

## Framework for the Third Year B. Pharm. (Credit Based System)

### Syllabus Framework

No	Semester- V Subject	Credits	Contact hrs/week	Weightage		Marks
				Continuous internal assessment	End Semester Examination	
1	Organic Chemistry - III	4	4	30	70	100
2	Cosmeticology	3	3	30	70	100
3	Pharmaceutical Biotechnology	4	4	30	70	100
4	Pharmacology-II	4	4	30	70	100
5	Pharmaceutical Management	3	3	30	70	100
<b>Total</b>		<b>18</b>	<b>18</b>	<b>150</b>	<b>350</b>	<b>500</b>
<b>Practicals</b>						
6	Organic Chemistry Lab - II	2	4	15	35	50
7	Pharmaceutical Biotechnology Lab	2	4	15	35	50
8	Cosmeticology Lab	2	4	15	35	50
<b>Total</b>		<b>6</b>	<b>12</b>	<b>45</b>	<b>105</b>	<b>150</b>
<b>Total Teaching Hrs.</b>			<b>30</b>			
<b>Total Credits</b>		<b>24</b>				
<b>Total Marks</b>				<b>195</b>	<b>455</b>	<b>650</b>

<b>No.</b>		<b>Semester -VI</b>				
1	Pharmaceutical Chemistry-II	3	3	30	70	100
2	Pharmaceutical Analysis- II	3	3	30	70	100
3	Pharmaceutics -III	3	3	30	70	100
4	Pharmacognosy & Phytochemistry-I	4	4	30	70	100
5	Hospital Pharmacy and Drug Store Management	3	3	30	70	100
<b>Total</b>		<b>16</b>	<b>16</b>	<b>150</b>	<b>350</b>	<b>500</b>
<b>Practicals</b>						
6	Pharmaceutical Chemistry Lab - II	2	4	15	35	50
7	Pharmaceutical Analysis Lab - II	2	4	15	35	50
8	Pharmaceutics Lab - III	2	4	15	35	50
9	Pharmacognosy & Phytochemistry Lab - I	2	4	15	35	50
<b>Total</b>		<b>8</b>	<b>16</b>	<b>60</b>	<b>140</b>	<b>200</b>
<b>Total Teaching Hrs.</b>			<b>32</b>			
<b>Total Credits</b>		<b>24</b>				
<b>Total Marks</b>				<b>210</b>	<b>490</b>	<b>700</b>
<b>Credits Sem V plus Sem VI</b>		<b>48</b>				

### Scheme of Examination

No	Semester- V	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
			Duration (hrs)	Maximum marks	Minimum for passing	Duration (hrs)	Maximum marks	Continuous Evaluation		
<b>Subject - Theory</b>										
1	Organic Chemistry - III	1	3	70	28	1	15	15	100	40
2	Cosmeticology	1	3	70	28	1	15	15	100	40
3	Pharmaceutical Biotechnology	1	3	70	28	1	15	15	100	40
4	Pharmacology-II	1	3	70	28	1	15	15	100	40
5	Pharmaceutical Management	1	3	70	28	1	15	15	100	40
<b>Practicals</b>										
7	Organic Chemistry Lab - II	1	4	35	14	4	8	7	50	20
8	Pharmaceutical Biotechnology Lab	1	4	35	14	4	8	7	50	20
9	Cosmeticology Lab	1	4	35	14	4	8	7	50	20

No	Semester- VI	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
			Duration (hrs)	Maximum marks	Minimum for passing	Duration (hrs)	Maximum marks	Continuous Evaluation		
<b>Subject - Theory</b>										
1	Pharmaceutical Chemistry-II	1	3	70	28	1	15	15	100	40
2	Pharmaceutical Analysis- II	1	3	70	28	1	15	15	100	40
3	Pharmaceutics -III	1	3	70	28	1	15	15	100	40
4	Pharmacognosy & Phytochemistry-I	1	3	70	28	1	15	15	100	40
5	Hospital Pharmacy and Drug Store Management	1	3	70	28	1	15	15	100	40
<b>Practicals</b>										
6	Pharmaceutical Chemistry Lab - II	1	4	35	14	4	8	7	50	20
7	Pharmaceutical Analysis Lab - II	1	4	35	14	4	8	7	50	20
8	Pharmaceutics Lab - III	1	4	35	14	4	8	7	50	20
9	Pharmacognosy & Phytochemistry Lab - I	1	4	35	14	4	8	7	50	20

**Detailed Syllabus  
Semester V**

**Organic Chemistry – III**

**4 Hrs/week**

Unit	Topic	Hours
<b>1</b>	<b>Heterocyclic Chemistry</b>	<b>27</b>
1.1	Nomenclature of mono, bi- and tri-cyclic hetero-aromatic, fused heterocyclic ring and bridge head system of the drug molecules.	2
	Synthesis, properties and reaction of the following heterocycles	
1.2	<p>Furan :</p> <p>Synthetic methods including synthesis using carbohydrates, oxazoles, Diels-Alder Adduct, Paal-Knorr synthesis.</p> <p>Reactions with acids, bases, Electrophilic Aromatic Substitution (EAS), carbenes, nitrenes, oxidizing and reducing agents, Diels-Alder reaction.</p> <p>Pyrrole :</p> <p>Synthetic methods including synthesis using furan, ammonium mucate, primary amines, Knorr synthesis, Paal-Knorr synthesis, Hantzsch synthesis, Piloty-Robinson synthesis.</p> <p>Reactions with acids, bases, alkylation, Electrophilic Aromatic Substitution (EAS), carbenes, nitrenes, oxidizing and reducing agents, Diels-Alder reaction.</p> <p>Thiophene :</p> <p>Synthetic methods including synthesis using Na- succinate, Ring closure, Paal-Knorr synthesis and Hinsberg synthesis.</p> <p>Reactions with acids, Electrophilic Aromatic Substitution (EAS), carbenes, nitrenes, nucleophiles, Free Radicals, aldehydes and ketones, oxidizing and reducing agents, Diels-Alder reaction.</p>	9
1.3	<p>Imidazole:</p> <p>Synthetic methods including synthesis from imidazolines, <math>\alpha</math>-haloketones, Radiszewskii reaction.</p> <p>Reactions with acids, Electrophilic Aromatic Substitution (EAS), nucleophiles, oxidizing and reducing agents, imidazoles as catalysts in ester hydrolysis.</p> <p>Pyridine :</p> <p>Synthetic methods including synthesis using 1,5-diketones, cyclic diketones, other ring systems, Hantzsch synthesis.</p> <p>Reactions with acids, Electrophilic Aromatic Substitution (EAS), alkyl and aryl halides, nucleophilic substitution, Hetaryne formation, oxidizing and reducing agents, Diels-Alder reaction, ring opening.</p> <p>Pyrimidine :</p> <p>Synthesis using malonic ester; 2,4-dichloropyridine, amidine and maleic acid</p> <p><b>Reactions</b> with acids, Electrophilic Aromatic Substitution (EAS), nucleophiles, hydrazines, oxidizing and reducing agents.</p>	9
1.4	<p>Quinoline :</p> <p>Synthetic methods including Skraup synthesis, Doebner-Miller synthesis, Friedlander synthesis, Pfitzinger synthesis, Pictet synthesis, Conrad-Limpach synthesis.</p> <p>Reactions with acids, Electrophilic Aromatic Substitution (EAS), nucleophiles, oxidizing and reducing agents, reaction with S and Hg.</p> <p>Isoquinoline :</p> <p>Synthetic methods including Bischler-Napieralski, Pictet-Gams, Pomeranz-Fritsch, Pictet-Spengler syntheses.</p> <p>Reactions including EAS, nucleophiles, oxidizing and reducing agents.</p> <p>Indole :</p> <p>Synthesis by Fischer indole synthesis, Mandelung synthesis, Reissert synthesis and Bischler synthesis.</p> <p>Reactions with acids, EAS, Metallic K, Mannich reaction, oxidizing and reducing agents.</p>	7
<b>2</b>	<b>Pericyclic Reactions</b>	<b>10</b>
2.1	HOMO and LUMO of pi systems, molecular orbitals and pericyclic reactions, concerted and pericyclic reactions.	

