibiotics as per IP.

BOOKS RECOMMENDED
3. Davis, Dulbetco, Eisen Microbiology.
10. Virella G. Microbiology and Infectious Diseases, William & Wilkins.
PHARMACOLOGY-I
(PROGRAMME & TOXICOLOGY)

Unit I
A. **General Pharmacology:** Introduction to pharmacology, routes of drug administration, combined effect of drugs, factors modifying drug action. Discovery and development of new drugs. Bioassay of drugs.
B. **Basic Concepts of Pharmacokinetics and Pharmacodynamics:** Absorption, distribution, metabolism and excretion. Principles of drug action, mechanisms of drug action, receptors.

Unit II
**Pharmacology of ANS:** Drug acting on autonomic nervous system:
A. **Cholinergic system:** Parasympathomimetic (cholinergic) drugs, parasympatholytic (anti-cholinergic) drugs, drug acting on autonomic ganglia (stimulants and blocking agents).
B. **Adrenergic system:** Sympathomimetic (adrenergic) drugs, sympatholytic (anti-adrenergic) drugs.

Unit III
**Drugs acting on PNS:** Local anesthetics, skeletal muscle relaxants (peripherally and centrally acting muscle relaxants).

Unit IV
**Pharmacology of CNS:** General anaesthetics, alcohols and disulfiram, sedative and hypnotics. antiepileptic drugs, drugs for neurodegenerative diseases, opioid analgesics and their antagonists. Psychopharmacological Agents: Anti anxiety agents, antipsychotics, antidepressants.

Unit V
**Principles of Toxicology:** Definition of poison, general principles for treatment of poisoning with particular reference to barbiturates, opioids, organophosphorous and atropine poisoning. Heavy metal antagonists.
PHARMACOLOGY-I
(PHARMACOLOGY & TOXICOLOGY) PRACTICAL

1. Use of computer simulated (CDs or video cassettes) for pharmacology practical where possible.
3. Study of different routes of administration of drugs in mice/rats.
4. To study the effect of hepatic microsomal enzyme inhibitors and induction on the pentobarbitone sleeping time in mice, using software alternative to use of animals.

BOOKS RECOMMENDED

ENVIRONMENT & ECOLOGY

Unit I
Environment studies: Definition, scope and importance. Natural resources-renewable and non renewable, utilization, exploitation and associated problems of forests. Water resources, mineral resources, food resources, energy resources, land resources, equitable use of resources for sustainable life style, role of an individual in conservation.

Unit II

Unit III
Environmental pollution: Introduction, causes and control measures of air, water, soil, marine, noise, thermal, nuclear pollutions.

Unit IV

Unit V

BOOKS RECOMMENDED
3. Relevant Acts and Rules Published by Government of India with latest amendments.
HOSPITAL TRAINING-I

Training of students at a hospital establishment for a minimum duration of 45 days. The hospital training shall include: First aid (wound dressing, artificial respiration etc.), different routes of injection, study of patient observation charts, prescriptions and dispensing, simple diagnostic reports etc.

May be performed at the end of the 4th semester.
SIXTH SEMESTER

BOP-361

PHARMACEUTICAL CHEMISTRY-VI
(MEDICINAL CHEMISTRY-II)

Classification, mode of action, uses, recent advances and structure activity relationship of the following classes of drug (Synthetic procedures of individually mentioned drugs only).

Unit I
Drug design: Basic concepts of drug design, introduction to analogue based drug design, structure based drug design, introduction to basic concepts of QSAR, molecular descriptors (2D and 3D parameters), quantitative models, introduction to 2D and 3D QSAR methodologies.

Unit II
Cardiovascular agents
Antiarrhythmic drugs: Atenolol, Procainamide.
Antianginal drugs: Isosorbide dinitrate.
Antihypertensive drugs: Captopril, Amlodipine.
Antihyperlipidemics: Lovastatin, Clofibrate.

Unit III
Hypoglycaemics: Insulin, Metformin, Tolbutamide, Glibenclamide, Alogliptin.
Diuretics: Acetazolamide, Chlorthiazide, Furosemide, Spironolactone.
Thyroid and antithyroids: Carbimazole, Propylthiouracil, Methimazole.

Unit IV
Non steroidal anti-inflammatory drugs (NSAIDS) and analgesics: Aspirin, Paracetamol, Ibuprofen, Diclofenac, Mefenamic Acid.
Coxibs: Celecoxib.
Anticoagulants: Heparin, Warfarin.

