Semester IV

Course Code	Name of the course	No. of hours per week (L/P)	Credit points
BP401T	Herbal Drug Technology (Theory)	3	3
BP402T	Medicinal Chemistry (Theory)	3	3
BP403T	Pharmaceutical Biotechnology (Theory)	3	3
BP404T	Social Pharmacy and Public Health (Theory)	2	2
BP405T	Systemic Pharmacology I (Theory)	3	3
BP406P	Herbal Drug Technology (Practical)	3	1
BP407P	Medicinal Chemistry (Practical)	3	1
BP408P	Pharmaceutical Biotechnology (Practical)	3	1
BP409P	Social Pharmacy and Public Health (Practical)	2	1
BP410P	Systemic Pharmacology I (Practical)	3	1
BP411I	Internship (Mandatory)	8	4
Total		**28**	**23**

Course Code	Course Title			Course Type
BP401T	**Herbal Drug Technology (Theory)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
3	3	--	--	45
Maximum Marks	SE			ESE
75	30			45

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand and apply plant tissue culture techniques and related approaches for biomass and secondary metabolite production.
2. Introduce biomanufacturing concepts in herbal drug technology, including plant-based production systems and edible vaccines.
3. Develop skills in the preparation and optimization of standardized herbal extracts using metabolite analysis and TLC fingerprinting.
4. Study the formulation of herbal products using standardized extracts in conventional and novel dosage forms.
5. Understand quality control, standardization, regulatory guidelines, and interaction studies for safe herbal drug development.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Demonstrate tissue culture applications for herbal drug production and edible vaccines.
2	Summarize the concept of standardized extracts and incorporate them in herbal formulations and cosmetics.
3	Apply analytical methods for quality control of herbal preparations.
4	Analyze herb–drug/food interactions and their clinical significance.
5	Interpret national regulatory provisions and global standards related to herbal drug development.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
I	**Plant Tissue Culture and Standardized Extracts:** **Plant tissue culture as an alternative source of medicine:** • Historical development • Types of cultures • Nutritional requirements • Growth and maintenance of callus and suspension culture • Role of elicitation, genetic transformation, biotransformation, precursor feeding, and somaclonal variation in biomass and secondary metabolite production **Introduction to biomanufacturing:** • Medicinal plant–based biomanufacturing • Utilising plant factories in obtaining valuable ingredients for food, pharmaceutical, and cosmetic industries • Examples: **Shikonin and Paclitaxel** • Oral vaccines in healthcare **Optimization and production of standardized extracts of medicinal plants:** Strategies for preparation of desired quality extracts by optimizing and adjusting bioactives ensuring quality using analysis of metabolites and TLC fingerprints of the following: • Aqueous and hydro-alcoholic extracts of **Ashwagandha, Shatavari, Licorice, Neem, and Haritaki** • Flavonoid-rich fraction of **Sweet lime peel** • Terpenoid-rich fraction of **Bacopa** • Phenol-rich fraction of **Green Tea** • Steroid-rich fraction of **Tribulus** • Alkaloid-rich fraction of **Vasaka**	10 Hours
II	**Herbal Formulations, Excipients and Cosmetics:** **Herbal formulations:** • Conventional herbal formulations: syrups, mixtures, powders, capsules, tablets, creams, ointments • Novel dosage forms: phytosomes (phytocomplexes), liposomes, nanoformulations • Composition, preparation, and characterization using standardized extracts and bioactives **Herbal cosmetics:** • Sources and description of raw materials of herbal origin as active agents in skincare, hair care, and oral hygiene products • Applications in skincare, hair care, and oral hygiene products such as: o Sunscreen-lotion/gel o Hair oil, shampoo, herbal dye o Herbal mouthwash, chewing gums, candies, gargles • Face serums and herbal face packs **Excipients of Natural origin** • Colorants, sweeteners, binders, diluents	10 Hours

	• Viscosity builders, disintegrants • Flavors and perfumes • Protective agents, waxes, bleaching agents and antioxidants	
III	**Quality Control and Standardisation of Herbal Medicines:** • WHO, AYUSH, and EU guidelines on quality control, stability, and shelf life studies of herbal medicines • Approaches for standardisation and quality control of botanicals and formulations • Testing methods and regulatory considerations • Role of DNA fingerprint and molecular markers such as **rbcL, matK, and SCAR** in quality control • **Forensic pharmacognosy:** Role in identification of illicit herbal drugs (e.g., **Cannabis, Opium**)	7 Hours
IV	**Herb–Drug / Food / Herb Interactions:** • General introduction to interactions and role of ADME, Cytochrome P450, and P-gp • **Herb–drug interactions:** o St. John's Wort with warfarin o Ginkgo biloba with aspirin • **Herb–food interactions:** o Licorice with salty foods o Turmeric with fats o Green tea with iron-rich foods • **Herb–herb interactions:** o Ephedra with Ginseng o Chamomile with Valerian • Adverse reactions related to plants and foods such as allergy, intolerance, and toxicity	10 Hours
V	**Regulatory Requirements of Herbal Drugs and Botanicals:** **Regulatory framework in India for Herbal and ASU medicines:** a) Role of regulatory bodies b) ASU DTAB (Ayurveda, Siddha, and Unani Drugs Technical Advisory Board) c) ASU DCC (Drugs Consultative Committee for ASU drugs) d) Schedule T – GMP requirements for ASU drugs e) Schedule E1 – Poisonous drugs listed under AYUSH f) Drugs and Cosmetics Act – Regulatory provisions relevant to herbal/ASU medicines, procedures for registration, trade, and export g) Concept of **Phytopharmaceuticals** and **Ayush Aahara** in bridging Indian traditional knowledge with modern science.	8 Hours

Recommended References (Preferably latest editions):

1. Waldesch, F. G. *Herbal Medicinal Products.* CRC Press.
2. *Indian Herbal Pharmacopoeia.* Indian Drug Manufacturers' Association.
3. World Health Organization. *Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants.*
4. *Drugs and Cosmetics Act and Rules (India).* Government of India.

Course Code	Course Title			Course Type
BP402T	**Medicinal Chemistry (Theory)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
3	3	--	--	45
Maximum Marks	SE			ESE
75	30			45

COURSE OBJECTIVES:

The objectives of this course are to:

1. Develop a comprehensive understanding of the fundamental principles of medicinal chemistry, including physicochemical properties, drug metabolism, and prodrug concepts.
2. Classify and describe the chemical structures, therapeutic uses, and structure–activity relationships of drugs acting on the autonomic and cardiovascular systems.
3. Apply the principles of structure–activity relationships (SAR) to explain and predict the pharmacological activity.
4. Understand the synthetic pathways of drugs, emphasizing important reaction steps and chemical transformations.
5. Analyze the relationship between drug structure and pharmacological activity in relation to therapeutic efficacy and safety.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Relate the physicochemical properties of drug molecules to their biological activity and pharmacokinetic behavior.
2	Categorize drugs affecting the autonomic nervous system and predict their therapeutic outcomes.
3	Analyze and interpret the structure-activity relationships of selected drug classes (e.g., beta-blockers, local anesthetics, thiazide diuretics, NSAIDs) to optimize drug design.
4	Outline the synthetic routes of selected drugs, identifying key intermediates and reactions involved in their preparation.
5	Correlate the chemical structure of drugs with their therapeutic uses and potential adverse effects. Apply the knowledge of medicinal chemistry principles to understand and potentially contribute to the drug discovery and development process.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
	Study of the development of the following classes of drugs, Chemical Classification, Structure, uses of drugs mentioned in the course, Structure activity relationship of selective class of drugs as specified in the course and Synthesis of selected drugs as superscripted (*)	
I	**Fundamentals of Medicinal Chemistry** • **Introduction:** History and scope of medicinal chemistry • **Physicochemical properties in relation to biological action:** Ionization, solubility, partition coefficient, hydrogen bonding, Chelation, Bioisosterism and protein binding • **Drug metabolism:** Phase I & II reactions	7 hours
II	**Drugs Acting on the Autonomic Nervous System** 1. **Adrenergic or Sympathomimetic agents:** Nor-epinephrine, Epinephrine, Phenylephrine*, Dopamine, Methyldopa, Clonidine, Dobutamine, Isoproterenol, Terbutaline, Salbutamol*, Bitolterol, Naphazoline, Oxymetazoline and Xylometazoline, Hydroxyamphetamine, Pseudoephedrine, Propylhexedrine, Metaraminol. 2. **Anti-adrenergic or Sympatholytic agents:** Tolazoline*, Phentolamine, Phenoxybenzamine, Prazosin, Dihydroergotamine, Propranolol*, Metibranolol, Atenolol, Betazolol, Bisoprolol, Esmolol, Metoprolol, Labetalol, Carvedilol. SAR of beta adrenergic blockers. 3. **Cholinergic or Parasympathomimetic agents:** Acetylcholine, Carbachol*, Bethanechol, Methacholine, Pilocarpine, Physostigmine, Neostigmine, Pyridostigmine, Edrophonium chloride, Tacrine hydrochloride, Ambenonium chloride, Isofluorphate, Echothiophate iodide, Parathione, Malathion. Pralidoxime chloride. **4. Anti-Cholinergic or Parasympatholytic agents:** Atropine, Hyoscyamine, Scopolamine, Homatropine, Ipratropium*, Tropicamide, Cyclopentolate, Clidinium Glycopyrrolate, Dicyclomine*, Methantheline, Propantheline, Benztropine mesylate, Orphenadrine, Biperidine, Procyclidine, Tridihexethyl, Isopropamide, Ethopropazine, SAR of cholinergic blockers. 5. **Local anesthetic agents:** Cocaine, Hexylcaine, Meprylcaine, Cyclomethycaine, Piperocaine. Benzocaine, Butamben, Procaine*, Butacaine, Propoxycaine, Tetracaine, Benoxinate, Lignocaine, Mepivacaine, Prilocaine, Etidocaine, Phenacaine, Diperodon, Dibucaine.* SAR of Local anesthetics.	15 hours
III	**Drugs Acting on the Cardiovascular System** 1. **Anti-anginals:** Amyl nitrite, Nitroglycerin, Pentaerythritol, Isosorbide dinitrite*, Dipyridamole, Verapamil, Bepridil	09 hours