2.2	Electrocyclic reactions and stereochemistry, Woodward Hoffmann rule [ $4n$ and $4n+2$ ] (conrotatory and disrotatory), Diel's Alder, Retro Diel's Alder.	
2.3	Cycloaddition: $2\pi+2\pi$ and $4\pi+2\pi$ .	
2.4	Sigmatropic rearrangement: 1,5 rearrangement, 3,3-rearrangements (Cope and Claisen).	
<b>3</b>	<b>Synthon Approach:</b>	<b>6</b>
3.1	Definition of retrosynthesis or disconnection approach, synthon, synthetic equivalent, functional group interconversion, functional group addition, functional group removal.	
3.2	Strategies for disconnection approach.	
3.3	Disconnection of simple alcohols, alkyl halide, ethers, olefins, esters, carboxylic acids, aryl ketones, heterocyclics ring.	
3.4	Design of retrosynthesis of drugs: Paracetamol, benzocaine, sulfadiazines, atenolol, ibuprofen.	
<b>4</b>	<b>Chemistry of Steroids</b>	<b>7</b>
4.1	Definition of steroids and sterols, numbering and ring letters, orientation of projection formulae, stereochemistry of ring junction and side chain attachments, stereochemistry of substituents in the side chain.	
4.2	Types of steroid hormones: androgens, estrogens, progestins, corticosteroids. Structure and synthesis of steroids, squalene, cholesterol, pregnenolone. Conformation and chemical reactivity, steroid specific reactions of A and B rings, Addition-elimination, epoxide opening, relative rates of esterification, oxidation of epimeric alcohols, reduction of ketones.	
<b>5</b>	<b>Application of Catalysis in Organic Chemistry</b>	<b>10</b>
5.1	Role of catalysis and its development -Classical and non-classical organic synthesis with examples like hydroquinone, amino acid ester synthesis.	
5.2	Catalysis by solid acid-base and its application in Friedal Craft reaction, Beckmann rearrangement, H-USY as solid acid catalyst and hydrocalcite base catalyst, application of base catalyst in condensation reactions. Catalytic hydrogenation and application in chemoselective synthesis of saquinavir intermediate, zeolite based MPV reduction. Catalytic oxidation by stable free radical and application in progesterone synthesis, application in sigmatropic reaction e.g. citral, catalytic oxidation with $H_2O_2$ under phase transfer catalysis. Catalytic C-C bond formation and its application in lozabemide, naproxen and in synthesis of biaryl compounds by Suzuki, Negishi, Kumada coupling. Biocatalysis and its significance, applications in 6-APA, aspartame, heteroaromatic oxidation mediated by yeast, vitamin B-6. Enantioselective catalysis and application in menthol synthesis.	
5.3	Application of catalysis in sustainable technology: Concept of E-factor and atom efficiency	
	Total	<b>60</b>

Latest editions of following books to be adopted.

1. I. L. Finar: Organic chemistry- Volumes 1 and 2, Pearson Education, Ed:5
2. Morrison and Boyd, Organic chemistry, Prentice Hall.
3. Clayden and Greeves, Organic chemistry, Oxford University Press.
4. S. H. Pine et al, Organic chemistry, McGraw-Hill Science/Engineering/Math.
5. S. Warren, Designing organic synthesis, and the disconnection approach, Wiley India Pvt. Ltd.
6. Corey and Chelg, The logic of chemical synthesis, JOHN WILEY & SONS, New York.
7. R. P. Iyer and A. Prabhu, Synthesis of drugs : A synthon approach.
8. D. Lednicer: Steroid chemistry at a glance, Wiley.
9. I. Arends, R. Sheldon, U. Hanefeld, Green chemistry and catalysis, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheimpp 1-48.
10. J.G. Vries, A.H M. Vries, Innovations in pharmaceutical technology, Chemical Technology.
11. C. A. Busacca, D. R. Fandrick, J. J. Song, and C. H. Senanayakea, Adv. Synth. Catal. 2011, 353, 1825 – 1864 " The growing impact of catalysis in the pharmaceutical industry-Review"



## Cosmeticology

3 Hrs/week

Unit	Topic	Hours
<b>1.</b>	<b>General Aspects in Cosmeticology</b>	<b>11</b>
1.1	Definition of cosmetics, historical background, classification. Structure of skin, hair, nails, teeth ( <b>self study</b> ). Regulatory aspects- Schedules to Drug and Cosmetics Rules - M II, S, Q.	1 1 1
1.2	Raw materials including colours, perfumes, antioxidants, preservatives and water, herbal products ( <b>self study</b> ).	3 2
1.3	Microbiological aspects of cosmetics.	1
1.4	Toxicology of cosmetics-irritation and sensitization reactions to cosmetics, sensitivity testing and safety aspects.	2
<b>2.</b>	<b>Skin care products - raw materials, formulation, large scale manufacturing and quality control (including BIS) and functional evaluation.</b>	<b>7</b>
2.1	Skin creams and lotions - Cleansing, cold, vanishing, moisturizing, hand and body products, face packs.	3
2.2	Sunscreen, suntan and anti-sunburn preparations.	2
2.3	Protective preparations-Barrier products, anti-acne, anti-wrinkle, bleach products.	2
<b>3.</b>	<b>Colored cosmetics products- raw materials, formulation, large scale manufacturing and quality control (including BIS).</b>	<b>8</b>
3.1	Foundation, face powders. Rouge ( <b>self study</b> ).	1 1
3.2	Eye makeup products.	1
3.3	Lipsticks.	2
3.4	Nail speciality products-cuticle softener, nail bleach, nail strengthener, nail whites.	1
3.5	Nail lacquer.	2
<b>4.</b>	<b>Hair care products -raw materials, formulation, large scale manufacturing and quality control (including BIS) and functional evaluation.</b>	<b>7</b>
4.1	Shampoos (including antidandruff and antilice)	2
4.2	Hair grooming, hair waving, hair straighteners and conditioners.	2
4.3	Hair colorants.	2
4.4	Depilatories.	1
<b>5.</b>	<b>Shaving preparations raw materials, formulation, large scale manufacturing and quality control (including BIS) and functional evaluation.</b>	<b>4</b>
5.1	Wet shaving preparations-foaming and brushless.	3
5.2	Dry shaving preparations and after shave products.	1
<b>6.</b>	<b>Oral and personal hygiene products - raw materials, formulation, large scale manufacturing and quality control (including BIS) and functional evaluation.</b>	<b>8</b>
6.1	Toothpaste, medicated toothpaste. Toothpowder ( <b>self study</b> ).	2 1
6.2	<b>Self study.</b> Mouthwashes and denture cleansers. Bath products-shower gels, body washes, bubble washes, bath salts.	3
6.3	<b>Self study.</b> Antiperspirants and deodorants, insect repellants. Baby toiletries - Oils, creams & lotions, shampoos, powders.	2
	<b>Total</b>	<b>45</b>

