Second Year

Fourth Semester

FOURTH SEMESTER

Code	Description	Credit hours	Pre-requisite course	Core Course
PHT 202	Pharmaceutics IV (Dosage forms and Formulations)	3	PHT 201	☼
PHT 203	Pharmaceutics V (Biopharmaceutics A)	3	PHT 201	☼
MBL 251	Pharmaceutical Microbiology I (General)	3	…….	☼
IML 261	Immunology (Fundamentals of Immunology)	3	……..	……..
PHC 272	Pharmaceutical Chemistry V (General Chemical Reaction)	3	PHC 172	☼
PHG 282	Pharmacognosy III (Natural Products Chemistry)	3	PHG 281	☼
LAB-8	Pharmaceutical Laboratory 8	1	……..	……..
LAB-9	Pharmaceutical Laboratory 9	1	……	……
LAB-10	Pharmaceutical Laboratory 10	1	…….	……..
SEM-3	Pharmaceutical Seminar-3	1	……	…….
	TOTAL	22		

PHT 202 (Credit hours 3)

Pharmaceutics IV
(Dosages Forms and Formulation B)
B. Pharm., Second Year, Fourth Semester

Course Objectives:
The students will become familiar with the commonly administered dosage forms, their characteristics and preparations methods, which shall provide a broad view of pharmaceuticals.

Unit	Course Description	Hours	Details	Suggestions
1.	**Dermatological Dosage Forms**	**15**		
	Percutaneous absorption, Skin, Transdermal drug delivery systems, Ointments, Preservation, Creams, Pastes, Lotions, Topical solutions, Tinctures, Liniments, Collodions, Glycerogelations, Plasters, Powders for application to the skin, Topical aerosols, Tapes, Packaging		Structure and Physiology of Skin, percutaneous absorption of drugs Factors affecting transdermal bioavailability (Physiological and Formulation), Advantages and Disadvantages of Transdermal Drug Delivery, Current Technology for Transdermal Drug Delivery, New and Evolving Technologies for Transdermal Drug Delivery (chemical penetration enhancer, Iontophoresis, Prodrug, Novel Formulation approaches). Ointments, paste, gel and other semisolid dosage forms: definition and classification of semisolid classification of ointment bases, selection of ointment base, formulation and manufacturing of ointment paste and gel, rheological consideration, evaluation and quality analysis. Classification, Formulation, Manufacturing, properties, advantages. Disadvantages, packaging, evaluation and quality analysis of Lotions, Topical solutions, Tinctures,	

			Liniments, Collodions, Glycerogelations, Plasters, Powders for application to the skin, Topical aerosols, Tapes, Packaging	
2.	**Dosage Forms Applied Topically to Eye, Ear, Nose and Oral Cavity**	**8**		
	Ophthalmic preparations, Sterilization and preservation, Isotonicity, Ophthalmic solutions, Ophthalmic suspensions, Ophthalmic ointments, Ophthalmic inserts, Contact lenses, Nasal preparations, Optic preparations, Packaging		Ophthalmic preparations, Requirements, Sterilization and preservation, Isotonicity, Ophthalmic solutions, Ophthalmic suspensions, Ophthalmic ointments, Ophthalmic inserts, Contact lenses, Nasal preparations, Optic preparations, formulation, preservatives and choice thereof, methods of preparation, containers and evaluation.	
3.	**Rectal, Vaginal and Urethral Dosage Forms**	**6**		
	Suppositories, Vaginal dosage forms, Urethral preparations, Packaging		Suppositories, Vaginal dosage forms and Urethral preparations: Ideal requirements, advantages & disadvantages, classification, bases, formulation, manufacturing procedure, displacement value of testing of suppositories, mechanism of absorption of medicaments from the dosage forms, packaging and evaluation.	
4.	**Pharmaceutical Aerosols**	**6**		
	Aerosols, Containers, Inhalations, Sprays		Pharmaceutical Aerosols: Definition, propellants, general formulation, different types of atomizers, manufacturing and packaging methods, pharmaceutical applications.	