	hydrochloride, Diltiazem, Nifedipine, Amlodipine, Felodipine, Nicardipine, Nimodipine. 2. **Anti-hypertensives:** Timolol, Captopril, Lisinopril, Enalapril, Benazepril, Quinapril, Methyldopate,* Clonidine, Guanethidine, Guanabenz, Sodium nitroprusside, Diazoxide, Minoxidil, Reserpine, Hydralazine. 3. **Drugs to treat Congestive Heart Failure (CHF):** Digoxin, Digitoxin, Nesiritide, Bosentan,Tezosentan. 4. **Anti-arrhythmics (Class I–IV):** Quinidine sulphate, Procainamide, Disopyramide*, Phenytoin, Lidocaine, Tocainide, Mexiletine, Lorcainide, Amiodarone, Sotalol.	
IV	**Drugs acting on blood and Renal System** 1. **Antihyperlipidemic Agents:** Fenofibrate*, Lovastatin, Cholesteramine and Cholestipol 2. **Coagulants and Anti-Coagulants:** Menadione, Acetomenadione, Warfarin, Anisindione, clopidogrel. 3. **Diuretics:** Acetazolamide*, Methazolamide, Dichlorphenamide, Chlorthiazide, Hydrochlorothiazide, Hydroflumethiazide, Cyclothiazide, Furosemide*, Bumetanide, Ethacrynic acid, Spironolactone, Triamterene, Amiloride. Mannitol. SAR of Thiazides.	06 hours
V	**Autacoids and related drugs** 1. **Antihistamines** a. **H1–antagonists:** Diphenhydramine hydrochloride*, Dimenhydrinate, Doxylamines, Clemastine, Diphenylphyraline, Tripelenamine, Chlorcyclizine, Meclizine, Buclizine, Chlorpheniramine, Triprolidine, Phenindamine, Promethazine*, Trimeprazine, Cyproheptadine, Azatidine, Astemizole, Loratadine, Cetirizine, Levocetrizine Cromolyn. b. **H2-antagonists:** Cimetidine*, Famotidine, Ranitidine. 2. **Gastric Proton pump inhibitors:** Omeprazole, Lansoprazole, Rabeprazole, Pantoprazole **Non-Steroidal Anti-Inflammatory Drugs (NSAIDs), Antipyretics:** Sodium salicylate, Aspirin, Diflunisal, Mefenamic acid*, Niflumic acid, Meclofenamate, Indomethacin, Sulindac, Tolmetin, Zomepirac, Diclofenac, Ketorolac, Ibuprofen*, Naproxen, Piroxicam, Phenacetin, Acetaminophen, Antipyrine, Phenylbutazone, Celecoxib, Etoricoxib, SAR of representative agents by class.	08 hours

Recommended References (Preferably latest editions):

1. Lemke, T. L., Williams, D. A. and Roche, V. F. *Foye's Principles of Medicinal Chemistry.* Lippincott Williams & Wilkins.
2. Beale, J. M., Thomas, J. T. and Duckett, M. H. *Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry.* Lippincott Williams & Wilkins.
3. Abraham, D. J. and Griffin, J. L. *Burger's Medicinal Chemistry and Drug Discovery.* Wiley.
4. Patrick, G. L. *An Introduction to Medicinal Chemistry.* Oxford University Press.
5. Kar, A. *Medicinal Chemistry.* New Age International.
6. Li, J. J. and Welch, W. M. *Modern Drug Synthesis.* Wiley.
7. Lednicer, D. *The Organic Chemistry of Drug Synthesis.* Wiley.
8. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry.* Pearson Education.

9. Brunton, L., Hilal-Dandan, R. and Knollmann, B. *Goodman and Gilman's The Pharmacological Basis of Therapeutics.* McGraw-Hill Education.
10. Williams, D. A. Foye's Principles of Medicinal Chemistry. Lippincott Williams & Wilkins**.**

Course Code	Course Title			Course Type
BP403T	**Pharmaceutical Biotechnology (Theory)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
3	3	--	--	45
Maximum Marks	SE			ESE
75	30			45

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand and apply plant tissue culture techniques and related approaches for biomass and secondary metabolite production.
2. Introduce biomanufacturing concepts in herbal drug technology, including plant-based production systems and edible vaccines.
3. Develop skills in the preparation and optimization of standardized herbal extracts using metabolite analysis and TLC fingerprinting.
4. Study the formulation of herbal products using standardized extracts in conventional and novel dosage forms.
5. Understand quality control, standardization, regulatory guidelines, and interaction studies for safe herbal drug development.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Explain the role of biotechnology in pharmaceutical sciences, including monoclonal antibodies and enzyme immobilization.
2	Apply genetic engineering and recombinant DNA technology for the production of biopharmaceuticals such as insulin, interferons, and vaccines.
3	Describe microbial biotransformation and analyze fermentation processes used in pharmaceutical industries.
4	Assess the role of bioinformatics and artificial intelligence in the Human Genome Project and personalized medicine.
5	Describe vaccine and sera development, including preparation, evaluation, standardization, and regulatory requirements, and critically evaluate challenges and emerging approaches in vaccine and sera development and commercialization

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
I	**Introduction to Pharmaceutical Biotechnology** Introduction to biotechnology in pharmaceutical sciences; protein therapeutics; analytical characterization of proteins; monoclonal antibodies; antigens; enzyme immobilization; cell culture and immobilization techniques; pharmaceutical applications.	9 Hours
II	**Genetic Engineering and Recombinant DNA Technology** Principles of genetic engineering; recombinant DNA technology; production of interferons, hepatitis-B vaccine, and insulin; polymerase chain reaction (PCR) and its applications; mutations and types of mutants.	9 Hours
III	**Microbial Biotransformation and Fermentation Technology** Microbial biotransformation; fermentation principles and process control; industrial production of alcohol, penicillins, citric acid, and vitamin B_{12}; blood products—collection, processing, and storage.	9 Hours
IV	**Gene Therapy, Genomics and Personalized Medicine** Gene therapy—types and methodologies; delivery systems; ethical concerns and challenges; Human Genome Project; role of bioinformatics and artificial intelligence in personalized medicine.	9 Hours
V	**Immunology, Vaccines and Sera** Basics of immunology; types and generations of vaccines; immunization strategies; vaccine preparation, evaluation, and standardization; regulatory aspects; sera therapy; marketed products; challenges and newer approaches.	9 Hours

Recommended References (Preferably latest editions):