Latest editions of following books to be adopted

1. Harry's Cosmeticology Edited by J. B. Wilkinson and R. J. Moore, Longman Scientific & Technical Publishers
2. Cosmetics Science and Technology, Edited by M. S. Balsam, E. Sagarin, S. D. Gerhon, S. J. Strianse and M. M. Rieger, Volumes 1,2 and 3.Wiley-Interscience, Wiley India Pvt. Ltd.



3. Poucher's Perfumes, cosmetics & Soaps, Editor- Hilda Butler, Kluwer Academic Publishers, Netherlands
4. Cosmetic Technology, Ed. By S. Nanda, A. Nanda and R. Khar, Birla Publications Pvt. Ltd., New Delhi
5. Handbook of Cosmetic Science and Technology, edited by M. Paye, A. O.Barel, H. I. Maibach, Informa Healthcare USA, Inc.
6. Encyclopedia of Pharmaceutical Technology, Vol. 6, Eds. James Swarbrick, James C. Boylan, Marcel Dekker Inc.
7. BIS Guidelines for different cosmetic products.

**Pharmaceutical Biotechnology**

**4 Hrs/week**

<b>Unit</b>	<b>Topic</b>	<b>Hours</b>
<b>1</b>	<b>Introduction to Biotechnology</b>	<b>4</b>
<b>1.1</b>	Definitions, scope, relevance to Pharma Industry. Microbiological limit tests – Need, standards for raw materials of natural origin (Pharmacopoeial with some examples)	2
<b>1.2</b>	Microbiological assays - Diffusion bioassays, turbidometry, end point assays. Self study : Historical perspectives.	2
<b>2</b>	<b>Fermentation Technology</b>	<b>7</b>
<b>2.1</b>	Example of products of fermentation (microbial, animal and plant), types of fermenters (mechanically stirred, air-lift, tray), design of fermenter, factors affecting fermentation (inoculum preparation, temperature, pH, media composition, aeration, agitation, antifoam agents, strain optimization, growth kinetics) and down stream process.	4
<b>2.2</b>	Production of penicillin, single cell protein. Self study : Production of dextran, tetracycline, amylase.	3
<b>3</b>	<b>Recombinant DNA technology</b>	<b>11</b>
<b>3.1</b>	Steps involved in rDNA technology, enzymes involved in DNA technology with reference to restriction endonucleases and ligase, vectors (Plasmid, Cosmid, YAC), Gene expression/Host- (Bacterial expression system, yeast expression system, animal expression system, plant expression system)	8
<b>3.2</b>	Application of rDNA technology for production of pharmaceutical products e.g. Insulin. Self study : Production of human growth hormone, interferon. Preparation of a list of approved biotech derived products.	3
<b>4</b>	<b>Techniques used in molecular biology</b>	<b>9</b>
<b>4.1</b>	Introduction to polymerase chain reaction, DNA sequencing (Sanger, Maxam and Gilbert), RFLP, DNA fingerprinting, cDNA library, gene library, Southern blotting technique, Northern blotting, Western blotting, introduction to gene therapy, transgenic animal and transgenic plants.	8
<b>4.2</b>	Self study: SDS- PAGE.	1
<b>5</b>	<b>Enzyme and cell immobilization.</b>	<b>6</b>
<b>5.1</b>	Methods for enzyme immobilization (adsorption, covalent binding, entrapment, microencapsulation) with examples and applications. Introduction to biosensor and applications e.g. glucose oxidase, penicillinase.	5
<b>6</b>	<b>Immunology</b>	<b>15</b>
<b>6.1</b>	a) Host-microbe interactions, Introduction to terms-infection, infestation, pathogen, resistance, susceptibility etc. b) Factors affecting pathogenicity and infection, c) Innate defense mechanism – first line of body defense, physiological phenomena-inflammatory response, fever, cellular, mediators; soluble (humoral) mediators, phagocytosis. d) Specific defense Mechanism – Characteristics, Antigen, Cell-mediated immunity, humoral immunity. e) Antibody structure and types, pathways of immune response, clonal selection theory. Self study: organization of immune system-organs & cells involved.	8
<b>6.2</b>	<b>Serology</b> -Precipitation , agglutination, complement fixation tests, immunofluorescence, RIA, ELISA. Introduction to Hypersensitivity & Allergy.	2
<b>6.3</b>	Immunodeficiency states- Primary & acquired, autoimmunity. Hybridoma technology – Production and application of monoclonal antibodies.	5

<b>7</b>	<b>Vaccines &amp; Sera-</b> Definitions and classification, outline of general method of preparation of bacterial & viral vaccines, typical examples of each type (diphtheria, TAB, polio), antisera (anti-tetanus sera) Q. C. aspects, recent trends in vaccines (recombinant vaccines) Self study: Outline of general method of preparation of BCG and rabies vaccine	<b>4</b> 2 2
<b>8</b>	<b>Cell culture (plant and animal)</b> Tissue culture media, primary cell culture, continuous cell culture, pharmaceutical applications of animal cell culture. Stem cell culture, cryopreservation/stem cell bank Self study: Media and media composition (typical) for plant and animal cell culture, names of commonly used animal cell lines, their tissue origin and typical applications.	<b>4</b> 2 2
	Total	<b>60</b>

Latest editions of the following books to be adopted.

1. R. C. Dubey , A textbook of biotechnology
2. B. D. Singh, Biotechnology.
3. S. P. Vyas and Dixit, Pharmaceutical Biotechnology, CBS publisher & distributors.
4. S. S. Kori , Pharmaceutical Biotechnology.
5. H. D. Kumar, Biotechnology, Affiliate East-West press Pvt. Ltd New Delhi.
6. Ananthnarayan, A textbook of microbiology, Orient Longman Pvt. Ltd.
7. W. B. Hugo and A. D. Russell, Pharmaceutical Microbiology, Blackwell Science.
8. David, Nelson, Lehninger - Principle of Biochemistry, W. H. Freeman & Co.
9. Pelezar, Chan & Krieg, Microbiology-Concepts and Applications, International Edn., McGraw Hill, Inc.,
10. Weir Stewart: Immunology, Churchill Livingstone.
11. Chandrakant Kakote, Pharmaceutical Biotechnology.
12. Desmond S.T. Nicholl, An introduction to genetic engineering, Panima Publishing Corporation, New Delhi.