			Containers, Inhalations, Sprays.	
5.	**Radiopharmaceuticals**	**3**		
	The practice of nuclear pharmacy, Positron emission tomography, Radiopharmaceuticals		Introduction to radioactive elements, types of elements that possess radioactive properties, Positron emission tomography, their uses in pharmaceutical and medical sciences.	*This is the chapter which is covered in the section of Pharmaceutical Chemistry (Inorganic Pharmacy). So, it is better to replace this chapter by the chapter named* ***"Blood Products and Plasma Substitutes"****
6.	**Biotechnology and Drugs**	**4**		
	Recombinant DNA, Products of biotechnology, The future, Role of pharmacist		Pharmacist and Biotechnology, Approved biotechnological product and vaccines, GMP compliance and biopharmaceutical facilities..Recombinant DNA Technology: Introduction, Cutting and rejoining of DNA, Mutagenesis, Polymerase Chain Reaction (PCR) in gene amplification, Pharmaceutical application of recombinant DNA technology, Drug delivery system, Gene therapy, Basic Molecular mechanism of gene transfer, Prerequisite of human gene therapy, gene therapy for cancer and HIV, Various problems in gene therapy.	
7.	**Novel Drug Delivery Systems**	**3**		

	Drugs and vaccines presently available on the market, The future		Advanced Drug Delivery and Targeting, An overview of Implantable System, Drug Targeting Systems: Fundamentals and Applications to Perenteral Drug Delivery, Oral Transmucosal Drug Delivery, Nasal Drug Delivery and Pulmonary Drug Delivery.	

Reference Books:

1. Howard C. Ansel, Loyd V. Allen and Nicholas G. Popovich: *Pharmaceutical Dosage form and Drug Delivery System* (7th Ed.) 1999, Lippincott Williams and Wilkins, Philadelphia.
2. Michael E. Aulton (Ed.): *Pharmaceutics, The Science of Dosage Form Design*, 1999, Churchill Livingstone, International Student Edition, New Delhi.
3. E. A. Rowlins (Ed.): *Bentley's The Textbook of Pharmaceutics* (8th Ed.) 2001, Bailliere Tindall, London.
4. A. R. Gennaro (Ed.): *Remington's Pharmaceutical Sciences* (18th Ed.) 1990, Mack Publishing Company, Easton.

*** Blood Products and Plasma Substitutes:** Collection, processing and storage of; whole human blood, concentrated human RBC, dried human plasma, human fibrinogen, human thrombin, human normal immunoglobulin, human fibrin foam, plasma substitutes, ideal requirements, PVP, dextrin, etc., control and/or maintenance of blood pressure.

PHT 203 (Credit hours 3)

Pharmaceutics V
(Biopharmaceutics A)
B. Pharm., Second Year, Fourth Semester

Course Objectives:
This course will provide the students the knowledge on general principles of bioavailability and biopharmaceutics applicable to pharmaceutical sciences.

Unit	Course Description	Hours	Details
1.	**The Concept of Biopharmaceutics**	**10**	
	General principles of drug absorption, Dissolution and drug absorption, Biological membranes and drug transport, Routes of administration and absorption processes		**Introduction To Biopharmaceutics And Pharmacokinetics** **Drug Product Considerations** ➢ Pharmacokinetics of the Drug ➢ Bioavailability of the Drug ➢ Dose Considerations ➢ Dosing Frequency ➢ Patient Considerations ➢ Route of Drug Administration **Absorption of Drug** **Gastrointestinal Absorption of Drugs** Cell Membrane Structure and Physiology **Mechanism of Drug Absorption** ➢ Passive diffusion ➢ Pore transport ➢ Facilitates diffusion ➢ Active transport ➢ Ionic or electrochemical diffusion ➢ Ion pair transport ➢ Endocytosis **Factors influencing GI absorption of drug from its dosage form** I. Pharmaceutics factors: ➢ Physiochemical properties of Drug substances….. ➢ Dosage form Characteristics and Pharmaceutical Ingredients II. Patient related factors (Anatomy and physiology consideration of GI tract, GI content and interaction) **Route of Administration**