1. Crommelin, D. J. A., Sindelar, R. D. and Meibohm, B. *Pharmaceutical Biotechnology: Fundamentals and Applications.* Springer.
2. Walsh, G. *Biopharmaceuticals: Biochemistry and Biotechnology.* Wiley-Blackwell.
3. Brown, T. A. *Gene Cloning and DNA Analysis: An Introduction.* Wiley-Blackwell.
4. Glick, B. R., Pasternak, J. J. and Patten, C. L. *Molecular Biotechnology: Principles and Applications of Recombinant DNA.* ASM Press.
5. Doran, P. M. *Bioprocess Engineering Principles.* Academic Press.
6. Vogel, H. C. and Todaro, C. L. *Fermentation and Biochemical Engineering Handbook.* William Andrew.
7. Primrose, S. B., Twyman, R. M. and Old, R. W. *Principles of Gene Manipulation and Genomics.* Wiley-Blackwell.
8. Strachan, T. and Read, A. *Human Molecular Genetics.* Garland Science.
9. Plotkin, S. A., Orenstein, W. A., Offit, P. A. and Edwards, K. M. *Plotkin's Vaccines.* Elsevier.
10. Kindt, T. J., Goldsby, R. A., Osborne, B. A. and Kuby, J. *Kuby Immunology.* W. H. Freeman.
11. Janeway, C. A., Travers, P., Walport, M. and Shlomchik, M. *Janeway's Immunobiology.* Garland Science.

Semester-IV

Course Code	Course Title			Course Type
BP404T	**Social Pharmacy and Public Health (Theory)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
2	2	--	--	30
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the concepts of social pharmacy, public health, and their interrelation.
2. Identify the social determinants of health and their impact on health outcomes and medication use.
3. Recognize the role of pharmacists in public health initiatives, health promotion, and disease prevention.
4. To gain knowledge about the Indian healthcare system, national health policies, and important health programs.
5. To understand basic epidemiological principles and their application in public health.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Describe the scope of social pharmacy and the pharmacist's role in the public health system.
2	Explain the influence of socio-cultural and behavioral factors on health, illness, and medication adherence.
3	Discuss various national health programs and the pharmacist's contribution to their success.
4	Apply basic principles of epidemiology to understand disease distribution and control.
5	Develop health education materials and counsel patients on preventive healthcare measures and rational drug use.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
I	**Introduction to Social Pharmacy and Public Health** a) Social Pharmacy: Definition, scope, historical development, and importance. Social pharmacy as a multidisciplinary field. b) Public Health: Definition, concepts, history, core functions, and ethical	6 Hours

	considerations. c) Interplay between Social Pharmacy and Public Health: The evolving role of the pharmacist in the public health arena. d) Concept of Health and Disease: WHO definition of health; dimensions of health – physical, mental, social, spiritual, and environmental. e) Determinants of Health: Social, economic, environmental, lifestyle, and healthcare service determinants and their impact on population health. f) Health Indicators: Indicators used to measure health status and health outcomes in a population.	
II	**Health Systems, Policy, and Pharmacoepidemiology** a) Healthcare Delivery Systems: Overview of global healthcare systems. b) Indian Healthcare System: Structure, public and private sectors, primary, secondary, and tertiary levels of care. c) Health Policy: Introduction to health policy formulation and analysis; objectives of India's National Health Policy. d) National Health Mission (NHM): NRHM and NUHM – goals, strategies, and impact on public health indicators. e) Pharmacoepidemiology: Definition, aims, scope, and applications. f) Measures of Disease Frequency and Distribution: Incidence, prevalence, endemic, epidemic, pandemic; morbidity and mortality rates, Odds ratio and relative risk. g) Introduction to Biostatistics: Role in public health; types of data; basic data presentation methods.	6 Hours
III	**Preventive Healthcare, Health Promotion, and Communicable Diseases** a) Levels of Prevention: Primordial, primary, secondary, and tertiary prevention with examples. b) Role of Pharmacists in Disease Prevention and Health Promotion: Immunization services, screening programs, lifestyle counselling. c) Health Education: Definition, principles, methods, and importance; development of effective health education materials. d) Mother and Child Health (MCH): Antenatal care, postnatal care, breastfeeding, immunization schedules. e) Communicable Diseases: Modes of transmission, prevention, and control of tuberculosis, HIV/AIDS, malaria, dengue, typhoid, influenza; pharmacist's role.	6 Hours
IV	**Non-Communicable Diseases, Nutrition, Mental Health, and National Programs** a) Non-Communicable Diseases (NCDs): Diabetes, hypertension, cardiovascular diseases, chronic respiratory diseases, cancer; prevention and management. b) Nutrition and Health: Balanced diet, macro- and micronutrients, malnutrition, nutritional deficiency disorders, food safety, and adulteration. c) Mental Health: Common mental disorders, stigma, promotion of mental well-being; pharmacist's role. d) National Health Programs in India: Programs related to MCH, NCDs, communicable diseases, tobacco control, and deafness prevention.	6 Hours

V	**Pharmacoeconomics, Rational Use of Medicines, Professional Roles, and Future Trends** a) Pharmacoeconomics: Introduction, significance; Cost-Benefit Analysis (CBA), Cost-Effectiveness Analysis (CEA), Cost-Utility Analysis (CUA). b) Rational Use of Medicines (RUM): Definition, importance, problems of irrational drug use; pharmacist's role. c) Medication Adherence: Factors affecting adherence, consequences of non-adherence, improvement strategies. d) Drug Misuse and Abuse: Alcohol, tobacco, opioids, prescription drug abuse; pharmacist's role. e) Professionalism and Ethics in Social Pharmacy: Ethical dilemmas in public health pharmacy. f) Disaster Management: Role of pharmacists. g) Emerging Trends: Telepharmacy, digital health, personalized medicine, expanding public health responsibilities of pharmacists.	6 Hours

Recommended References (Preferably latest editions)

1. Anderson, S., Dedrick, R. and Tiffany, B. *Community Pharmacy Practice for Public Health.* McGraw-Hill Education.
2. Desselle, S. *Public Health and Pharmacy Practice.* McGraw-Hill Education.
3. Donyai, P. *Social and Cognitive Pharmacy: Theory and Case Studies.* Pharmaceutical Press.
4. Gillam, S., Yates, J. and Badrinath, P. *Essential Public Health: Theory and Practice.* Cambridge University Press.
5. Levin, B. L. and Hanson, A. *Essentials of Public Health Pharmacy.* Jones & Bartlett Learning.
6. Park, K. *Park's Textbook of Preventive and Social Medicine.* Banarsidas Bhanot Publishers.
7. Schneider, M. J. *Introduction to Public Health.* Jones & Bartlett Learning.
8. Taylor, K. and Harding, G. *Pharmacy Practice.* CRC Press.
9. Wertheimer, A., Ibrahim, M. I. M. and Babar, Z. U. D. *Social and Administrative Aspects of Pharmacy in Low- and Middle-Income Countries.* Elsevier.

Course Code	Course Title			Course Type
BP405T	**Systemic Pharmacology I (Theory)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
3	3	--	--	45
Maximum Marks	SE			ESE
75	30			45

COURSE OBJECTIVES:

The objectives of this course are to:

1. Develop a comprehensive understanding of neurohumoral transmission, neurotransmitters, and the organization and function of the autonomic nervous system.
2. Provide knowledge of the classification, mechanisms of action, and pharmacological effects of various classes of drugs.
3. Explain the pharmacology of drugs acting on the peripheral nervous system, cardiovascular system, and urinary system.
4. Describe the physiological roles of autacoids and the pharmacology of drugs used in the management of pulmonary diseases and related disorders.
5. Familiarize students with the pharmacology of drugs acting on the immune system, hematopoietic system, and blood, and relate pharmacological principles to clinical conditions through case-based learning.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Explain the classification of neurotransmitters and describe neurohumoral transmission, including the organization, function, and pharmacological modulation of the autonomic nervous system.
2	Classify and explain the mechanisms of action, pharmacological effects, and therapeutic uses of drugs used in cardiovascular disorders such as heart failure, arrhythmias, hypertension, angina, and lipid disorders.
3	Describe the pharmacology and therapeutic uses of drugs acting on blood and kidney, including anticoagulants, antiplatelet agents, hematinics, and diuretics.
4	Explain the physiological roles of autacoids and analyze the pharmacology of drugs that modulate autacoid pathways, including antihistamines, antimigraine agents, NSAIDs, and antirheumatic drugs.
5	Evaluate the mechanisms of action, therapeutic uses, and adverse effects of drugs acting on the respiratory and immune systems.