**Pharmacology – II**

**4 Hrs/week**

<b>Unit</b>	<b>Topic</b>	<b>Hours</b>
<b>1</b>	<b>Chemotherapy</b>	<b>30</b>
1.1	Introduction to chemotherapy including drug resistance.	2
1.2	Sulfonamides, trimethoprim, fluoroquinolones, nitrofurantoin.	3
1.3	Penicillins, cephalosporins and cephamycins.	3
1.4	Tetracyclines, chloramphenicol, macrolides, clindamycin, linezolid, streptogramins and fusidic acid.	3
1.5	Aminoglycosides and spectinomycin.	2
1.6	Antifungal agents.	2
1.7	Antiviral agents including anti-HIV agents.	2
1.8	Chemotherapy of tuberculosis, leprosy, and malaria.	3
1.9	Chemotherapy of amoebiasis.	1
1.10	Anthelmintic drugs.	1
1.11	Chemotherapy of neoplastic diseases (Anticancer drugs).	3
	SELF STUDY	
1.12	Rational use of antimicrobials.	3
1.13	General principles of chemotherapy of infection.	2
<b>2</b>	<b>Immunomodulators</b>	<b>9</b>
2.1	Immunology: Regulation of immune system, signalling pathways for its activation and inhibition.	1
2.2	Immunostimulants and immunosuppressants.	2
2.3	Immunomodulators in the treatment of HIV and Cancer.	2
	SELF STUDY	
2.4	Physiology of immune system.	4
<b>3</b>	<b>Drugs in Endocrine Disorders</b>	<b>11</b>
3.1	Thyroid and anti-thyroid drugs.	2
3.2	Insulin, antidiabetic agents including DPP-IV inhibitors.	3
3.3	Agents affecting bone mineral homeostasis.	1
3.4	Oxytocics.	1
3.5	Oral contraceptives.	1
	SELF STUDY	
3.6	Corticosteroids	3
<b>4</b>	<b>Drugs in Haematological Disorders</b>	<b>10</b>
4.1	Drugs used in anemia.	2
4.2	Coagulants and anti-coagulants.	3
4.3	Thrombolytics and anti-platelet agents.	2
	SELF STUDY	
4.4	Physiology of blood coagulation.	3
	Total	<b>60</b>

Latest editions of the following books to be adopted

1. Goodman & Gilman's Pharmacological Basis of Therapeutics, McGraw Hill Companies Inc.
2. Satoskar R.S. Bhandarkar S.D. & Rege N. N. Pharmacology & Therapeutics, Popular Prakashan.
3. Rang & Dale Pharmacology, Churchill Livingstone.
4. Lippincott's Illustrated Reviews: Pharmacology- Lippincott-Raven Howland & Nyeets Publishers NY.
5. Laurence D. R. & Bennett Clinical Pharmacology, Elsevier NY.

6. Kulkarni S. K. Handbook of Experimental Pharmacology, Vallabh Prakashan, New Delhi.
7. Katzung B. G. -Basic and Clinical Pharmacology, Appleton and Lange publications.
8. Ghosh M. N. Fundamentals of Experimental Pharmacology Hilton & Company, Kolkata.

**Pharmaceutical Management**

**3 Hrs/week**

<b>Unit</b>	<b>Topic</b>	<b>Hours</b>
<b>1</b>	<b>Understanding of health care industry</b>	<b>5</b>
1.1	Different components of health care industry/ What constitutes health care industry	1
1.2	Indian pharmaceutical industry (in today's scenario and its potential as your career option)	1
1.3	Details of therapy segment, major companies and major brands	1
1.4	Elements of pharmaceutical industry in order to understand its working uniqueness of medical products marketing-C&F agent, stockist & retailer/chemist.	1
1.5	Different working style of acute, chronic and OTC therapy segment	1
<b>2.</b>	<b>Financial Management</b>	<b>2</b>
2.1	Understanding basic concept of market share, growth, profitability	1
2.2	Basics of balance sheet and profit and loss account	1
<b>3</b>	<b>SWOT analysis</b>	<b>3</b>
3.1	Basic concept SWOT analysis.	1
3.2	Application of SWOT analysis considering any therapeutic class of a drug.	2
<b>4</b>	<b>Brand Plan</b>	<b>4</b>
4.1	Importance of brand plan.	1
4.2	Basic elements of a brand plan	3
<b>5</b>	<b>Identifying Market Segments and Targets (STP)</b>	<b>3</b>
5.1	Segmentation: Geographic, demographic, psychographic and behavioral Targeting: Effective segmentation criteria, evaluation and selection of market segment	1
5.2	Positioning: Understanding the importance of positioning based on indication with live examples from pharmaceutical industry	2
<b>6</b>	<b>Product Life Cycle (PLC)</b>	<b>4</b>
6.1	Importance of PLC	1
6.2	How to manage product at different stages of PLC	3
<b>7</b>	<b>4 P's of Marketing Mix (Product, Price, Promotion, Place)</b>	<b>3</b>
7.1	Product: Different types of pharmaceutical products (acute, chronic and OTC) Pricing: How to determine the pricing of products, determination of NRV (Net Retail Value) and MRP (Maximum Retail Price) Place: All India, Hospitals, Govt./ Corporate purchasers, ESIS schemes, NGOs. Promotion: direct distribution, direct home delivery, dispensing, scheme, etc.	2
7.2	Packaging: importance of packaging in pharmaceutical products, types of packing and its importance.	1
<b>8</b>	<b>Important Marketing models</b>	<b>4</b>
8.1	BCG matrix	2
8.2	Porter's 5 force model	2
<b>9</b>	<b>Soft skills and self development</b>	<b>2</b>
9.1	Human resource management: Leadership, motivation, delegation, conflict management and communication, time management, multitasking, planning and organizing and stress management	1
9.2	Skills to excel in interview: dress code, body language and handling difficult situations, dos and donts of resume making ( <b>Self Study</b> )	1
<b>10</b>	<b>Pharmaceutical quality and legal regulatory bodies</b>	<b>6</b>
10.1	DPCO- meaning and its role	1
10.2	Quality management: FDA regulations and approvals, WHO requirements,	1
10.3	General awareness of Global requirements of MHRA/ MCA/ TGA/ USFDA/ ISO up gradation/ Six sigma concept,	2
10.4	Clinical research, patent registration and IPR	2

<b>11</b>	<b>Case Studies</b>	<b>5</b>
<b>12</b>	<b>Presentations</b>	<b>4</b>
	<b>Total</b>	<b>45</b>

Latest editions of the following books to be adopted

1. Kotler, Loshy & Jha , Marketing Management.
2. Dr. Rajan Saxena, Marketing Management.
3. Adrian Palmer, Introduction to Marketing Management.
4. Prasanna Chandra, Financial Management.
5. M. Pandey, Financial Management.
6. K. Ashwathapa, Human Resource management.
7. Subba Rao, Personnel & Human Resource Management.
8. K. Ashwathapa, Production & Operations Management.
9. S. N. Chary, Production & Operations Management.
10. S. A. Chunawala, Production & Operations Management.
11. Ronald Ballon, Business Logistics/ Supply Chain Management.
12. Robert Hanfiels, Introduction to Supply Chain Management.