			(Buccal/ sublingual, rectal route, topical route Intramuscular Administration, Subcutaneous Administration, Inhalation Drug Delivery, Nasal Drug Delivery, Intraocular Administration, Vaginal Administration……)
2.	**Pharmacokinetic Principles**	**8**	
	Reaction rate and Reaction order, Half-life, Concept of clearance, Dosage regimen considerations, Blood concentration-time curve		**PHARMACOKINETIC PRINCIPLES** **Plasma drug concentration time curve with detail labeling** ➢ Pharmacokinetic parameters ➢ Pharmacodynamic parameters **Rate, Rate Constants and Orders of Reactions** ➢ Zero order Kinetics (Constant Rate Processes) ➢ First Order Kinetics (Linear Kinetics) ➢ Mixed Order Kinetics **Half life (Calculation of half life …. first and zero order kinetics)** **Concept of Clearance** **Dosage Regimen Consideration** ➢ Individualization of Drug Dosage Regimens ➢ Drug Selection ➢ Dosage Regimen Design ➢ Determination of Dose ➢ Determination of Frequency of Drug Administration ➢ Loading Dose ➢ Determination of Route of Administration ➢ Dosing of Drugs in Infants and Children ➢ Dosing of Drugs in the Elderly
3.	**Fate of Drugs after Administration**	**8**	
	ADME process, Pharmacokinetic models, Non-linear pharmacokinetics**,** Excretion of drugs		**Absorption Distribution of Drugs** **Tissue Permeation of the Drugs** **Physiochemical Properties of the Drug** **Physiological Barrier to Distribution of Drug** **(**Simple capillary endothelial barrier**,** Simple

			cell membrane barrier **,**Blood brain barrier, Cerebrospinal fluid barrier, Placental barrier **,**Blood-testis barrier……) **Miscellaneous Factors Affecting Drug Distribution** (Age, *Pregnancy*, obesity, *Diet, Disease, Distribution volume,….)* **Metabolism** **Enzyme Kinetics** **Drug Biotransformation Reactions** **Pathways of Drug Biotransformation** **Hepatic Enzymes Involved in the Biotransformation of Drugs** **DRUG EXCREATION** **Renal Excretion of Drug** (Glomerular Filtration, Active Tubular Secretion, Tubular Reabsorption……) **Factor Affecting Renal Excretion or Renal Clearance** (Physiochemical properties of the drug, Plasma concentration of the drug, Distribution and binding characteristics of the drug, Urine PH, Blood flow to the kidney, Biological factors , Drug interaction , Disease states) **Non Renal Routes of Drug Excretion** ➢ Biliary excretion ➢ Pulmonary excretion ➢ Salivary excretion ➢ Mammary excretion ➢ Skin/dermal excretion ➢ Gastrointestinal excretion ➢ Genital excretion **Concept of Clearance** ➢ Renal Clearance ➢ Measurement of Glomerular Filtration Rate ➢ Renal Function ➢ Dose Adjustment ➢ Extracorporeal Removal of Drugs

			➢ Dialysis ➢ Peritoneal Dialysis ➢ Hemodialysis ➢ Pharmacokinetic Models **Compartmental Modeling** (Use of compartmental model) ➢ One-Compartment **Drug Clearance in the One-Compartment Model** ➢ ***Two compartment (intravascular and extravascular administration*** ➢ **Multi Compartment** ***(Mammillary model, Caternary model)*** **Non-compartmental modeling** **Physiological modeling** **Non Linear Pharmacokinetics** ➢ Cause of Nonlinearity ➢ Clinical and Adverse Toxicity Due to Nonlinear Pharmacokinetics ➢ Bioavailability of Drugs that Follow Nonlinear Pharmacokinetics
4.	**Bioavailability and Bioequivalence**	**13**	
	The concept of bioavailability, Factors affecting bioavailability, Drug absorption from GI tract, Assessment of bioavailability, *In vitro* and *in vivo* bioavailability testing, Regulatory bioavailability requirements		
5.	**Drug Interactions and Incompatibilities**	**6**	
	pH effect *in vitro* and *in vivo*, Cation-anion interaction, Chelation and complexation, Adsorption of drugs, Drugs interactions with plastics, Protein binding, Drugs interaction based on physical		**Bioavailability** **Objective of bioavailability studies** **Relative Availability** **Absolute Availability** **Factors Affecting Bioavailability** (pharmaceutic related, patients related and route of administration