Detailed Syllabus:

Unit No.	Topics	No. of Lectures
I	**Pharmacology of drugs acting on the peripheral nervous system** a) Organization and functions of PNS. b) Neurohumoral transmission, co-transmission. Neurotransmitters and their receptors, including non-adrenergic and non-cholinergic (NANC) neurotransmitters. c) Parasympathomimetic and Parasympatholytic drugs. d) Sympathomimetic and sympatholytic drugs. e) Skeletal muscle relaxants (peripheral and central). f) Drugs used in the treatment of myasthenia gravis and glaucoma	10 Hours
II	**Pharmacology of drugs acting on the cardiovascular system** a) Introduction to cardiovascular hemodynamic and cardiac electrophysiology. b) Drugs used in congestive cardiac failure. c) Anti-arrhythmic drugs. d) Anti-anginal and newer anti-ischemic drugs. e) Anti-hypertensive drugs. f) Shock, types of shocks and drugs used in their management. g) Stroke, types of strokes and drugs used in their management	10 Hours
III	**Pharmacology of drugs acting on blood and kidney** 1.Pharmacology of drugs acting on blood a) Anti-platelet agents b) Coagulants and anticoagulants. c) Fibrinolytics and Plasma expanders. d) Haematinics. e) Anti-hyperlipidaemic drugs. 2. Pharmacology of drugs acting on kidney a) Diuretics. b) Anti-diuretics.	10 Hours
IV	**Pharmacology of autacoids and related drugs** a) Introduction to autacoids and their classification. Therapeutic significance of important agonists and antagonists of prostaglandins, thromboxane, leukotrienes, angiotensin, bradykinin and substance P. b) Histamine and antihistamines. c) 5-HT, its agonists and antagonists, drugs used in migraine. d) Non-steroidal anti-inflammatory drugs, antipyretics and analgesics. e) Anti-gout and Antirheumatic drugs including Disease Modifying Antirheumatic Drugs (DMARDs).	9 Hours
V	**i) Pharmacology of Drugs acting on respiratory system** a) Drugs used in the treatment of bronchial asthma and COPD. b) Definitions, classification and therapeutic uses of nasal decongestants,	6 Hours

	mucolytics, expectorants and antitussives. c) Respiratory stimulants. **ii) Pharmacology of Drugs acting on immune system** Mechanism of action, adverse effects and therapeutic uses of important classes of immune stimulants and immunosuppressants.	

Recommended References (Preferably latest editions):

1. Brunton, L., Hilal-Dandan, R. and Knollmann, B. *Goodman and Gilman's The Pharmacological Basis of Therapeutics.* McGraw-Hill Education.
2. Craig, C. R. and Stitzel, R. E. *Modern Pharmacology with Clinical Applications.* Lippincott Williams & Wilkins.
3. DiPiro, J. T., Talbert, R. L., Yee, G. C. and Matzke, G. R. *Pharmacotherapy: A Pathophysiologic Approach.* McGraw-Hill Education.
4. Katzung, B. G. and Trevor, A. J. *Basic and Clinical Pharmacology.* McGraw-Hill Education.
5. Rang, H. P., Dale, M. M., Ritter, J. M., Flower, R. J. and Henderson, G. *Rang and Dale's Pharmacology.* Elsevier.
6. Tripathi, K. D. *Essentials of Medical Pharmacology.* Jaypee Brothers Medical Publishers.

Course Code	Course Title			Course Type
BP406P	**Herbal Drug Technology (Practical)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	--	--	3	45
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are:

1. To apply seed germination and plant tissue culture techniques for medicinal plants.
2. To prepare and standardize herbal extracts and phytoconstituent-enriched fractions as per Pharmacopoeial procedures.
3. To evaluate natural excipients and standardized herbal extracts for formulation development.
4. To develop and evaluate herbal cosmetic, pharmaceutical, and novel delivery systems using standardized extracts.
5. To assess the quality of marketed herbal formulations and extracts through experiential learning and surveys.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Perform seed germination and plant tissue culture of medicinal plants.
2	Prepare and standardize herbal extracts and enriched phytoconstituent fractions following official guidelines.
3	Evaluate excipients of natural origin and select suitable ingredients for herbal formulations.
4	Formulate and assess herbal cosmetics, dosage forms, and novel delivery systems as per Pharmacopoeial standards.
5	Analyze and compare marketed herbal medicines and cosmetics for quality, compliance, and performance

Detailed Syllabus:

List of practical
(Minimum 12 experiments must be performed) 1. To establish seed germination and plant tissue culture of a medicinal plant. 2. Preparation and standardization of extracts of Phenol-rich fraction of Green Tea. 3. Preparation and standardisation of Aqueous and hydro-alcoholic extracts of Ashwagandha or Haritaki (as per IP procedure) 4. Preparation and standardization of Flavonoid-enriched fraction of Sweet lime peel

5. Preparation and standardization of Terpenoid-rich fraction of Bacopa.
6. Preparation and standardization of Steroid-rich fraction of Tribulus
7. Preparation and standardization of Alkaloid-rich fraction of Vasaka
8. Evaluation of excipients of natural origin.
9. To develop and evaluate herbal cosmetics in form of gel, cream, lotion using standardized herbal extract.
10. To develop and evaluate herbal shampoo using standardized herbal extract.
11. To develop herbal formulations in form of syrups and mixtures using standardized herbal extract and their evaluation as per Pharmacopoeial guidelines.
12. To develop herbal tablets using standardized herbal extract and their evaluation as per Pharmacopoeial guidelines.
13. Preparation of botanicals-based new herbal medicinal product delivery systems (phytosomes).
14. Experiential learning-based experiments involving collection of herbal formulations/ extracts from the market and their quality evaluation as per Pharmacopoeial guidelines.
15. Survey on different commercialized marketed herbal cosmetics.
16. Survey on different commercialized marketed herbal medicine.

Recommended References (Preferably latest editions):

1. Evans, W. C. *Trease and Evans' Pharmacognosy.* Elsevier.
2. Harborne, J. B. *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis.* Springer.
3. Houghton, P. J. and Raman, A. *Laboratory Handbook for the Fractionation of Natural Extracts.* Chapman & Hall.
4. Indian Pharmacopoeia Commission. *Indian Pharmacopoeia.* Indian Pharmacopoeia Commission.
5. Mukherjee, P. K. *Quality Control and Evaluation of Herbal Drugs.* Elsevier.
6. Sarker, S. D., Latif, Z. and Gray, A. I. *Natural Products Isolation.* Humana Press.
7. World Health Organization. *WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants.*
8. World Health Organization. *WHO Quality Control Methods for Herbal Materials.*

Course Code	Course Title			Course Type
BP407P	**Medicinal Chemistry (Practical)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	--	--	3	45
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Comprehend the fundamental principles of drug synthesis, assay, and monograph analysis.
2. Acquire practical skills in the synthesis of selected drug molecules and intermediates.
3. Develop proficiency in performing qualitative and quantitative assays of drugs.
4. Understand the requirements and procedures involved in drug monograph analysis.
5. Apply appropriate techniques and methodologies for the preparation, assay, and monograph analysis of various drugs.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Demonstrate the ability to synthesize various drug molecules and intermediates using standard laboratory procedures.
2	Perform qualitative and quantitative assays of drugs with accuracy and precision.
3	Analyze and interpret drug monographs according to pharmacopeial standards.
4	Utilize appropriate instrumentation and techniques for drug preparation, assay, and monograph analysis.
5	Document and report experimental procedures and results in a clear and concise manner.

