

B.Pharm Final year

B.Ph. 401T	Instrumental Analysis	50 Hrs
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Unit-I

1. **Chromatography:** Theoretical consideration, application in drug analysis and quality control of the following analytical techniques: column chromatography, GC, HPLC.

Unit-II

2. Theoretical consideration and application in drug analysis and quality control of the following analytical techniques: TLC, HPTLC, paper chromatography.

Unit-III

The theoretical aspects, basic instruments, interpretation of spectra (for UV, IR, NMR, and mass spectroscopy), and applications of the following analytical techniques should be discussed:

1. **Absorption spectroscopy:**
 - I. Ultraviolet and visible spectrophotometry
 - II. Infrared spectroscopy
 - III. Atomic absorption spectroscopy.
4. Nuclear magnetic resonance spectroscopy including ^{13}C -NMR

Unit-IV

5. Mass spectroscopy
6. Emission spectroscopy
 - I. Flame photometry
 - II. Fluorimetry
 - III. X-ray diffraction

Unit-V

7. **Quality assurance:**
 - I. GLP, ISO 9000, TQM, quality review and quality documentation.
 - II. Regulatory control, regulatory drug analysis and interpretation of analytical data.
 - III. Validation, quality audit, quality of equipment, validation of equipment and validation of analytical procedures.

B.Ph. 402P	Instrumental Analysis	75 Hrs
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1. Experiments involving separation of drugs by different analytical techniques.
2. Experiments involving chromatographical analysis of some pharmaceutical products for (e.g. amino acids, alkaloids, proteins, sulpha drugs, terpenes, etc.)
3. Quantitative estimation of at least ten formulations containing single drug or more than one drug, using instrumental techniques.
4. Estimation of Na^+ , K^+ , Ca^{++} and iron, using flame photometry.
5. I.R. of samples with different functional groups (-COOH, -COOR, -CONHR, -C=C-NH₂, -NHR, -OH etc.)
6. Workshop to interpret the structure spectral of simple organic compounds using UV, IR, NMR, and MS.

B.Ph. 403T	Medicinal Chemistry-II	75 Hrs
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Unit-I

1. **Principles of drug design:** QSAR methods, quantum, mechanics, computer aided drug design (CADD) and molecular modeling.
The following topics shall cover classification, nomenclature, S.A.R., synthesis, physicochemical properties, metabolism and therapeutic uses of drugs mentioned under each category. (Biochemical approaches in drug design wherever applicable should be discussed. A brief introduction of latest drugs under each category shall also be discussed).

Unit-II

2. **Drugs acting on autonomic nervous system:**

- (i) **Cholinergic and anticholinesterases:** Acetylcholine, methacholine, carbachol, bethanechol, pilocarpine, muscarine, edrophonium, physostigmine, neostigmine, rivastigmine, parathion, diazinon, malathion.
- (ii) **Anticholinergics:** Atropine, scopolamine, pirenzepine, tolterodine.
- (iii) **Adrenergics:** Epinephrine, nor-epinephrine, salbutamol, dopamine, dobutamine, terbutaline, tyramine, albuterol, amphetamine, ephedrine, isoprenaline, naphazoline, oxymetazoline.
- (iv) **Agents acting at the neuromuscular junction and autonomic ganglia:** Atracurium, tubocurarine, decamethonium, succinylcholine, nicotine, hexamethonium, mecamlamine.

3. Drugs acting on peripheral nervous system:

- (i) **Skeletal muscle relaxants:** Mephenesin, methocarbamol, carisoprodol, metaxalone, chlorzoxazone, orphenadrine
- (ii) **Local anaesthetics:** Cocaine, benzocaine, procaine, tetracaine, lidocaine, articaine, bupivacaine, etidocaine, ropivacaine, dibucaine, dyclorine, pramoxine.