	mechanism		**Assessment of Bioavailability** ➢ ***Pharmacokinetic methods*** **(**Plasma level time studies & Urinary excretion studies) ➢ **Pharmacodynamic methods (**Acute pharmacological response & Therapeutic response) ***Method for enhancement of bioavailability*** **In Vitro Drug Dissolution** Factor that must be consider in the designing of a dissolution test Compendial methods of dissolution **In-Vivo Bioequivalence Studies (Biowaivers)** ***In-Vitro–In-Vivo*** **Correlation** **BIOEQUIVALENCE STUDIES** **Definition and Other Terms Related to Bioequivalence** (*Equivalence, Pharmaceutical equivalents, Bioequivalent drug products, Therapeutic equivalents, Drug product, Drug substance, Single source drug products,* A *multisource drug product, Generic name, Brand name, Generic substitution, Pharmaceutical alternatives, Pharmaceutical substitution, Therapeutic alternatives Therapeutic substitution,* **Bioequivalence –When Regulatory Requirements**

Reference Books:

1. Howard C. Ansel, Loyd V. Allen, Jr., and Nicholas G. Popovich: *Pharmaceutical Dosage form and Drug Delivery System* (7th Ed.) 1999, Lippincott Williams and Wilkins, Philadelphia.
2. A. T. Florence and D. Attwood: *Psysicochemical Principles of Pharmacy* (2nd Ed) 1994, The Macmillan Press Ltd., London.
3. Michael E. Aulton (Ed.): *Pharmaceutics, The Science of Dosage Form Design*, 1999, Churchill Livingstone, International Student Edition, New Delhi.
4. P. I. D. Lee and G. L. Amidon: *Pharmacokinetic Analysis*: *A Practical Approach*, 1996, Technomic Publ. Co, Lancaster.

MBL 251 (Credit hours 3)

Pharmaceutical Microbiology I
(General)
B. Pharm., Second Year, Fourth Semester

Course Objectives:
This course will provide the basic knowledge on microbiology and its general application to pharmaceutical preparation.

Unit	Course Description	Hrs	Details
1.	**Fundamentals of Microbiology**	**10**	
	Virus, Rickettsiae, Chlamydiae, Mycoplasm, Bacteria, Actinomycetes, Fungi,		Introduction & history of microbiology **Virus**: definition, structure, general lifecycle & classification; **Rickettsiae**: general properties, cultivation, infections; **Chlamydiae**: general properties, classification based on human infections; **Mycoplasma**: general properties, cultivation, infection; **Actinomycetes**: morphology, pathogenesis, clinical diseases; **Fungi**: general properties, morphological classification, classification based on reproduction, fungal infections; **Bacteria**: introduction, general requirements for bacterial growth, bacterial growth phase, anatomy of bacterial cell, gram positive & gram negative bacteria, classification based on shape & arrangement, bacterial culture media
2.	**The Action of Physical and Chemical Agents on Micro-organisms**	**10**	
	The kinetics of cell inactivation, Antimicrobial effect of moist and dry heat, Ionizing Radiation, Ultraviolet radiation, Gases, Antimicrobial effects of Chemical agents, Antibiotics and chemotherapeutic agents		**Kinetics of cell inactivation:** definition & derivation, condition influencing antimicrobial action; Dry heat sterilization: principle & types; Moist heat sterilization; procedure & types, autoclaving; Chemical sterilization: ethylene oxide, formaldehyde, formalin, hydrogen peroxide; Disinfectants: high level, intermediate & low level, alcohol, heavy metals & their compounds, phenolic compounds;