## Organic Chemistry Lab. – II

4 Hrs/week

- 1) Separation and quantification of binary mixtures by physical and chemical methods.  
Identification of one component and confirmation by preparation of a suitable derivative.  
Minimum eight binary mixtures, covering a wide variety of types to be studied
- 2) Theoretical aspects of recrystallization
- 3) Recrystallization of organic compounds: at least two with the use of different solvents.

Latest editions of the following books to be adopted

1. A laboratory hand book of organic qualitative analysis and separation, V.S. Kulkarni, S. P. Pathak, D. Ramchandra & Co., Pune.
2. Text book of organic practical chemistry, V.S. Kulkarni, S. P. Pathak, D. Ramchandra & Co., Pune.
3. R. L. Shriner, R. C. Fuson and D. Y. Curtin, The systematic Identification of Organic compounds, 6th Ed., Wiley, New York, 1980.
4. A. I. Vogel, A textbook of practical organic chemistry, 4th edition, Wiley New York, 1978.
5. Comprehensive Practical Organic Chemistry: Qualitative Analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India) Limited, 2000.
6. Comprehensive Practical Organic Chemistry: Preparation and Quantitative analysis, V.K. Ahluwalia, Renu Aggarwal, Universities Press (India) Limited, 2000.



**Pharmaceutical Biotechnology Lab.**

**4 Hrs/week**

1. Air microbiology by solid and liquid impingement methods.
2. Coliform count of water by MPN technique.
3. Test for sterility as per IP (Injection water/ nonabsorbent cotton/soluble powder/ear drops).
4. Microbial limit test on excipients as per I.P. – Hard gelatin, tragacanth, starch, lactose
5. Studies on selective media: McConkey Agar, Cetrimide Agar, Vogel Johnson, Salt mannitol agar.
6. Antibiotic sensitivity test by disc method.
7. Widal's test tube agglutination method
8. Biochemical tests (Catalase, Oxidase, Urease, Nitratase, Protease, Amylase and IMVIC).
9. Antimicrobial assay of antibiotic, introduction to zone of inhibition and calculation.
10. Immobilization of enzymes/cells by calcium alginate/gelatin/agar.
11. Isolation of DNA.
12. Selection and isolation of bacteria by replica plating.
13. Determination of thermal death time and thermal death point.
14. Effect of Ultra-Violet exposure on growth of E coli.
15. Demonstration of electrophoresis either by PAGE or Agarose gel electrophoresis.

Latest editions of the following books to be adopted

1. Medical Laboratory Technology: A Procedure Manual for Routine Diagnostic Tests (Vols. I, II & III), Kanai L. Mukherjee (Chief Editor), Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. An Introduction to GENETIC ENGINEERING, 2<sup>nd</sup> Edition, Desmond S. T. Nicholl, Cambridge University Press.
3. Biotechnology: A Textbook of Industrial Microbiology, 2<sup>nd</sup> Edition, Wulf Crueger & Anneliese Crueger, Panima Publishing Corporation, New Delhi/Bangalore.

Formulation and evaluation of the following cosmetic products:

1. Cleansing milk/lotion
2. Cold cream
3. Vanishing cream
4. Sunscreen cream
5. Foundation makeup
6. Moisturizing Lotion
7. Anti-acne cream
8. Anti-wrinkle cream
9. Clear liquid shampoo
10. Eye shadow
11. Nail lacquer
12. Lipstick
13. Toothpaste/medicated toothpaste
14. Mouthwash
15. Lather shaving cream
16. Brushless shaving cream
17. Aftershave lotion
18. Face powder
19. Facepack

Latest editions of the following books to be adopted

1. Harry's Cosmeticology Edited by J.B. Wilkinson and R. J. Moore, Longman Scientific & Technical Publishers
2. Cosmetics Science and Technology, Edited by M.S. Balsam, E. Sagarin, S. D. Gerhon, S. J. Strianse and M. M. Rieger, Volumes 1,2 and 3.Wiley-Interscience, Wiley India Pvt. Ltd.
3. Poucher's Perfumes, cosmetics & Soaps, Editor- Hilda Butler, Kluwer Academic Publishers, Netherlands
4. Cosmetic Technology, Ed. By S. Nanda, A. Nanda and R. Khar, Birla Publications Pvt. Ltd., New Delhi
5. Handbook of Cosmetic Science and Technology, edited by M. Paye, A. O. Barel, H. I. Maibach, Informa Healthcare USA, Inc.
6. Encyclopedia of Pharmaceutical Technology, Vol. 6, Eds. James Swarbrick, James C. Boylan, Marcel Dekker Inc.
7. BIS Guidelines for different cosmetic products.

**Semester –VI**  
**Pharmaceutical Chemistry – II**

**3 Hrs/week**

Unit	Topic	Hours
<b>1</b>	<b>Pharmacodynamics</b>	<b>5</b>
1.1	Drug targets at molecular level – Cell Structure. Lipids, carbohydrates, proteins and nucleic Acids as drug targets.	2
1.2	Intermolecular bonding forces like electrostatic, hydrogen bonding, van der Waal's interactions, dipole-dipole and ion-dipole interactions and hydrophobic interactions.	3
<b>2</b>	<b>Proteins as Drug Targets</b>	<b>9</b>
2.1	Primary, secondary, tertiary and quaternary structure of proteins and post translational modifications (Self Study).	1
2.2	Proteins as drug targets / Drugs. Monoclonal antibodies, peptides. Introduction to proteomics.	2
2.3	Enzymes as Drug targets	
2.3.1	Enzyme Inhibitors – Reversible and irreversible (Self Study).	1
2.3.2	Enzyme Inhibitors against microorganisms, viruses, body's own enzymes.	1
2.4	Receptors as Drug Targets.	
2.4.1	Types of receptors and signal transduction - Ion Channels, G-protein coupled receptor (GPCR), Kinases, nuclear receptors.	3
2.4.2	Concept of agonist, antagonist, partial agonist, inverse agonist, concept of desensitization/sensitization, tolerance, affinity, efficacy, potency (Self Study).	1
<b>3</b>	<b>Nucleic Acids as Drug target</b>	<b>8</b>
3.1	Primary, secondary and tertiary structure of DNA (Self Study)	1
3.2	DNA intercalation, DNA alkylation, antisense therapy	1
4	Pharmacokinetics and Physicochemical Properties of Drug Action	
4.1	Solubility, partition coefficient, acidity-basicity, pK <sub>a</sub> , bioisosterism, stereochemistry (geometrical, optical and conformational), Protein Binding	2
4.2	Drug metabolism – Phase I and Phase II Reactions	4
<b>5</b>	<b>Tools of the Trade (Structure Activity Relationship – SAR)</b> <b>Introduction to the concepts of SAR –A Case Study</b>	<b>1</b>
<b>Discussion on the following classes of drugs including enzyme/receptor structure, classification, chemical nomenclature, structure including stereochemistry, generic names, chemistry, SAR, metabolism, molecular mechanism of action, introduction to rational development, drug resistance, if any, of following classes of drugs</b>		
<b>6</b>	<b>Antiinfective Agents</b>	<b>10</b>
6.1	Antibiotics Penicillins (natural and semisynthetic penicillins like Penicillin G, Penicillin V, ampicillin*, amoxicillin, cloxacillin*, oxacillin, nafcillin, methicillin and ampicillin prodrugs like bacampicillin and hetacillin). □-lactamase inhibitors like clavulanic acid, (self study – tazobactam). Cephalosporins (cephalexin, cefadroxil, cefazolin, cefamandole, cefoxitin, cefuroxime, cefotaxime, ceftriaxone, cefpodoximeproxetil) Tetracyclines (tetracycline, chlortetracycline, oxytetracycline, doxycycline, and minocycline and its prodrug – rolitetracycline); Macrolides, (erythromycin, roxithromycin, azithromycin - only highlights of structure to be discussed). Aminoglycosides (gentamicins, and neomycins, - only highlights of structure to be discussed) Carbapenems (Emepenem, meropenem). Monobactams (Aztreonam, Tigemonam). Chloramphenicol, Linezolid. Only highlights of structures of Vancomycin, Bacitracin, Polymyxin B.	7
6.2	Sulfonamides (Self study) Short, intermediate and long acting sulfonamides, sulfonamides for ophthalmic infections,	1