Detailed Syllabus:

List of practical
(Minimum 12 experiments must be performed) **1. Preparation of Drugs / Intermediates** a. Aspirin b. Benzotriazole c. Benzocaine d. Phenytoin e. Dibenzalacetone f. Paracetamol **2. Assay of Drugs *(Any 3)*** a. Aspirin b. Ibuprofen c. Furosemide d. Paracetamol **3. Monograph Analysis *(Any 3)*** a. Paracetamol b. Aspirin c. Phenobarbital d. Diclofenac e. Phenytoin
Recommended References (Preferably latest editions): 1. Abraham, D. J. and Rotella, D. P. *Burger's Medicinal Chemistry, Drug Discovery and Development.* John Wiley & Sons. 2. Beckett, A. H. and Stenlake, J. B. *Practical Pharmaceutical Chemistry.* CBS Publishers & Distributors. 3. Furniss, B. S., Hannaford, A. J., Smith, P. W. G. and Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry.* Pearson Education. 4. Indian Pharmacopoeia Commission. *Indian Pharmacopoeia.* Indian Pharmacopoeia Commission. 5. Kar, A. *Advanced Practical Medicinal Chemistry.* New Age International Publishers. 6. Lednicer, D. *The Organic Chemistry of Drug Synthesis.* John Wiley & Sons. 7. Moffat, A. C., Osselton, M. D. and Widdop, B. *Clarke's Analysis of Drugs and Poisons.* Pharmaceutical Press. 8. United States Pharmacopeial Convention. *United States Pharmacopeia–National Formulary (USP–NF).* United States Pharmacopeial Convention. 9. Vogel, A. I. *Vogel's Textbook of Quantitative Chemical Analysis.* Longman Scientific & Technical.

Course Code	Course Title			Course Type
BP408P	**Pharmaceutical Biotechnology (Practical)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	--	--	3	45
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Provide fundamental knowledge of biotechnology concepts, including protein therapeutics, monoclonal antibodies, enzyme immobilization, and their pharmaceutical applications.
2. Explain the principles and applications of genetic engineering and recombinant DNA technology in pharmaceutical sciences.
3. Develop understanding of microbial biotransformation, fermentation processes, and large-scale production of pharmaceutical products such as alcohol, antibiotics, vaccines, and blood products.
4. Describe the principles, methodologies, delivery systems, and ethical considerations associated with gene therapy and modern vaccine technologies.
5. Introduce the regulatory requirements and standardization procedures for vaccines, sera, and other biopharmaceutical products.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Explain the fundamental principles of biotechnology and apply genetic engineering and recombinant DNA technology concepts in pharmaceutical sciences.
2	Describe the production and applications of biopharmaceutical products such as protein therapeutics and monoclonal antibodies.
3	Explain the principles, delivery systems, and ethical considerations associated with gene therapy.
4	Describe fermentation processes and microbial biotransformation involved in the large-scale production of pharmaceutical products such as vaccines, hormones, and blood products.
5	Explain the principles of immunization, types of vaccines and sera, and the regulatory and ethical considerations involved in the development of biopharmaceutical products.

Detailed Syllabus:

List of practical
(Minimum 12 experiments must be performed) 1. Understanding Good microbiological laboratory practices while working in Microbiology laboratory aseptic handling in microbiology lab: growth and isolation of microbes using streaking, spreading and subculturing techniques: microbial staining, study of various equipments such as loop, straight wire, spreader, forceps, pipette, test tube, petridish, burner etc and apparatus used in microbiology lab- BOD incubator, laminar flow, aseptic hood, autoclave, hot air sterilizer, deep freezer and microscopes. 2. Handling of biological spill, decontamination procedures and hygiene while handling microorganisms and disposal 3. Sterilization and evaluation of glassware and apparatus using hot air oven 4. Preparation and sterilization of solid and liquid culture medium using different techniques 5. Determination of microbiological efficacy of disinfectant/ preservative efficacy test 6. Tests for sterility of ophthalmic or parenteral marketed formulation according to IP. 7. Analysis of Biotechnological product (Protein, nucleic acid materials) by UV Vis and FTIR spectrophotometer 8. Production of alcohol using Fermentation process 9. Practice Whole cell immobilization technique (any one) 10. Practice Enzyme immobilization technique and its kinetics 11. Isolation and estimation of DNA and RNA 12. Isolation of plasmids and expression of protein 13. Agarose gel electrophoresis of DNA/ RNA 14. SDS – polyacrylamide gel electrophoresis for proteins. 15. Microbiological assay of antibiotics.
Recommended References (Preferably latest editions): 1. Baltz, R. H., Davies, J. E. and Demain, A. L. *Manual of Industrial Microbiology and Biotechnology.* ASM Press. 2. Carter, S. J. *Cooper and Gunn's Tutorial Pharmacy.* CBS Publishers & Distributors. 3. Chou, S. L. M. *Practical Biotechnology: A Guide to Biochemical Engineering.* Springer. 4. Denyer, S. P., Hodges, N. A. and Gorman, S. P. *Hugo and Russell's Pharmaceutical Microbiology.* Wiley-Blackwell. 5. Glick, B. R., Pasternak, J. J. and Patten, C. L. *Molecular Biotechnology: Principles and Applications of Recombinant DNA.* ASM Press. 6. Lachman, L., Lieberman, H. A., Kanig, J. L. and Khar, R. K. *The Theory and Practice of Industrial Pharmacy.* CBS Publishers & Distributors. 7. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. *Microbiology.* McGraw-Hill.

Course Code	Course Title			Course Type
BP409P	**Social Pharmacy and Public Health (Practical)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	--	--	2	30
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand and apply basic health assessment techniques (blood pressure, BMI, and blood glucose levels), and perform essential first aid skills.
2. Gain skills in the development of health education tools and communication strategies to promote prevention and control of communicable diseases and encourage healthy lifestyle modifications.
3. Familiarize with mental health assessment tools and improve clinical communication skills through simulated role-play exercises focused on patient screening.
4. Acquire practical knowledge of immunization practices and demonstrate correct vaccine administration techniques using simulation models.
5. Understand the principles of epidemiology and designing preventive strategies for common communicable diseases. Develop foundational knowledge of Pharmacoeconomics and its applications. Evaluate health interventions, while identifying irrational drug use practices.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Perform basic health screening and first aid procedures using appropriate techniques.
2	Develop and disseminate health promotion and disease prevention materials
3	Apply mental health screening tools and demonstrate patient assessment skills using role plays and relevant psychological scales.
4	Demonstrate vaccination techniques using appropriate models and standard protocols for immunization practices.
5	Interpret epidemiological data and apply to create preventive measures Evaluate healthcare interventions using pharmacoeconomic principles and recognize irrational drug use in real-world scenarios.

Detailed Syllabus:

List of practical
(Minimum 12 Experiments must be performed; * Mandatory experiments)   1. Training on health screening services (Blood pressure, body mass index (BMI), blood glucose levels, heart rate (pulse rate), respiratory rate, body temperature, oxygen saturation (SpO_2), hemoglobin levels (basic anemia screening)).   2. Develop health promotion material for the prevention of communicable diseases.   3. Role play- usage of different mental scales in patient screening.   4. Case study on calculation of prevalence; incidence, odds ratio and relative risk.   5. Design and demonstrate preventive strategies for major communicable diseases (group activity)   6. Present a case study highlighting cost-benefit analysis in healthcare.   7. Perform cost-effectiveness analysis for selected health interventions.   8. Conduct cost-utility analysis to assess health program efficiency.   9. Perform basic first aid techniques.   10. Design informational leaflet on lifestyle modifications for disease prevention.   11. Identify and illustrate irrational drug use with a real-world example.   12. Prepare an immunization chart, interpret the vaccination schedule and perform patient counselling for vaccination*.   13. Hand wash and hand sanitizing techniques*.   14. Demonstration and practice of wound dressing in first aid and basic suturing techniques*.   15. Practical training on routes of drug administration-oral, and other non-parenteral routes*.   16. Practical training on routes of drug administration- parenteral routes*.   17. Training on basic life support (BLS)*.
Recommended References (Preferably latest editions):   1. Drummond, M. F., Sculpher, M. J., Claxton, K., Stoddart, G. L. and Torrance, G. W. *Methods for the Economic Evaluation of Health Care Programmes.* Oxford University Press.   2. Harding, G. and Taylor, K. *Social Pharmacy.* Pharmaceutical Press.   3. Jain, S. and Parle, M. *Community Pharmacy Practice.* CBS Publishers & Distributors.   4. Park, K. *Park's Textbook of Preventive and Social Medicine.* Banarsidas Bhanot Publishers.