			Radiations: ionizing & non ionizing, x-ray, gamma rays, electron beams, UV rays; **Antibiotics & chemotherapeutic agents:** Introduction & history, classification of antibiotics based on mode of action- cell wall inhibitors, protein synthesis inhibitors, metabolic inhibitors; **Antifungal agents:** Polyenes, azoles, nucleoside derivatives.
3.	**Principles of Sterilization**	**4**	
	The importance of sterility, Definition, Determination of sterilization protocols, Integrated lethality in sterilization practice, Test for sterility of the products		**Sterility:** definition, principle; Thermal death time & decimal reduction time, Z-value; Sterility test method- sterility standards of different pharmaceutical products, growth promotion test;. Test methods-Method A(membrane filter method) & method B(direct method)
4.	**Microbial Contamination and Preservation of Pharmaceutical Preparation**	**6**	
	Source and incidence of contamination, Growth of microorganisms in pharmaceutical products, Consequences of contamination, Screening for contamination, Control of microbial contamination, The preservation of pharmaceutical preparation, Microbial standard for pharmaceutical preparation		Source & incidence of contamination- water, environment, packaging material, human source, equipments; Growth & consequences of microbial contamination- physical changes seen on the products, pharmaceutical ingredients susceptible to microbial attack; control of microbial attack- on various aspects as raw material& water, environment, human sources, equipments; Preservation of medicines- different preservatives used; screening of contamination- direct & membrane filter test; Microbial standard of pharmaceutical preparations- water, raw material, finished products.
5.	**Pharmaceutical Application of Microbiological Techniques**	**8**	
	Measurement of antimicrobial activity, Antibiotic assay, Aminoacid and vitamin assay, The measurement of minimum inhibitory concentration (MIC), Counting of micro-organism in pharmaceutical products, Pyrogen testing, Challenge tests (preservative		Measurement of antimicrobial activity- tube dilution technique, disc diffusion technique & phenol coefficient method; Antibiotic assay- cylinder plate method, perforated plate method, Turbid metric method; Amino acid & vitamin assay- concept & procedure;

	efficacy test), Disinfactant evaluation		Challenge test- concept & procedure; Counting of microorganism- plate count method, multiple or serial dilution method & membrane filtration method.
6.	**Biologicals**	**7**	
	Production of vaccines and antisera, Biological testing and pathogenecity, Toxicity, Pyrogen tests		Production of vaccines- types of vaccines, production of microbial vaccines- various steps involved; production of antisera- concept & procedure; Biological testings- pyrogen test, Bacterial endotoxin test, Depressor substances test, biological reactivity test, systemic injection test, Intracutanous test & implantation test; Pathogen city- portal of entry, penetration of host immune defences; Toxicity- definition, types, health hazards, classification.

Reference Books:

1. M. E. Aulton (Ed.): *Pharmaceutics, The Science of Dosage Form Design*, 1999, Churchill Livingstone, International Student Edition, New Delhi.
2. E. A. Rowlins (Ed.): *Bentley's The Textbook of Pharmaceutics* (8th Ed.) 2001, Bailliere Tindall, London.
3. W. B. Hugo and A. D. Russel: *Pharmaceutical Microbiology* (6th Ed.) 1998, Blackwell Scientific Publication, Oxford.
4. M. J. Pelczar, E. C. S. Chan and N. R. Krieg: *Microbiology* (5th Ed.) 1986, Tata Mc Graw-Hill Book Company, New Delhi.

IML 261 (Credit hours 3)

Immunology
(Fundamentals of Immunology)
B. Pharm., Second Year, Fourth Semester

Course Objectives:
This course will provide the fundamental knowledge on the immune system.