	ulcerative colitis and for reduction of bowel flora. Sulfamethoxazole, sulfadiazine*, sulisoxazole, sulfacetamide, sulfasalazine.	
6.3	Fluoroquinolones Norfloxacin, ciprofloxacin*, sparfloxacin, gatifloxacin, levofloxacin, lomefloxacin.	2
<b>7</b>	<b>Antiparasitic Agents</b>	<b>6</b>
7.1	Antimalarial Agents Natural products like cinchona alkaloids (with stereochemistry and drug action) and artemisinin and its derivatives like artether, artemether and artesunate, synthetic antimalarials such as 8- aminoquinolines e.g. primaquine*, 4- aminoquinilines e.g. chloroquine*, Quinolinemethanols e.g. mefloquine; misc like halofantrine, lumefantrine and; DHFR inhibitors like pyrimethamine* and proguanil, cycloguanil, atovaquone, sulfadoxine Combination therapy.	3
7.2	Drugs for treatment of amoebiasis, giardiasis and trichomoniasis (Self Study). Metronidazole*, tinidazole, secnidazole, diloxanide furoate*, nitazoxanide.	1
7.3	Anthelmintics Albendazole, mebendazole*, thiabendazole, diethylcarbamazine, ivermectin, praziquantel, pyrantel pamoate	1
7.4	Drugs for the treatment of pneumocystis, trypanosomiasis, leishmaniasis(Self Study) Atovaquone, pentamidine, co-trimoxazole, trimetrexate, benznidazole, eflornithine, melarsoprol, suramin, nifurtimox, sodium stibogluconate, miltefosine)	1
8	Antimycobacterial Agents Antitubercular drugs - PAS*, ethionamide, isoniazid, pyrazinamide, ethambutol*, antitubercular antibiotics (streptomycin, rifampin, rifapentine, capreomycin, cycloserine – the first four only highlights of structure to be discussed), fluoroquinolones, bedaquiline. Antileprotic drugs.- Dapsone*, clofazimine, rifampin. Combination therapy	3
9	Antifungal Agents Natural products like griseofulvin , amphotericin B and nystatin (later two only general aspects of structure related to activity). Antifungal azoles like clotrimazole*, miconazole, ketoconazole, fluconazole, and itraconazole. Allyl amines like naftifine, butenafine and terbinafine. Flucytosine and tolnaflate.	3
	Total	<b>45</b>

**\*Synthesis to be taught**

Latest editions of the following books to be adopted.

1. Graham L. Patrick, An Introduction to Medicinal Chemistry, Oxford University Press.
2. Gareth Thomas, Fundamentals of Medicinal Chemistry, Wiley, New York.
3. Richard B. Silverman, The Organic Chemistry of Drug Design and Drug Action, Academic Press.
4. Thomas L. Lemke, David A Williams, Foye's Principles of Medicinal Chemistry, Lippincott Williams & Wilkins.
5. John M. Beale, John H. Block, Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams & Wilkins.
6. Ashutosh Kar, Medicinal Chemistry, New Age International Publishers.
7. Alex Gringauz, Introduction to Medicinal Chemistry, Wiley.
8. Daniel Lednicer, Lester A. Mitscher, The Organic Chemistry of Drug Synthesis, John Wiley and Sons.
9. H. J. Roth & A. Kleemann, Pharmaceutical Chemistry, Volume 1, Organic Synthesis, Ellis Horwood Series in Pharmaceutical Technology, Halsted Series.
10. Ruben Vardanyan and Victor Hruby, Synthesis of Essential Drugs, Elsevier.
11. Kleemann & Engel, Pharmaceutical Substances: Syntheses, Patents, Applications, Thieme Publications.

## Pharmaceutical Analysis – II

3 Hrs/week

Unit	TOPIC	Hours
<b>1</b>	<b>Basis of spectrophotometry</b>	<b>8</b>
1.1	<b>Terms-</b> <ul style="list-style-type: none"> <li>Electromagnetic radiation, Visible light and electromagnetic spectrum, wavelength, wave number, frequency, absorbance, transmittance (<i>Self study-0.5h</i>), singlet state, triplet state, fluorescence, phosphorescence and energy transitions.</li> <li>Atomic spectra, molecular spectra, atomic absorption spectroscopy, atomic emission spectroscopy, molecular absorption spectroscopy, molecular emission spectroscopy.</li> </ul>	2
1.2	Instrumentation for: UV-Vis, Fluorescence ( <i>Self study-1 hr</i> ), FTIR spectroscopy <ul style="list-style-type: none"> <li>Sources of electromagnetic radiation</li> <li>Monochromators (Filters, prisms, gratings)</li> <li>Sample cells</li> <li>Detectors</li> </ul>	4
1.3	<ul style="list-style-type: none"> <li>Colorimeter &amp; UV-Vis Spectrophotometers-Single beam and Double beam (including Block diagram &amp; ray diagram).</li> <li>Filter fluorimeter (including Block diagram) and Spectrofluorimeter.</li> <li>Interferometer in FTIR</li> </ul>	2
<b>2</b>	<b>Atomic absorption spectroscopy (AAS) and Flame emission spectroscopy (Flame photometry)</b>	<b>3</b>
2.1	<ul style="list-style-type: none"> <li>Principle, partial emission spectrum of sodium</li> <li>Difference between atomic absorption spectroscopy and flame emission spectroscopy, Advantages and disadvantages (<i>Self study-1 hr</i>)</li> <li>Instrumentation: Radiation sources (For AAS-Hollow cathode lamp, Electrode discharge lamps; For Flame photometry-Inductively coupled plasma source, Direct current plasma source); Flame atomization (types of flames, flame structure, flame atomizers).</li> </ul>	2
2.2	<ul style="list-style-type: none"> <li>Sample preparation</li> <li>Spectral Interferences and Chemical Interferences in AAS.</li> <li>Cationic, Anionic and Physical interferences in Flame photometry.</li> <li>Pharmaceutical applications.</li> </ul>	1
<b>3</b>	<b>UV-Visible spectroscopy</b>	<b>7</b>
3.1	<b>Terms-</b> chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromism, hypochromism, wavelength maxima, specific absorbance, molar absorptivity, cut-off wavelength for solvents.	1
3.2	<ul style="list-style-type: none"> <li>General concepts-Types of absorbing electrons, electronic transitions,</li> <li>Beer-Lambert's law-statement, derivation of mathematical expression, limitations.</li> <li>Choice of solvents (<i>Self study-0.5 h</i>)</li> <li>Chemical derivatization.</li> </ul>	2
3.3	<ul style="list-style-type: none"> <li>Application of Beer's law in quantitative spectrophotometric assays-Single component assays-use of a standard absorptivity value <ul style="list-style-type: none"> <li>-use of a calibration graph</li> <li>-single and double point standardization</li> </ul> </li> <li>Measurement of Equilibria constant.</li> <li>Measurement of rate constant.</li> </ul>	2
3.4	Numericals based on Beer-Lambert's law.	2
<b>4</b>	<b>Fluorescence spectroscopy</b>	<b>3</b>
4.1	Origin of fluorescence and phosphorescence spectra, Fundamental equation for fluorescence intensity, factors affecting fluorescence intensity (intensity of radiation source, quantum yield, molecular structure and rigidity, temperature, solvents, pH, dissolved oxygen, quenchers & concentration).	2