Unit V
Antihistaminics: Diphenhydramine, Chlorpheniramine, Ranitidine.
Proton pump inhibitors: Rabeprazole.
Cosmeceuticals: Isotretinoin, Minoxidil, Tazarotene.
Synthesis of selected drugs from the course content involving two or more steps and characterize /establish their Pharmacopoeial standards (if available). Spectral analysis of the synthesized drugs.

2. To evaluate the Pharmacopoeial standards of Paracetamol.
4. To characterize the synthesized Anthranilic Acid.
5. Synthesis of antipyrine (2,3-Dimethyl-1-phenyl-pyrazol-5-one).
6. To characterize antipyrine (2,3-Dimethyl-1-phenyl-pyrazol-5-one).
7. Few experiments based on Green Chemistry Approach.
8. To study the Cartesian and internal coordinates for small molecules [MOLDEN (freeware program)].
9. To study the architecture of Protein Data Bank (PDB) file.
10. To study the Hansch and Free Wilson analysis (any free statistical program).
11. To study the protein-ligand interaction [AUTODOCK (freeware)].
12. To develop and validate a 3D-QSAR model [Open3D-QSAR (freeware program) or any other licensed program].

BOOKS RECOMMENDED

9. Pharmacopoeia of India, Ministry of Health, Govt. of India.
Unit I
Pharmaceutical polymers: Classification of polymers, synonyms, storage and pharmaceutical applications of Carbomers, Microcrystalline cellulose, Chitosan, Cyclodextrin, Hydroxypropyl methyl cellulose, Polyethylene glycol, Polymethyl methacrylate, Polyvinyl pyrrolidone (PVP), Poly(lactic co-glycolic) acid, Poloxamers.

Unit II
Tablets: Classification, granulation technology on large-scale, physics of tablets making, different types of tablet compression machinery and the equipment, evaluation of tablets.
Coating of tablets: Types of coating, film forming materials, formulation of coating solution, equipment for coating process, evaluation of coated tablet.

Unit III

Unit IV
Controlled and sustained release dosage forms: Basic mechanism of sustained and controlled release, definition, advantages and limitations of liposomes, niosomes, resealed erythrocytes, dendrimers, solid lipid nanoparticle (SLN), nano lipid carriers (NLC), implants and transdermal patches.

Unit V
Nanoparticles: Introduction, methods of preparation (emulsion solvent evaporation, double emulsion solvent evaporation, coacervation-phase separation technique), evaluation (particle size,
surface characterizations, poly dispersity index, entrapment and loading, \textit{in-vitro} release and release kinetics).

**Packaging of Pharmaceutical Products:** Packaging component types, specifications and methods of evaluation, stability aspects of packaging equipments, factors affecting choice of containers, legal and other official requirements for containers, package testing.

\textit{BOP-362P}

**PHARMACEUTICS-VIII**

* (PHARMACEUTICAL TECHNOLOGY-II) PRACTICAL*

1. Preparation, evaluation and packaging of the following dosage forms containing drugs mentioned in IP.
   a) Capsules.
   b) Microcapsules and microspheres.
   c) Tablets.
   d) Film coated tablets.
   e) Enteric coated tablets
2. To perform film coating of tablets.
3. To study the gel strength and gelling time of different grades of carbomers and HPMC.
4. To formulate and evaluate sustained release dosage forms.
5. To perform the evaluations of packages (containers and closures) and packaging materials.

**BOOKS RECOMMENDED**

7. Potdar M. A., C-GMP for Pharmaceuticals.
PHARMACOLOGY-II

Unit I
Pharmacology of CVS: Cardiac glycosides, antihypertensive drugs, antianginal drugs, antiarrhythmics, antihyperlipidemics.

Unit II
Drugs acting on haemopoietic system: Haematinics, Vit. K and anticoagulants, fibrinolytics and antiplatelet drugs, plasma volume expanders.
Drugs acting on respiratory system: Anti-asthmatic drugs, antitussives and expectorants, respiratory stimulants.

Unit III
Autocoids: Histamine, 5HT and its antagonists, prostaglandins, thromboxane, leukotrienes, angiotensin, bradykinin.

Unit IV
NSAIDS, Anti-gout drugs, diuretics, immunomodulators, anticancer agents.

Unit V
Drugs acting on GIT: Antacids and antiulcer drugs, laxatives and anti-diarrhoeal agents, emetics and anti-emetics.