Unit	Course Description	Hours	Details
1.	**Introduction to the Immune System**	**6**	
	Adaptive and innate immunity, Cells of the immune system, Soluble mediators of immunity, Antigens, Immune responses, Defences against extracellular and intracellular pathogens, Vaccination, Immunopathology		Immunity, types of immunity, cells involved, mediators of immunity, soluble mediators, (Ags, Complement), Ags and their types for immune responses (Clonal selection), Defences against extracellular and intracellular pathogens, defenses for pathogens by vaccination (principle, types) immunopathology (Types with definition, inflammation, Hypersensitivity,).
2.	**Cells Involved in Immune Responses**	**4**	
	Lymphoid cells, Mononuclear phagocyte system, Polymorphonuclear granulocytes and platelets		Morphology, different types (neutrophil, eosinophil, basophils and mast cells), functions in immune response. Cell markers
3.	**The Lymphoid System**	**4**	
	Primary and secondary lymphoid tissue, Primary lymphoid organs, Secondary lymphoid organs and tissues, Lymphocyte traffic		Role and function of different lymphoid tissue and organs (Primary lymphoid organs, Secondary lymphoid tissues) lymphocyte traffic.
4.	**Antigen Receptor Molecules**	**4**	
	Immunoglobulins, T-cell antigen receptors, Major histocompatibility complex antigens		Structure and function of different immunoglobulins, mechanism of T cell Ag receptor structure and function of different classes of MHC.
5.	**Antigen Recognition**	**6**	
	Antigen-Antibody binding, The structure of antigens, T-cell-antigen recognition, Antigen processing and presentation, Role of accessory molecules, basic immunological application (Immunofluroscence, RIA, ELISA)		Mechanism of Ag-Ab binding, Immunological application- different types, procedure and application. Antigen-Antibody binding, The structure of antigens, T-cell-antigen recognition, Antigen processing and presentation, Role of accessory molecules, basic immunological application (Immunofluroscence, RIA, ELISA)

6.	**Cell Cooperation in the Antibody Response**	**4**	
	Cooperation between different cell types, Cell activation, Antibody responses *in vivo*		Antigen presenting, antigen processing, T cell dependent and independent antigens, Haptens and carriers, Cell activation,(Role of interleukins, costimulatory signals), Activation in response to Ags and its response *in vivo*.(Enhanced secondary response, Class switching, Affinity maturation)
7.	**Cell-Mediated Immune Reactions**	**6**	
	T-cell-independent cell-mediated defense mechanism, T-cell-dependent cell-mediated responses, Cell-mediated cytotoxicity, Lymphokine-mediated activation of macrophages, Granuloma formation, Immunopathology, The cytokine network		T-cell-independent cell-mediated defense mechanism, (Phagocytosis, attachment, uptake , cytokine release) T-cell-dependent cell-mediated responses, regulatory role of cytokines, Antibody dependent and antibody independent cell mediated cytotoxicity, Cell-mediated cytotoxicity, Lymphokine-mediated activation of macrophages, Granuloma formation, Immunopathology, The cytokine network
8.	**Regulation of the Immune Response**	**4**	
	Regulation by antigen, Regulation by antibody, Regulation by immune complexes, Regulation by lymphocyte		Regulation by antigen, Regulation by antibody, Regulation by immune complexes, Regulation by lymphocyte
9.	**Immunological Tolerance**		
	T-cell tolerance to self antigens, B-cell tolerance to self antigens, Artificially induced tolerance *in vivo*, Artificially induced tolerance *in vitro*, Potential therapeutic applications of tolerance.	**4**	T-cell tolerance to self antigens, B-cell tolerance to self antigens, Artificially induced tolerance *in vivo*, Artificially induced tolerance *in vitro*, Potential therapeutic applications of tolerance.
10.	**Complement**	**4**	
	Introduction, Activation of complement, Complement receptors, Biological effects of complement		History, nomenclature, activation of complement system, different complement pathway, Membrane attack complex, Biological effects of complements-complement, inflammation and anaphylatoxins.

Reference Books:

1. Ivan Roitt, Jonathan Brostoff and David Male (Ed.): *Immunology* (3rd Ed.) 1993, Mosby-Year Book EuropeLimited, London.
2. Ivan Roitt: *Essential Immunology* (8th Ed.) 1994, Blackwell Scientific Publication, London.