4.2	Chemical derivatization of non-fluorescent compound to fluorescent compound (e.g: use of Dansyl chloride, Fluoresamine, o-phthalaldehyde) ( <i>Self study-0.5 h</i> ), Choice of fluorimetry over UV-Vis spectroscopy with respect to Sensitivity and Specificity. Pharmaceutical Applications ( <i>Self study-0.5 h</i> )	1
<b>5</b>	<b>Infrared / Near IR spectroscopy</b>	<b>6</b>
5.1	I.R. regions, requirements for I.R. absorption, vibrational and rotational transitions, dipole changes, types of molecular vibrations, potential energy diagrams (harmonic oscillator and anharmonic oscillator), Vibrational frequency, factors influencing vibrational frequencies, force constants, vibrational modes (normal mode, combination bands and overtone bands), Finger print region	2
5.2	<ul style="list-style-type: none"> <li>• Sample preparation for I.R spectroscopy-Solids (mulling, pelleting &amp; thin film deposition, and in solution form), Liquids (Neat and in solution form).</li> <li>• Sample handling: Attenuated Total Reflectance and Diffuse Reflectance.</li> <li>• Pharmaceutical applications of IR spectroscopy (including characteristic IR absorption frequencies of some common bond types such as hydroxyl stretch, nitrile stretch and carbonyl stretch of aldehydes and ketones, aliphatic and aromatic C-H stretch) (<i>Self study-1 hr</i>)</li> <li>• Pharmaceutical applications of Near IR spectroscopy including PAT (Process Analytical Techniques).</li> </ul>	4
<b>6</b>	<b>Raman Spectroscopy</b>	<b>3</b>
6.1	<ul style="list-style-type: none"> <li>• Principle of Raman scattering.</li> <li>• Comparison between I.R. Spectroscopy and Raman Spectroscopy (<i>Self study-0.5 h</i>)</li> <li>• Raman instrumentation-Sources of light, Sample illumination system (Liquid, solid and fibre optic sampling), Block diagram of Raman spectrometer.</li> <li>• Applications(<i>Self study- 0.5 h</i>)</li> </ul>	3
<b>7</b>	<b>Thermal methods of analysis</b>	<b>4</b>
7.1	<ul style="list-style-type: none"> <li>• Principle, instrumentation, working and applications of thermogravimetry(TG)</li> <li>• Factors affecting TG curve</li> </ul>	2
7.2	Principle, instrumentation, working and applications of : <ul style="list-style-type: none"> <li>• Differential Thermal Analysis (DTA) (<i>Self study-1 hr</i>)</li> <li>• Differential Scanning Calorimetry (DSC)</li> </ul>	2
<b>8</b>	<b>Radiochemistry and Radiopharmaceuticals</b>	<b>5</b>
8.1	Fundamentals of radioactivity: <ul style="list-style-type: none"> <li>• Properties of radionuclide, Radionuclide, Radioisotope, Radioactive decay, half-life of radioactivity, specific activity, Becquerel, curie, Sievert and Gray(<i>Self study-0.5 h</i>)</li> <li>• Relative biological effectiveness, Radionuclidic purity, Radiochemical purity, Geiger-Muller Counting, liquid Scintillation Counting</li> <li>• Safety aspects of radiopharmaceutical laboratory (<i>Self study-0.5 h</i>)</li> </ul>	2
8.2	Quality control of radiopharmaceuticals: Physical, Chemical (Radionuclidic purity, Radiochemical purity), and pharmaceutical properties ( <i>Self study-0.5 h</i> -apyrogenicity, pH and absence of particulate), Isotope dilution analysis (Direct and Inverse), 99mTc generator.	3
<b>9</b>	<b>X-Ray Diffraction Technique</b>	<b>2</b>
9.1	<ul style="list-style-type: none"> <li>• Fundamentals- Origin of X-ray, Bragg's law &amp; its mathematical derivation, and Miller indices (<i>Self study-0.5 h</i>)</li> <li>• Pharmaceutical applications</li> </ul>	2
<b>10</b>	<b>Statistical data handling</b>	<b>4</b>
10.1	<ul style="list-style-type: none"> <li>• Normal Distribution</li> </ul> Numericals based on: <ul style="list-style-type: none"> <li>• Confidence limits &amp; Tests of significance (F-test, Student t-test-paired and unpaired)</li> <li>• Linear regression analysis and correlation coefficient</li> </ul>	