Unit-III

4. Drugs acting on central nervous system:

- (i) **General anaesthetics:** Isoflurane, sevoflurane, nitrous oxide, thiopental, ketamine, etomidate, propofol.
- (ii) **Sedative and hypnotics:** Alprazolam, chlordiazepoxide, clonazepam, diazepam, lorazepam, nitrazepam, oxazepam, midazolam, zolpidem, phenobarbitone, pentobarbitone, meprobamate.
- (iii) **Antidepressants:** Amitriptyline, doxepine, desipramine, citalopram, fluoxetine, sertraline, bupropion, phenelzine, pargyline, meclonamide.
- (iv) **Antipsychotics:** Chlorpromazine, fluphenazine, trifluoperazine, thiothixene, clozapine, haloperidol, loxapine, pimozide, ziprasidone, risperidone.
- (v) **Antiepileptics:** Phenytoin, carbamazepine, ethosuximide, lamotrigine, valproic acid, gabapentin, lamotrigine, zonisamide.
- (vi) **Antiparkinsonian drugs:** Levodopa, carbidopa, bromocriptine, pergolide, trihexyphenidyl.
- (vii) **Opioid analgesics:** Morphine, heroin, codeine, naloxone, nalorphine, meperidine, fentanyl, methadone, dextro-propoxyphene, dextromethorphan, pentazocine.
- (viii) **Non-steroidal anti-inflammatory drugs:** Aspirin, paracetamol, indomethacin, mefenamic acid, tolmetin, diclofenac, ibuprofen, ketoprofen, phenylbutazone, analgin, piroxicam, nimesulide, valdecoxib, etoricoxib, aceclofenac.
- (ix) **CNS stimulants:** Strychnine, picrotoxin, nikethamide, bemegride, caffeine, theophylline.

Unit-IV

5. Drugs acting on cardiovascular system:

- (i) **Antihypertensive agents:** Reserpine, guanethidine, diazoxide, hydralazine, minoxidil, methyldopa, prazosin, clonidine, pargyline, propranolol, phenoxybenzamine, atenolol, captopril, enalapril, lisinopril, nifedipine, amlodipine, diltiazem, verapamil.
- (ii) **Antiarrhythmic agents:** Quinidine, di-isopyramide, procainamide, moxilitene, amiodarone, flecainide.
- (iii) **Antianginal agents:** Glyceryltrinitrate, amylnitrate, isosorbide dinitrate.
- (iv) **Antiatherosclerotic agents:** Atorvastatin, simvastatin, colestipol, clofibrate, gemfibrozil.

6. Drugs acting on kidney: Diuretics – Mannitol, furesamide, bumetanide, ethacrynic acid, chlorthiazide, hydrochlorthiazide, chlorthalidone, acetazolamide, amiloride, triamterene, spironolactone.

Unit-V

7. Hormones and related drugs:

- (i) **Hypoglycaemic agents:** Insulin, tolbutamide, chlorpropamide, phenformin, metformin, glyburide, glipizide, repaglinide, pioglitazone.
- (ii) **Thyroid hormone and antithyroid drugs:** Thyroxine, propylthiouracil, methimazole, carbimazole.

8. Autocoids and related drugs:

- (i) **Antihistaminics:** Diphenhydramine, dimenhydrinate, doxylamine, mepyramine, tripellamine, pheniramine, chlorpheniramine, dexachlorpheniramine, triprolidine, promethazine, methdilazine, antazoline, cyprohepatadine, azatidine, astemizole, cetirizine, fexofenadine.
- (ii) **Eicosinoids:** Prostaglandins: misoprostol, rioprostil, dinoprostone, carboprost tromethamine, alprostadil, metenprost.

9. Drugs acting on gastrointestinal tract:

- (i) **Antiulcer drugs:** Cimetidine, ranitidine, famotidine, loratidine, roxatidine, omeprazole, lansoprazole, pantoprazole, rabeprazole.
- (ii) **Antidiarrhoeal drugs:** Loperamide, diphenoxylate, racecadotril.
- (iii) **Emetics and antiemetics:** Emetine, apomorphine, ondansetron, metoclopramide, cyclizine, promethazine, domperidone.

10. Combinatorial chemistry: Introduction, supports, linkers, solution-phase combinatorial chemistry, pooling strategies, detection, purification, analysis, high-throughput screening, chemical diversity and library design.

B.Ph. 404P	Medicinal Chemistry-II	75 Hrs
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Typical synthesis of drugs & drug intermediates by use of the following types of reactions and establishing pharmacopoeial standards of the drugs synthesized.

- (i) Benzoin condensation
- (ii) Benzilic acid arearrangement
- (iii) Friedel Crats alkylation and acylation
- (iv) Hoffmann – Bromamide reaction
- (v) Perkin condensation
- (vi) Grignard reaction
- (vii) Claisen condensation
- (viii) MVP reduction,
- (ix) Catalytic hydrogenation
- (x) Skraup synthesis.

B.Ph. 405T	Dosage Form Design and Cosmeticology	50 Hrs
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Unit-I

1. **Preformulation studies:** Study of physical properties of drugs like physical form, particle size, shape, density, wetting and dielectric constant, solubility, dissolution and organoleptic properties and their effect on formulation, stability and bioavailability.