Suggested books:

Thomas J. Kindt, Richard A. Goldsby and BarbarabA. Osborne (6^{th} Ed.) Kuby Immunology 2007, W. H. Freeman and Company, New York.

PHC 272 (Credit hours 3)

Pharmaceutical Chemistry
(Basic Organic Reaction)
B. Pharm., Second Year, Fourth Semester

Course Objectives:
This course is designed to understand the basic principles of reaction mechanism of some common organic reactions.

Unit	Course Description	Hours	Details
1.	**Nucleophilic Aliphatic Substitution**	**10**	
	Definition of nucleophilic aliphatic substitution reaction, Nucleophile and leaving groups, Mechanism and kinetics of SN2 reaction, Role of substrate, Stereochemistry, Steric hindrance and solvent in SN2 reaction, Mechanism and kinetics of SN1 reaction, Role of substrate, Stereochemistry, Steric hindrance and solvent in SN1 reaction, Comparative study of SN1 and SN2 reactions, Some biologically important substitution reactions.		John McMurry, *Organic Chemistry* 5th Ed
2.	**Electrophilic Aromatic Substitution**	**8**	
	Introduction, Effect of substituent groups, Determination of orientation, Determination of relative reactivity, Classification of substituent group, Orientation of disubstituted benzene, Mechanism of nitration and sulfonation.		John McMurry, *Organic Chemistry*
3.	**Nucleophilic Acyl Substitution Reaction**	**8**	
	Introduction to carboxylic acid derivatives and nitriles, Nucleophilic acyl substitution reactions, Nucleophilic acyl substitution reactions of carboxylic acid, Chemistry of acid halides, acid anhydrides, esters, amides, nitriles, thiol ester, Biological carboxylic acid derivatives		John McMurry, *Organic Chemistry*
4.	**Elimination Reaction**	**8**	
	Definition and types of elimination reaction, Zaitsev's rule, Kinetics and mechanism E2 reaction, Elimination reaction and cylohexane conformation, Kinetics and mechanism E1 reaction, Comparative study of E2 and E1, Elimination vs. substitution, Dehydration of alcohol		John McMurry, *Organic Chemistry*
5.	**Addition Reaction**	**5**	
	Addition of halogen to alkene, Halohydrin formation, Additon of water to alkenes		John McMurry, *Organic Chemistry*

	(oxumercuration, hydroboration), Addition of carbene to alkene, Hydrogenation		
6.	**Nucleophilic Addition Reaction**	**6**	
	Aldehydes and ketones, Nucleophilic addition reaction of aldehydes and ketones, Relative reactivity of aldehyde and ketone, Nucleophilic addition of water, HCN, Grignard reagent, amines, hydrazine, alcohols, phosphorus ylide		John McMurry, *Organic Chemistry*

Reference Books:

1. John McMurry, *Organic Chemistry* (5th Ed.) 2000, Brooks/Cole Publishing Company (Asian Books Pvt. Ltd.), Pacific Grove.
2. Robert Thornton Morrison and Robert Neilson Boyd, *Organic Chemistry* (6th Ed.) 1999, Prentice-Hall of India Pvt. Ltd., New Delhi.
3. Jerry March, *Advanced Organic Chemistry* (4th Ed.) 2000, John Wiley and Sons, New York.
4. Ernest L. Eliel, *Stereochemistry of Carbon Compounds*, 1998, Tata-McGraw-Hill Pub. Co. Ltd, New Delhi.

PHG 282 (Credit hours 3)

Pharmacognosy III
(Natural Products Chemistry)
B. Pharm., Second Year, Fourth Semester

Course Objectives:
This course is designed to understand general principles of chromatographic methods used for the separation and isolation of organic compounds obtained from natural and synthetic sources.