Course Code	Course Title			Course Type
BP410P	**Systemic Pharmacology I (Practical)**			Core
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	--	--	3	45
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Provide understanding of the theoretical and practical aspects of different pharmacological experiments using virtual simulations and video demonstrations.
2. Develop skills to assess drug effects on various systems such as cardiovascular, respiratory, skeletal muscle, and gastrointestinal tract using simulation models.
3. Familiarize the learners with experimental methodologies such as Langendorff's heart preparation, spasmogen and spasmolytic effects, and PA2 value determination using Schild plot.
4. Provide knowledge of modern techniques for drug evaluation.
5. Explore clinical pharmacology aspects through case studies on drug interactions, management of cardiovascular and respiratory diseases, and plasma volume expanders.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to:
1	Describe the drug effects on blood pressure, heart rate, and understand their relevance to cardiovascular pharmacotherapy through virtual simulations.
2	Evaluate the pharmacological management of asthma, analyse drug actions on the respiratory system, and correlate them with clinical data.
3	Interpret experimental data, calculate and analyse PA2 values, plot standard curves, and estimate drug effects using hypothetical data from computer simulations.
4	Present case studies and explore drug interactions and rational drug management in cardiovascular situations and asthma, applying pharmacological knowledge to patient care.
5	Demonstrate competence in various pharmacological measurements, such as intraocular pressure estimation, nitric oxide estimation in plasma, and spirometry.

Detailed Syllabus:

List of practical
(Minimum 12 Experiments must be performed)
1. To demonstrate Langendorff's heart assembly and its applications in pharmacology (only video demonstration/or charts and illustrations). 2. Recording of the effects of different electrolytes, agonists and antagonists on the isolated and perfused frog heart preparation using interactive computer simulation experiment. 3. To study the effect of various drugs on blood pressure and heart rate anaesthetized dog using interactive computer simulation experiment. 4. Demonstration of the estimation of intraocular pressure on rabbit eye and human eye by using conventional Schiotz tonometer and non-contact tonometer. 5. To evaluate the muscle relaxant activity of drugs on Rota-rod apparatus using interactive computer simulation experiment. 6. Demonstration of the effect of spasmogens and spasmolytic using rabbit jejunum using interactive computer simulation experiment. 7. Determination of PA2 value of Atropine using a suitable isolated tissue preparation by Schild plot method with the help of hypothetical data using interactive computer simulation experiment. 8. Determination of PA2 value of Prazosin using a suitable isolated tissue preparation by Schild plot method with the help of hypothetical data using interactive computer simulation experiment. 9. To study the antiallergic effects of drugs using mast cell degranulation assay using interactive computer simulated experiment. 10. Evaluation of diuretic activity of drugs in rats using metabolic cages (simulation) and estimation of electrolytes in the urine samples/serum using flame photometer/commercially available kits. 11. Evaluation of effects of antihistaminic drugs on the histamine-induced bronchospasm in guinea pigs using interactive simulated experiment. 12. To study and analyse drug-drug interaction/ rational drug management of asthma with the help of Case Study/ hypothetical data/ any clinical report. 13. To study clinical pharmacology of the plasma volume expanders and their importance (using charts/open sources videos). 14. Demonstration of evaluation of anti-inflammatory activity in paw oedema model using plethysmometer using simulations. 15. Concept of Biobanking and its significance in drug screening. 16. Isolation of Polymorphonuclear cells from blood and evaluation of endotoxin-induced oxidative stress in them using Nitrobluetetrazolium dye method by colourimetry. 17. Determination of viability of cells (using isolated polymorphonuclear cells) by Trypan blue dye exclusion assay to determine cell viability using microscopy method. 18. Determination of anti-inflammatory activity of durgs in vitro using RBC membrane stabilization assay 19. Determination of protein concentrations using Bradford reagent and plotting of standard curve of bovine serum albumin. 20. Estimation of anticholinesterase inhibitory activity of drugs using Ellman's reagent (DTNB) 21. Determination and and plotting of standard curve for LPO, Nitric oxide and GSH.
Recommended References (Preferably latest editions): 1. Ghosh, M. N. *Fundamentals of Experimental Pharmacology.* Hilton & Company. 2. Goyal, R. K. *Practical Pharmacology.* B. S. Shah Prakashan. 3. Kulkarni, S. K. *Handbook of Experimental Pharmacology.* Vallabh Prakashan.

4. *Computer Assisted Learning (CAL) software packages for experimental pharmacology simulations.*

Course Code	Course Title		Course Type
BP411I	**Internship**		**Internship**
Credit	Hours Per Week (L-T-P)		
	L	T	P
4	--	--	8
Maximum Marks	SE		ESE
100	--		100

SEMESTER VI

Course Code	Course Title			Course Type
BP607T AEC1	**Green Chemistry (Theory)**			Elective
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	1	--	--	15
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Comprehend the foundational principles and overarching scope of green chemistry within pharmaceutical sciences.
2. Analyze and evaluate the environmental impact of traditional pharmaceutical manufacturing processes and the significance of green chemistry metrics.
3. Acquire knowledge of diverse green chemical techniques, including alternative solvents and various catalytic approaches, for sustainable drug synthesis.
4. Recognize the industrial application of green chemistry principles in pharmaceutical manufacturing processes, focusing on waste minimization and pollution control.
5. To articulate the principles of green chemistry.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Articulate the principles of green chemistry and provide relevant pharmaceutical examples for each.
2	Identify and propose suitable green solvents and catalysts,
3	Understand the advanced synthetic methods using Green synthesis using microwave, Ultrasonic for the production of active pharmaceutical ingredients (APIs).
4	Develop strategies for waste minimization and continuous flow reactor in pharmaceutical manufacturing in industries.
5	Articulate the principles of green chemistry and provide relevant pharmaceutical examples for each.

Detailed Syllabus

Unit No.	Topics	No. of Lectures
I	**Introduction to Green Chemistry in Pharmacy** 1. Definition and scope of green chemistry in pharmaceutical sciences 2. Principles of Green Chemistry with pharmaceutical examples	3 hours
II	**Environmental Aspects and Metrics in Green Pharmacy** • Comparison of traditional vs. green chemical approaches in drug synthesis • Environmental impact of pharmaceutical manufacturing • Overview of pharmaceutical pollutants and their life cycle • Metrics: Atom economy, E-factor, Process Mass Intensity (PMI)	3 hours
III	**Green Techniques in Pharmaceutical Synthesis – I** 1. Green Solvents and use of green solvents (e.g. water, supercritical fluids, ionic liquids) in drug synthesis 2. Solvent-free reactions in pharmaceutical synthesis 3. Green Catalysis and Reaction Enhancement in pharmaceutical green chemistry – Overview of catalysis in pharmaceutical green chemistry, Photochemical Transformations, Phase Transfer Catalysis	3 hours
IV	**Green Techniques in Pharmaceutical Synthesis – II** 1. Microwave assisted reactions: Merit and demerits of its use 2. Mechanism, superheating effects of microwave 3. Effects of solvents in microwave assisted synthesis 4. Microwave technology in process optimization 5. Applications in various organic reactions and heterocycles synthesis	3 hours
V	**Green Chemistry in Industrial and Regulatory Aspects** 1. Green chemistry in pharmaceutical manufacturing processes 2. Ultrasound assisted reactions: Types of sonochemical reactions, synthetic applications 3. Continuous flow reactors: Working principle, advantages and synthetic applications 4. Waste minimization and pollution control in formulation industries 5. Role of green chemistry in Good Manufacturing Practices (GMP)	3 hours

Recommended References *(Preferably latest edition)*:

1. Anastas, P.T. and Warner, J.C., 2000. Green chemistry: theory and practice. Oxford university press.
2. Lancaster, M. (2016). Green Chemistry: An Introductory Text (3rd ed.). Royal Society of Chemistry.
3. Green Chemistry in the Pharmaceutical Industry, Edited by Peter J. Dunn, Andrew Wells, and Michael T. Williams, 2010.
4. Green Chemistry and Sustainable Technology: Biological, Pharmaceutical, and Macromolecular Systems, Edited by Satish A. Dake, Ravindra S. Shinde, Suresh C. Ameta, A. K. Haghi, 2022.
5. Scalable Green Chemistry: Case Studies from the Pharmaceutical Industry, Edited by Stefan Koenig, 2013.