Study of chemical properties of drugs like hydrolysis, oxidation, reduction, racemization, polymerization etc. and their influence on formulation and stability of products.

Study of pro-drugs in solving problems related to stability, bioavailability and elegance of formulations.

Unit-II

2. Design, development and process validation methods for pharmaceutical operations involved in the production of pharmaceutical products with special reference to tablets and solutions.

Stabilization & stability testing protocol for various pharmaceutical products with special reference to tablets and solutions.

Unit-III

3. Performance evaluation methods:
In-vitro dissolution studies for solid dosage forms; methods, interpretation of dissolution data.
In-vivo methods of evaluation and statistical treatment.
4. GMP and quality assurance, quality audit.

Unit-IV

5. **Cosmeticology and cosmetic preparation:** Fundamentals of cosmetic science, structure and function of skin and hair. Formulation preparation and packaging of cosmetic for skin, hair, dentifrices and manicure preparation lipsticks, eyelashes, baby care products etc.

Unit-V

6. **Novel Drug Delivery Systems:** Basic concept, merits and demerits, design, development, production & evaluation of following delivery systems- sustained & controlled release dosage forms (with special reference to tablets, capsules and oral liquids), nanoparticles, liposomes, resealed erythrocytes, microspheres, microcapsules, fast dissolving dosage forms.

B.Ph. 406P	Dosage form Design and Cosmeticology	75 Hrs
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1. Preformulation studies including drug-excipient compatibility studies, effect of stabilizers, preservatives etc. in dosage form design.
2. Experiments demonstrating improvement in bioavailability through prodrug concept.
3. Stability evaluation of various dosage forms and their expiration dating.
4. Dissolution testing and data evaluation for oral solid dosage forms.
5. In-vivo bioavailability evaluation from plasma drug concentration and urinary excretion curves.
6. Design, development and evaluation of controlled release formulation.
7. Formulation of various types of cosmetics for skin, hair, dentifrices and manicure preparations.

B.Ph. 407T	Biopharmaceutics and Pharmacokinetics	50 Hrs
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BIOPHARMACEUTICS

Unit-I

1. **Introduction to Biopharmaceutics**
2. **Delivery of drugs:** Routes of administration, transport of drugs across biological barrier (passive diffusion, active transport, facilitated diffusion, pinocytosis, etc.).
3. **Absorption of drugs:** Factors influencing absorption such as physicochemical factors, biopharmaceutical factors, manufacturing processing factors, pharmacokinetic factors
4. **Distribution of Drugs:** Tissue permeability, physiological barriers, volume of distribution.

Unit-II

5. **Termination of drug action:** Biotransformation of drugs, protein binding of drugs, excretion of drugs, Concept of clearance – Renal clearance, mechanism of renal clearance, clearance ratio, determination of renal clearance, Non-renal routes of drug elimination (Extraction ratio, hepatic clearance, biliary excretion, extrahepatic circulation).
6. **Bioavailability and bioequivalence:** Measure of bioavailability, C_{max} , t_{max} , and area under the curve (AUC), Design of single dose bio-equivalence study and relevant statistics, Review of regulatory requirements for conduction of bioequivalent studies

PHARMACOKINETICS

Unit-III

7. **Introduction to Pharmacokinetics:** Rate, Rate constants and order of reactions (Zero order and first order kinetics)
8. **Concept of compartment modeling:** Introduction, compartment models- **Intravenous** administration, **Extravascular** administration

Unit-IV

9. **Non-linear Pharmacokinetics** with special reference to one compartment model after I V drug administration, Michaelis Menten Equation, determination of non - linearity (Saturation mechanism).

MISCELLANEOUS

10. *In vivo-In vitro* Correlation

Unit-V

11. Mean residence time concept
12. Statistical moments analysis
13. Multiple dosing and steady state levels and their relationship with single dose administration.
14. International regulation regarding bioavailability and bioequivalence studies

B.Ph. 408P	Biopharmaceutics and Pharmacokinetics	75 Hrs
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1. Experiments designed for the estimation of various pharmacokinetic parameters with given data.
2. Analysis of biological specifications for drug content and estimation of the pharmacokinetics parameters.
3. In vitro evaluation of different dosage forms for drug release.
4. Absorption studies in- vitro and in -situ.
5. Statistical treatment of pharmaceutical data.
6. Preparation of surgical dressings, sterile infusions, adhesive tapes and bandages.
7. Experiments based on sterilization of various types of materials like surgical dressings, surgical equipments, glasswares, gowns, headgears, mask, gloves etc. used in Hospitals.
8. Evaluation of cotton, bandages, dressings, tapes and infusion.