Unit	Course Description	Hours
1.	**Drugs and Natural products**	**3**
	An outline on discovery of some important drugs from natural products, History of natural products chemistry, Bioactivity screening of organic natural products	
2.	**Extraction, Isolation and Purification**	**8**
	General techniques of extraction, separation, and purification. Column chromatography, Thin-layer chromatography (TLC), Paper chromatography, Ion-exchange chromatography, Gas chromatography, Gel Chromatography, Droplet counter current chromatography, High performance liquid chromatography (HPLC), Electrophoresis, High performance capillary electrophoresis (HPCE)	
3.	**Structure Determination**	**5**
	Use of spectroscopic technique to elucidate the structure of natural products	
4.	**Biosynthesis**	**4**
	An outline of biosynthesis of natural products: Sugar, Isoprenoids, Polyketides, Phenylpropanoids, Amino acids, Polypeptides, Alkaloids, Concept of chemotaxonomy	
5.	**Fatty acids and Related Compounds**	**5**
	Aracidonic acid cascades, Prostaglandins, Thromboxan and postacyclin, Leukotriene and hydroperoxyeicosatetreenoic acid, ecosapentanoic acid	
6.	**Terpenoids**	**7**
	Introduction, Classification, General method of determining structure, Monotepenes, Sesquiterpene, Diterpenes, Sestertepene, Triterpenes	
7.	**Carotenoids**	**5**
	Introduction, Carotenes, β-Carotenes, α-Carotenes, Lycopenes, γ-Carotenes, Vitamin A, Xanthophyllus, Biosynthesis of carotenoids	
8.	**Steroids**	
	Introduction, Sterols, Cholesterol, Spectral properties of steroids, Stereochemistry of steroids, Ergosterol, Vitamin D, Stigmasterol, Biosynthesis of sterol, Bile acids, Steroid hormones, Homosteroids and Norsteroids, Adrenocortical horomines, Steriodal glycosides and alkaloids	

Reference Books:
1. Mitsubashi et al (Ed) *Integrated Essential Natural Product Chemistry* (3rd Ed.) 1999, Minami Publishing House, Tokyo (Japanese).

2. I. L. Finar: *Organic Chemistry Volume 2: Stereochemistry and Chemistry of Natural Products* (5th Ed.) 2000, Longman Scientific and Technical (Pearson Education Asia), New Delhi.
3. Gurdeep R. Chatwal: *The Chemistry of Organic Natural Products* Vol I and II, 1983, Himalaya Publishing House, Bombay.
4. Paul M. Dewick: *Medicinal Natural Products, A Biosynthetic Approach* (2nd Ed.) 2002, J. Wiley and Sons,Chichester.

LAB-8 (Credit hour 1)

Pharmaceutical Laboratory-8

B. Pharm., Second Year, Fourth Semester

Course Objectives: *The students will become familiar with the basic principles of manufacturing of drug dosage forms and formulations (B)*

Course Contents:

1. Ointments and creams
2. Pastes and lotions
3. Accelerated stability testing
4. Ophthalmic preparations
5. Nasal preparations
6. Otic preparations
7. Suppositories and vagitories

LAB-9 (Credit hour 1)

Pharmaceutical Laboratory-9

B. Pharm., Second Year, Fourth Semester

Course Objectives: *Student will learn simple preparation and Pharmacopoeal standards of some pharmaceutical products.*

Course Contents:

1. Preparation of some pharmaceutical compounds as mentioned in Japanese Pharmacopoeia and Indian
Pharmacopoeia (at least five samples)
2. Assay of Pharmaceutical compounds as mentioned in relevant Pharmacopoeia (at least 5 sample)

Reference Books:

1. Japanese Pharmacopoeia XIII
2. Indian Pharmacopoeia (1996)

LAB-10 (Credit hour 1)

Pharmaceutical Laboratory-10

B. Pharm., Second Year, Fourth Semester

Course Objectives: *Student will take part in field trip and prepare 20 herbaria and collect 10 crude drugs from the field.*

Course Contents:

1. Preparation of herbarium (at least 20 sample each) and crude drug (at least 10 sample each) in the field and identify and preserve in the laboratory. Prepare one report on collection and identification.