Course Code	Course Title			Course Type
BP607T AEC2	**Materiovigilance and Hemovigilance (Theory)**			Elective
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	1	--	--	15
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the concepts, scope, and importance of materiovigilance and hemovigilance systems in ensuring patient safety in healthcare.
2. Familiarize students with national and international regulatory frameworks, reporting systems, and global initiatives related to vigilance programs.
3. Identify and evaluate adverse events associated with medical devices and blood transfusion practices.
4. Develop competencies in detection, reporting, investigation, and documentation of vigilance-related incidents.
5. Promote awareness of safety culture, quality assurance, and ethical responsibilities in clinical and healthcare practices.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Explain the principles, scope, and significance of materiovigilance and hemovigilance in ensuring patient and public health safety.
2	Describe the structure and functioning of the Materiovigilance Programme of India (MvPI) and the procedures for reporting medical device-related adverse events.
3	Outline the framework of the Hemovigilance Programme of India (HvPI) and classify different types of transfusion-related adverse reactions.
4	Compare national and international vigilance systems and apply basic methods of risk assessment, signal detection, and root cause analysis.
5	Demonstrate appropriate documentation and reporting practices and recognize the role of healthcare professionals in promoting vigilance and patient safety.

Detailed Syllabus

Unit No.	Topics	No. of Lectures
I	**Introduction to Vigilance Systems** • Overview of Materiovigilance, Hemovigilance and other vigilance system in Healthcare • Importance of post-marketing surveillance in patient safety • Scope and objectives of materiovigilance and hemovigilance programs • Basic concepts of adverse event reporting and safety monitoring • Historical evolution and global relevance of Materiovigilance, Hemovigilance practices	3 hours
II	**Materiovigilance – Principles and Practices** • Introduction to Materiovigilance Programme of India (MvPI) • Roles of NCC-MvPI and technical collaborators (e.g., Sree Chitra Tirunal Institute) • Classification of medical devices (Class A to D) based on risk • Identification and documentation of Medical Device Adverse Events (MDAEs) • Medical device reporting forms, process flow, and responsibilities • Causality assessment of Medical Device Adverse Events	3 hours
III	**Hemovigilance – Principles and Practices** • Overview of Hemovigilance Programme of India (HvPI) • Organizational structure: NIB, NBTC, hospital-based hemovigilance • Adverse Transfusion Reactions (ATRs): Types and clinical manifestations • Use of TRRF (Transfusion Reaction Reporting Form) and Haemo-Vigil software • Responsibilities of blood banks, transfusion officers, and healthcare providers • Case examples along with Causality assessment of Hemolytic reactions, TRALI, TACO, allergic responses.	3 hours
IV	**Global Regulations, Risk Assessment & Root Cause Analysis** • International frameworks: US FDA (MAUDE), EU MDR, SHOT (UK), French Hemovigilance • Comparison of Indian and global materiovigilance/hemovigilance practices • Signal detection and evaluation of adverse events • Root cause analysis (RCA) and implementation of corrective & preventive actions (CAPA) • Risk communication and role of healthcare teams in mitigation	3 hours

V	**Reporting Systems, Quality Assurance, and Professional Role** Demonstration: Reporting of MDAEs and ATRs using mock forms • Practical exercises in form-filling and event documentation • Integration of vigilance into hospital quality systems (e.g., NABH, ISO) • Strategies to enhance adverse event reporting culture • Ethical considerations and communication with patients/families • Role of pharmacists, nurses, clinicians, biomedical engineers in vigilance programs	3 hours

Recommended References *(Preferably latest edition)*:

1. Bertil Jacobson - Medical Device Safety: The Regulation of Medical Devices for Public Health and Safety, CRC Press
2. Jack Wong - Handbook of Medical Device Regulatory Affairs in Asia, Pan Stanford Publishing
3. Denise M. Harmening - Modern Blood Banking and Transfusion Practices, F.A. Davis Company
4. World Health Organization (WHO)- Blood Safety: Basic Elements

Course Code	Course Title			Course Type
BP607T AEC3	**Scientific Writing (Theory)**			Elective
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	1	--	--	15
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Develop the ability to write clearly, concisely, and effectively for scientific audiences.
2. Understand the structure and components of scientific documents such as research papers, proposals, and literature reviews.
3. Learn the principles of scientific style, tone, and formatting in academic writing.
4. Apply correct citation practices and reference management techniques.
5. Recognize and address ethical issues in scientific communication, including plagiarism and data integrity.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Understand the principles of scientific writing
2	Develop clear and concise scientific writing skills
3	Use effective scientific citation techniques
4	Understand and apply the ethical principles of scientific writing
5	Develop the ability to critically evaluate scientific literature

Detailed Syllabus

Unit No.	Topics	No. of Lectures
I	**Introduction to Scientific Writing** • Overview of the course • Principles of scientific writing • Overview of scientific research • Introduction to Microsoft tools and its application	2
II	**Writing Literature Reviews and Scientific Papers** • Structure and format of literature reviews • Conducting a literature review • Analyzing literature and developing themes	5

	• Writing a compelling introduction • Developing a clear methodology • Results and analysis	
III	**Communicating Results and Data** • Understanding data presentation • Developing tables and figures • Using effective graphic design	3
IV	**Scientific Citation and Referencing** • Understanding citation styles • Citation and plagiarism • Referencing in scientific writing	3
V	**Ethical Issues in Scientific Writing and Peer Review and Revision** • Ethical principles in scientific writing • Misconduct and fraud in scientific writing • Peer review and publication ethics • Providing Constructive feedback • Responding to feedback	2

Recommended References *(Preferably latest edition)*:

1. Day, R. A., Gastel, B. How to Write and Publish a Scientific Paper. Bloomsbury Publishing, USA.
2. Hofmann, A. H. Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford University Press, USA.
3. Schimel, J. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded. Oxford University Press, USA.
4. Alley, M. The Craft of Scientific Writing. Springer, New York, USA.
5. Machi, L. A., McEvoy, B. T. The Literature Review: Six Steps to Success. SAGE Publications, Thousand Oaks, USA.
6. Jesson, J., Matheson, L., Lacey, F. M. Doing a Literature Review in Health and Social Care. SAGE Publications, London, UK.
7. Tufte, E. R. The Visual Display of Quantitative Information. Graphics Press, Cheshire, USA.
8. American Medical Association. AMA Manual of Style. Oxford University Press, New York, USA.
9. American Psychological Association. Publication Manual of the American Psychological Association. American Psychological Association, Washington, DC, USA.
10. National Academies of Sciences, Engineering, and Medicine. On Being a Scientist: A Guide to Responsible Conduct in Research. National Academies Press, Washington, DC, USA.

Course Code	Course Title			Course Type
BP607T AEC4	**Drug Store and Business Management (Theory)**			Elective
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	1	--	--	15
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the principles of trade, commerce, and different types of business organizations.
2. Gain knowledge on effective drug store layout, procurement, and inventory control.
3. Apply basic accounting and financial principles for pharmacy business operations.
4. Explore marketing and sales strategies applicable to pharmaceutical products.
5. Develop entrepreneurial skills and understand legal aspects of drug store management.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Describe different business models and their relevance to pharmaceutical trade.
2	Manage drug store operations, including procurement, storage, and customer service.
3	Maintain basic accounting records and interpret financial statements.
4	Implement inventory control techniques and pricing policies.
5	Apply marketing principles and legal guidelines for establishing a retail pharmacy.