9. Evaluation of containers and closures for parenteral use.
10. Preparation of haemostat.
11. Practicals designed on the use of computers in Drug Information Center, prescription filling, documentation of information on drug interaction.

B.Ph. 409T	Pharmacology – III and Clinical Pharmacy	75 Hrs
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Unit-I

1. **Chemotherapy:** General principles of chemotherapy
Antimicrobial drugs: Sulfonamides and cotrimoxazole, beta-lactam antibiotics, Cephalosporins, tetracyclines and chloromphenicol (broad spectrum antibiotics), quinolones, aminoglycoside antibiotics, macrolides and other antibacterial.

Unit-II

2. Antifungal, Antiviral, Antimalarial, Antiamoebic and other antiprotozoal drugs, anthelmintics.

Unit-III

3. Chemotherapy of urinary tract infections, cancer, tuberculosis, leprosy and sexually transmitted diseases and immunosuppressive agents.
4. Complete pharmacology of following Local anti infective agents, sera, vaccines, diagnostic agents and vitamins. Gene-therapy.

Unit-IV

5. Clinical Pharmacy:
 - a. Basic concepts of pharmacotherapy
 - b. Clinical pharmacokinetics and individualization of drug therapy
 - c. Drug delivery systems, their biopharmaceutical and therapeutic considerations.
 - d. Use of drugs in infants and in elderly patients
 - e. Use of drugs during pregnancy and lactation
 - f. Therapeutic Drug monitoring
 - g. Concept of essential drugs & Rational drug Use.
 - h. Drug induced diseases.
 - i. Basics of drug interactions.
 - j. Interpretation of clinical laboratory tests.

Unit-V

6. a. Principles of Toxicology: Definition of poison, general principles of treatment of poisoning with particular reference to barbiturates, opioids, salicylates, organ-ophosphorous and atropine poisoning.
- b. Heavy metals and heavy metal antagonists.

B.Ph. 410P	Pharmacology – III and Clinical Pharmacy	75 Hrs
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1. Bioassay of gallamine (d-tobocurarine), mepyramine and atropine.
2. Study of non-competitive antagonism between acetyl choline and papaverine on guinea pig ileum.
3. Study of competitive antagonism between histamine and mepyramine and to find out the PA^{-2} value of mepyramine on guinea pig ileum.
4. Study of competitive antagonism between acetyl choline and atropine and to find out the PA^{-2} value of atropine on rat ileum.
5. Demonstration of dose response curve of oxytocin on rat uterus.
6. Demonstration of dose response curve using guinea pig tracheal chain.
7. Study of the anti secretory and anti ulcer activity using rat pylorus.
8. Evaluation of anti-inflammatory activity of drugs.
9. Evaluation of antipsychotic and hypnotic drugs.
10. Evaluation of anticonvulsant drugs.
11. Evaluation of local anaesthetic drugs
12. Evaluation of analgesic drugs.
13. Study of the effect of antihistaminics on histamine induced asthma.
15. Pyrogen testing.

16. Demonstration of effect of drugs on dog B.P. and respiration, intestine and spleen (using suitable software system).
17. Clinical Pharmacology: To determine the effect of certain clinically useful drug on human volunteers like :
 - a. Antihistaminics.
 - b. Anti anxiety and sedative drug.
 - c. Analgesics.
 - d. Beta blockers.

B.Ph. 411T	Pharmacognosy II	75 Hrs
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Unit-I

1. Systematic study of biological source, cultivation, collection, processing, commercial varieties, chemical constituents, substitutes, adulterants, uses, diagnostic macroscopic and microscopic features and specific chemical tests of following alkaloid-containing drugs:
 - (a) Pyridine-piperidine: Tobacco, areca and lobelia.
 - (b) Tropane: Belladonna, hyoscyamus, datura, duboisia, coca and withania.
 - (c) Quinoline and isoquinoline: Cinchona, ipecac, opium.
 - (d) Indole: Ergot, rauwolfia, catharanthus, nux-vomica and physostigma.
 - (e) Imidazole: Pilocarpus
 - (f) Steroidal: Veratrum and kurchi
 - (g) Alkaloidal amine: Ephedra and colchicum.
 - (h) Glycoalkaloid: Solanum.
 - (i) Purines: Coffee, tea and cola.