PHARMACOLOGY-II PRACTICAL

1. To record the dose response curve (DRC) of Acetylcholine using chicken ileum.
2. To study the parallel shift of DRC in presence of competitive antagonist on DRC of Acetylcholine using chicken ileum.
3. To study effect of Physostigmine on DRC of acetylcholine using chicken ileum.
4. To study the CRC of Histamine on guinea pig ileum.
5. Study of the effect of antihistaminics using software.
BOOKS RECOMMENDED

10. Goodman and Gilman, The Pharmacological basis of Therapeutics, Edited by Hardman J.G.
18. Pillai K.K., Experimental Pharmacology, CBS Publishers, New Delhi
Unit I
Phytochemical screening
A. Introduction, principles and types of extraction methods/techniques.
B. An introduction to active constituents of drugs: Classification, isolation, properties and qualitative chemical tests of alkaloids, saponins, cardenolides and bufadienolides, cyanogenetic glycosides, flavanoids and leucoanthocyanidine.

Unit II
Study of the biological sources, commercial varieties, chemical constituents, uses, diagnostic macroscopic and microscopic features, substitutes/adulterants and specific chemical tests of drugs containing the following glycosides-

*Saponins:* Liquorice, Ginseng, Dioscorea, Coleus species.

*Cardioactive sterols:* Digitals, Squill, Stropanthus, Thevetia.

*Anthraquinone cathartics:* Aloe, Senna, Rhubarb, Cascara.

Unit III
*Tannins:* Study of tannins and tannin containing drugs like gumbir (pale catechu), black catechu, gall and myrobalans (Harde, Baheda, Arjuna and Ashoka).

Unit IV
*Plant bitters and sweeteners:* Introduction to plant bitters and sweeteners, biological source, chemical nature and therapeutic uses of bitter and sweetener principles of the following drugs-

*Plant bitters:* Chiratin (*Momordica charantia*), rotenone (*Derris elliptica*), limonin and naringin (*Citrus* fruits).

*Plant sweeteners:* Thaumatin (*Thaumatococcus danielli*), stevioside and rebaudioside (*Stevia rebaudiana*), neohesperidin (*Citrus aurantium*).

Unit V
*Study of traditional drugs:* Common vernacular name, biological sources, morphology, chemical nature of chief constituents, common uses and pharmacology of the following indigenous drugs: Psoralea, Gentian, Saffron, Chirata, Quassia, Amla, Kantkari, Shatavari,
Tylophora, Bilwa, Punarnava, Chitrag, Apamarg, Gokhru, Shankpushpi, Brahmi, Methi, Lehsun, Palash, Gymnema, Shilajit, Nagarmotha.

**BOP-364P**

**PHARMACOGNOSY-III PRACTICAL**

1. Morphology and microscopy (powder) of Liquorice along with its chemical tests.
2. Morphology of Aloe and chemical tests on Aloe-extract.
3. Morphology and microscopy (powder) of Rhubarb.
   a) Morphology of Nagarmotha and Neem.
   b) Identification Tests for Guggul lipids.
8. Test for identification of glycosides (saponin and anthraquinone).
9. Test for identification of tannins.
12. A report on marketed preparations based on traditional drugs mentioned in theory.

**BOOKS RECOMMENDED**

10. Indian Ayurvedic Pharmacopoeia, Govt. of India.
BOP-365

PROFESSIONAL COMMUNICATION

Unit I

Written skills:

a. Proposal writing formats.
c. Business letters.
d. Applications.
e. Covering letters.
f. Curriculum Vitae designing.

Unit II

a. Barriers to communication, time management simulation exercise.
b. Leadership skills.
c. Team work BSC (Boss, subordinates and colleagues).

Unit III

1. Group discussions (GDs).
   a. Tips.
   b. GD.

2. Non verbal aspects of communication.

Unit IV

a. Corporate communication, corporate expectation, office etiquettes.
b. Extempore.

Unit V

1. Interview Tips:
   a. What should be done before the interview, during the interview, after the interview and on the day of interview?
   b. Various questions that may be asked in an interview.
   c. Model interview (video-shooting and displaying optional).

2. Exit interview.
BOOKS RECOMMENDED


BOP-366P

INDUSTRIAL TRAINING

The training shall include training at an approved pharmaceutical unit for a minimum of 30 days. The industrial training shall compose of observation of various manufacturing sections, packaging section and testing section. It shall also include the study of GMP requirements, SOPs, batch production records (BPRs), analysis records etc.

May be performed at the end of the 5th semester.