Detailed Syllabus

Unit No.	Topics	No. of Lectures
I	**Introduction to Trade and Industry** • Objectives and scope of business • Classification of business activities – industry, commerce, trade • Forms of business organization: sole proprietorship, partnership, cooperatives, corporations • Features and merits/demerits of each form Pharmacy business and its legal considerations	3 hours
II	**Drug Store Management** • Selection of site, space, and layout of a drug store	3 hours

	• Types of drug stores – hospital pharmacy, community pharmacy, chain pharmacy • Procurement of drugs and inventory control • Storage conditions and stock maintenance (cold storage, poisonous drugs, etc.) • Records and registers to be maintained	
III	**Inventory Control and Sales Promotion** • Introduction to inventory control: need and methods • Economic Order Quantity (EOQ), Reorder Level (ROL), Lead time • FIFO and LIFO methods • Sales promotion techniques: advertising, displays, discounts • Customer relationship management (CRM) in pharmacy	3 hours
IV	**Financial Management and Bookkeeping** • Basics of accounting: journal, ledger, trial balance • Introduction to financial statements: profit and loss account, balance sheet • Pricing policies: markup, markdown, break-even analysis • Bank transactions: types of accounts, cheques, drafts • Taxation basics: GST, income tax (as applicable to pharmacies)	3 hours
V	**Pharmaceutical Marketing and Entrepreneurships** • Definition and scope of pharmaceutical marketing • Elements of marketing mix (4Ps) for pharmacy • Drug distribution channels: wholesale and retail • Entrepreneurship development in pharmacy • Regulatory aspects of retail drug licensing (Drug and Cosmetics Act overview)	3 hours

Recommended References *(Preferably latest edition)*:

1. Elements of Business Management by T.R. Jain & Mukesh Trehan, VK Publications
2. Retail Pharmacy Management by R.C. Goyal, CBS Publishers & Distributors
3. Principles and Practice of Management by L.M. Prasad, Sultan Chand & Sons
4. Business Organization and Management by C.B. Gupta, Sultan Chand & Sons
5. Drug Store and Business Management by R.M. Mehta, Pharma Med Press
6. A Textbook of Drug Store and Business Management by T.K. Ghosh, S. Chand Publishers
7. Pharmaceutical Marketing in India by Subba Rao Chaganti, Excel Books

Course Code	Course Title			Course Type
BP607T AEC5	**Career Building in Cultivation of Medicinal Plants (Theory)**			Elective
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	1	--	--	15
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Explain the significance, historical background, and therapeutic importance of medicinal plants.
2. Examine the structure, scope, and economic potential of the medicinal plant industry.
3. Identify and describe important medicinal plants of India and their applications.
4. Develop knowledge of sustainable, organic, and scientific cultivation practices for medicinal plants.
5. Explore entrepreneurship opportunities and value chain development in the medicinal plant sector.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	Explain the importance and historical development of medicinal plants in traditional and modern healthcare systems.
2	Describe the structure and functioning of the medicinal plant industry and its economic significance.
3	Identify major medicinal plants of India and explain their uses and sources.
4	Apply principles of sustainable and organic cultivation practices for medicinal plants.
5	Analyze entrepreneurship opportunities and value chain development in the medicinal plant sector.

Detailed Syllabus

Unit No.	Topics	No. of Lectures
I	**Introduction and Industry Overview** • Definition, importance, and cultural background (Ayurveda & ethnobotany) • Global and Indian demand, healthcare and pharma role • Key stakeholders: farmers, traders, processors, exporters • Value chain, supply-demand, government/private initiatives (NMPB, AYUSH, NABARD)	3 hours

II	**Key Medicinal Plants and Cultivation Basics** • Botanical characteristics and uses of major plants: Ashwagandha, Tulsi, Aloe vera, Shatavari, Brahmi, etc. • Regional suitability and agro-climatic zones • Factors affecting Cultivation: Soil, propagation, irrigation, pest control, organic inputs • Harvesting, post-harvest management and storage	3 hours
III	**Organic Farming and Market Linkages** • Organic certification and sustainable farming practices • Biodiversity conservation and agroforestry integration • Processing, drying, packaging, branding • Market linkages: pharma, cooperatives, online platforms, export guidelines	3 hours
IV	**Policy, Entrepreneurship and Digital Tools** • Government schemes and legal frameworks (NMPB, AYUSH, forest laws, GACP) • Entrepreneurship: starting herbal farms, franchises, consulting, contract farming • Digital tools: farm management software, GIS, mobile apps, e-commerce marketing	3 hours
V	**Practical Exposure and Project Presentation** • Virtual/shortened farm/nursery visit or guest lecture (can be online) • Group/individual project: business plan or herbal enterprise pitch presentation	3 hours

Recommended References *(Preferably latest edition)*:

1. Kumar, N., Misra, J. B. M., et al. Cultivation of Medicinal and Aromatic Crops. ICAR Publications, New Delhi, India.
2. Shah, B., Seth, A. Textbook of Pharmacognosy and Phytochemistry. Elsevier / Reed Elsevier India, New Delhi, India.
3. Planning Commission / National Medicinal Plants Board. Medicinal Plants Sector in India: Challenges and Opportunities. Government of India, New Delhi, India.
4. Planning Commission (NITI Aayog). Herbal Industry in India. Government of India, New Delhi, India.
5. National Medicinal Plants Board (NMPB). Annual Reports. Ministry of AYUSH, Government of India, New Delhi, India.
6. World Health Organization. Good Agricultural and Collection Practices (GACP) for Medicinal Plants. WHO Press, Geneva, Switzerland.

Course Code	Course Title			Course Type
BP607T AEC6	**Active Pharmaceutical Ingredients and Excipient Sciences (Theory)**			Elective
Credit	Hours Per Week (L-T-P)			Max. Hours
	L	T	P	
1	1	--	--	15
Maximum Marks	SE			ESE
50	20			30

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understand the fundamental concepts of Active Pharmaceutical Ingredients (APIs) and excipients in dosage form development.
2. Analyse the physicochemical properties influencing API–excipient compatibility and formulation performance.
3. Develop knowledge of industrial methodologies for characterization and quality control.
4. Understand GMP protocols and regulatory frameworks governing API and excipient manufacturing.
5. Explore emerging industrial trends including green chemistry and bio-based excipients.

COURSE OUTCOMES (CO):

CO No.	Upon successful completion of this course, the students will be able to
1	To explain the classification, properties and functional roles of APIs and excipients.
2	To apply analytical and preformulation methodologies for compatibility and stability evaluation.
3	To understand manufacturing, scale-up and quality control procedures used in industry.
4	To evaluate regulatory documentation and compliance requirements for API and excipient approval.
5	To develop awareness of current industrial practices and innovation trends.

Detailed Syllabus

Unit No.	Topics	No. of Lectures
I	**Introduction to APIs and Excipients** • Definitions, classifications, and sources (synthetic, natural, biotech APIs; functional excipients). • Physicochemical properties: Solubility, polymorphism, hygroscopicity, particle characteristics. • Roles in formulations: Bioavailability enhancement, stability, manufacturability.	3 hours

	• Industry overview: Global market trends, common examples (e.g., paracetamol API, HPMC excipient).	
II	**Methodologies for Selection and Pre-formulation** • Excipient selection criteria: Functionality-related characteristics (FRC). • Compatibility studies: Binary mixtures via DSC, FTIR, XRD. • Analytical methodologies: HPLC/GC for purity, Karl Fischer titration, laser diffraction for PSD. • QbD approach: Risk assessment for API-excipient interactions.	3 hours
III	**Manufacturing Protocols** • API processes: Synthesis routes, crystallization, drying, milling; lab-to-pilot scale-up. • Excipient handling: Sieving, blending, lubrication protocols. • GMP essentials: Equipment qualification, process validation. • Unit operations: Wet/dry granulation, direct compression.	3 hours
IV	**Quality Control and Stability Protocols** • QC tests: Assay, dissolution, content uniformity (IP/USP methods). • Stability studies: ICH Q1A zones, accelerated/forced degradation. • Impurity profiling: Genotoxic impurities (ICH M7), residual solvents. • In-process controls: Blend uniformity, weight variation.	3 hours
V	**Regulatory Compliance and Industry Practices** • ICH Q7 guidelines for APIs • USP-NF excipient monographs and Schedule M requirements • Drug Master File (DMF) for APIs • Certificate of Suitability (COS) for excipients • Process and cleaning validation protocols • Regulatory inspections (USFDA 483, EMA expectations) • Emerging trends: green chemistry and bio-based excipients	3 hours

Recommended References *(Preferably latest edition)*:

1. Gibson, M. Pharmaceutical Preformulation and Formulation. Informa Healthcare, London.
2. Rowe, R. C., Sheskey, P. J., Quinn, M. E. Handbook of Pharmaceutical Excipients. Pharmaceutical Press, London.
3. Aulton, M. E. Aulton's Pharmaceutics: The Design and Manufacture of Medicines. Elsevier, London.
4. ICH Guidelines (Q7, Q8, Q1A). International Council for Harmonisation, Geneva.
5. Indian Pharmacopoeia (Latest Edition). Indian Pharmacopoeia Commission, Ghaziabad, India.
6. United States Pharmacopeia–National Formulary (USP-NF). USP Convention, USA.
7. Banker, G. S., Rhodes, C. T. Modern Pharmaceutics. CRC Press, USA.
8. Allen, L. V., Popovich, N. G., Ansel, H. C. Pharmaceutical Dosage Forms and Drug Delivery Systems. Lippincott Williams & Wilkins, USA.