Unit-II

2. Role of medicinal and aromatic plants in national economy. Biological sources, preparation, identification tests and uses of the following enzymes: Diastase, papain, pepsin, trypsin and pancreatin.
3. General techniques of biosynthetic studies and basic metabolic pathways. Brief introduction to biogenesis of secondary metabolites of pharmaceutical importance. Plant bitters and sweeteners. Introduction, classification and study of different chromatographic methods and their applications in evaluation of herbal drugs.

Unit-III

4. World-wide trade in medicinal plants and derived products with special reference to diosgenin (disocorea), taxol (Taxus sps) digitalis, tropane alkaloid containing Plants, Papain, Cinchona, Ipecac, Liquorice, Ginger, Aloe, Valerian, Rauwolfia, and Plants containing laxatives. . A brief account of plant based industries and institutions involved in work on medicinal and aromatic plants in India. Utilization and production of phytoconstituents such as quinine, calcium sennosides, podophyllotoxin, diosgenin, solasodine, and tropane alkaloids.

Unit-IV

5. Utilization of aromatic plants and derived products with special reference to sandalwood oil, mentha oil, lemon grass oil, vetiver oil, geranium oil and eucalyptus oil. Historical development of plant tissue culture, types of cultures, nutritional requirements, growth and their maintenance. Application of plant tissue culture in pharmacognosy.

Unit-V

6. Chemotaxonomy of medicinal plants. Marine pharmacognosy, novel medicinal agents from marine sources.
7. Natural allergens and photosensitizing agents and fungal toxins. Herbs as health foods. Herbal cosmetics.

B.Ph. 412P	Pharmacognosy II	75 Hrs
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1. Identification of crude drugs listed above.
2. Microscopic study of characters of eight-selected drugs (Belladonna, datura, sinchona, rauwolfia, nux-vomica, withania, ephedra, ipecac, etc.) given in theory in entire and powdered form.
3. Chemical evaluation of powdered drugs and enzymes.
4. Chromatographic studies of some herbal constituents.

5. Isolation of some selected phytoconstituents studied in theory (nicotine picrate, caffeine, ammonium glycyrrhizate, calcium citrate etc.)
6. Extraction of volatile oils and their chromatographic profiles.
7. Some experiments in plant tissue culture (like preparation of various plant tissue culture media, Aseptic transfer, Role of growth regulators, Micro-propagation etc).

B.Ph. 413T	Pharmaceutical Industrial Management	50 Hrs
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Unit-I

1. **Management:** Meaning, Evolution - Scientific, administrative and human relation approach. Process of management: Planning, organizing, staffing, directing, coordinating and controlling – a preliminary idea of their concepts, processes and techniques. Functional areas of management: Production management, marketing management, personnel management, financial management - their meaning and functions. Entrepreneurship development.
2. **Economics:** Principles of economics with special reference to the laws of demand and supply, demand schedule, demand curves, labour welfare.

Unit-II

3. **Production management:** Nature and scope of production and operations management, strategic operations management A brief exposure of different aspects of production management- visible and invisible inputs, methodology of activities, performance evaluation techniques, process flow, process know how and maintenance management. Production planning and control, production processes - mass, job and project; plant location and lay out; work study (preliminary idea only). manufacturing and services operations, product and process design, process planning, plant utilities, production technology, materials handling, factory building, shop floor planning. Materials management, purchasing, purchasing policies, materials storing and inventory management.

Unit-III

4. **Market research:** Marketing research and information system Market demands- major concepts in the demand measurement, estimating current demands, geo-demographic analysis, estimating industry sales, market share and future demand.
5. **Pharmaceutical marketing:** Evolution of modern concept; market segmentation; concept of marketing mix; product planning; pricing, promotion; channels of distribution developing the marketing mix – product and service strategies, new product development and product life cycle strategies. Field sales management, sales organization, training of sales personnel, compensation of sales force, field sales planning control and risk, sales forecasting, sales budget and budgetary control, sales literature, catalogue and price list. Concepts and nature of advertising, advertising and marketing, effects of advertising, social effects of advertising, ethics, advertising process, media selection, messages, planning and budget.

Unit-IV

6. **Personnel management:** Marketing – objective an scope, developing marketing opportunities and strategies Recruitment and selection of employees, orientation and training, evaluation and compensation, retrenchment, lay off and discharge. General principles of insurance and inland and foreign trade, procedure of exporting and importing goods.

Unit-V

7. **Industrial psychology:** Transactional analysis - Meaning, ego status, types of transactions and life positions – a preliminary idea. Organization development- (preliminary idea). Motivation – Maslow's theory, approaches and styles of leadership (preliminary idea).