	• Rejection of results (Q-test)	
		<b>Total 45</b>

Latest editions of the following books to be adopted

- 1 D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, Saunders College Publishing, USA.
- 2 K. A. Connors, A Textbook of Pharmaceutical Analysis, John Wiley and Sons, Canada.
- 3 A. H. Beckett and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I and II, CBS Publishers and Distributors, India.
- 4 D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry, Saunders College Publishing, USA.
- 5 G. D. Christian, Analytical Chemistry, John Wiley & Sons, Singapore, reprint by Wiley India Pvt. Ltd.
- 6 H. H. Willard, L. L. Merrit and J. A. Dean, Instrumental Method of Analysis, CBS Publishers & Distributors, New Delhi.
- 7 Ashutosh Kar, Pharmaceutical Drug Analysis, New Age International (P) Ltd. Publishers, India.
- 8 S. S. Mahajan, Instrumental Methods of Analysis, Popular Prakashan Pvt Ltd., India.
- 9 G.R. Chatwal and S. K. Anand, Instrumental methods of chemical analysis, Revised and enlarged, Himalaya Publishing House Pvt. Ltd.
- 10 Indian Pharmacopoeia, The Indian Pharmacopoeia Commission, Ghaziabad, Government of India.
- 11 United States Pharmacopoeia.
- 12 J. Mendham, R. C. Denney, J. D. Barnes, M.J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education Ltd.
- 13 D.G. Watson, Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists, Churchill Livingstone Elsevier.
- 14 J.W. Robinson, E. M. S. Frame and G. M. Frame II, Undergraduate Instrumental Analysis, Marcel Dekker, New York, USA.
- 15 R. Kellnar, J. M. Mermet, M. Otto, M. Valcarceland, H. M. Widmer, Analytical Chemistry: A modern approach to analytical science, Wiley-VCH, USA.
- 16 J. W. Munson, Pharmaceutical Analysis: Modern methods (in two parts), Marcel Dekker Inc., USA.
- 17 W. Kemp, Organic Spectroscopy, Reprinted, Palgrave Publishers Ltd., New York, USA.
- 18 R. M. Silverstein, F. X. Webster and D. J. Kiemle, Spectrometric identification of organic compounds, John Wiley & Sons, Inc. (Indian edition), New Delhi.
- 19 D.B. Troy and P. Beringer, Remington-The Science and Practice of Pharmacy, Vol. I & II, Walters Kluwer/ Lippincott Williams & Wilkins (Indian edition), New Delhi.
- 20 J.W. Robinson, E. M. S. Frame and G. M. Frame II, Undergraduate Instrumental Analysis, 6th Ed., Marcel Dekker, New York, USA.
- 21 J.R. Dyer, Applications Of Absorption Spectroscopy Of Organic Compounds, Prentice- Hall of India Pvt. Ltd, New Delhi, India.
- 22 D. L. Pavia, G. M. Lampman, G.S. Kriz and J. R. Vyvyan, Introduction to Spectroscopy, Brooks / Cole Cengage Learning, Australia.
- 23 S. Bolton and C. Bon, Pharmaceutical statistics: Practical and clinical applications, Drugs and Pharmaceutical Sciences Series, Vol. 203, Informa Healthcare, USA.

## Pharmaceutics – III

3 Hrs/week

Unit	Topic	Hours
<b>1</b>	<b>TABLETS</b>	<b>19</b>
1.1	Definition, advantages and limitations, preformulation aspects.	3
1.2	Tablet formulation and design, additives, excipients with examples.	3
1.3	Large scale manufacturing. Drying as a unit operation. Equipments for mixing. Direct compression, wet Granulation, dry Granulation (Slugging and roller compaction).	5
1.4	Compression – (Single station tablet press and Rotary press), physics of tablet compression (brief).	3
1.5	Processing problems in tableting. Quality control of tablets.	3
1.6	<i>Self Study</i> -Types of tablets-Effervescent, succal, lozenges, chewable, sublingual, dispersible, soluble, orodispersible. layered tablets.Layout of tablet section.	2
<b>2.</b>	<b>CAPSULES</b>	<b>9</b>
2.1	Definition, types of capsules, advantages and limitations, and raw materials including gelatin and other materials. <i>Self Study</i> -Manufacture of gelatin.	1 1
2.2	Hard gelatin capsule: Manufacturing of hard gelatin capsule shells, size, size selection, sealing, storage, defects of shells.	1
2.3	Hard capsule fill formulation aspects: Large scale manufacturing. Filling of hard capsule shells, types of fills and excipients. Filling equipments: classification-volumetric, dosator type and tamping type (one example of each type of equipment). Humidity control in capsule manufacturing and filling area. Problems in capsule filling & remedies	3
2.4	Soft gelatin capsules: Properties, nature of shell and contents, Formulation aspects-concepts(minim/gm) Large scale manufacturing- Rotary Die Process	2
2.5	<i>Self study</i> -Quality Control of empty capsule shell and hard and soft gel capsules. Layout of capsule section.	1
<b>3</b>	<b>PACKAGING</b>	<b>3</b>
3.1	Blister and strip Packing, manufacturing defects, QC	2
3.2	<i>Self study</i> -Packing materials	1
<b>4</b>	<b>AEROSOL</b>	<b>6</b>
4.1	Definition, advantages & disadvantages, desirable features. Components – Prepellants-types, selection, two phase & three phase systems	2
4.2	Containers – Tin Plate, Aluminum, Glass, Plastics, Valve, & Actuator Standard valve (detail) & specialized valves (in brief).	2
4.3	Product concentrate Different formulation systems- solution, Dispersions, Foams Powders.	1
4.4	Manufacturing and Quality Control testing.	1
<b>5</b>	<b>COATING OF TABLETS</b>	<b>8</b>
5.1	Need for tablet coating, types of coating, tablet core properties.	1
5.2	Sugar coating – Raw materials, Steps in detail, Sugar coating defects/problems.	2
5.3	Film coating including Enteric coating. Raw materials, Aqueous film coating, film coating defects/problems.	2
5.4	Coating Equipments – Conventional & modified pans, coating columns (fluidized bed coating), Spray equipment & other accessories..	2
5.5	<i>Self study</i> –Quality control of coated tablets.	1
	<b>TOTAL</b>	<b>45 hrs</b>



Latest editions of the following books to be adopted

1. Aulton Michael E., *Pharmaceutics: The Science of Dosage Form Design*, Churchill Livingstone Publishers.
2. Lachman Leon, Liberman Herbert A., Kanig Joseph I., *The Theory and Practice of Industrial Pharmacy*, Varghese Publishing House, Mumbai.
3. Liberman Herbert A., Lachman Leon, Schwartz Joseph B., *Pharmaceutical Dosage Forms – Tablets*, Volume 1/2/3, Marcel Dekker Inc., New York.
4. Larry L. Augsburger and Stephen W. Hoag., *Pharmaceutical Dosage Forms – Tablets Volume 1/2/3*, Informa healthcare, New York, London.
5. Cole G., *Pharmaceutical Coating Technology* Taylor and Francis Ltd., Bristol, PA.
6. S.J. Carter Ed., *Tutorial Pharmacy*, Cooper and Gunn, CBS Publishers & Distributors, India.

Unit	Topic	Hours
<b>1</b>	<b>Introduction to Pharmacognosy</b>	<b>7</b>
1.1	Historical development, modern concept and scope of Pharmacognosy and Phytochemistry. Sources of drugs of natural origin ( <b>DONO</b> ) including plants, animals, minerals, marines and plant tissue culture products with examples of each source. Significance of pharmacognosy in various systems of medicine practised in India viz. Ayurveda, Unani, Homeopathy and Siddha. Introduction to the concept of phytomedicines. <i>Self study: (4 or 5 examples of each of the following)</i> <ul style="list-style-type: none"> <li>• <i>Examples of sources of DONO</i></li> <li>• <i>Examples of drugs used in different traditional systems of medicine.</i></li> </ul>	2  2
1.2	Introduction to organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilages, oleoresins and oleo- gum -resins), unofficial and official drugs as per the Indian Pharmacopoeia with suitable examples. Classification of DONO based on alphabetical, morphological, pharmacological, chemical, taxonomical and chemotaxonomical methods along with the significance of each method	3
<b>2.</b>	<b>Commercial production, Collection &amp; Preparation of Crude Drugs</b>	<b>7</b>
2.1	Overview of cultivation, collection, preparation, drying and storage (Pest control, moisture control) of crude drugs. <i>Self study:</i> <i>Commerce of crude drugs and 4-5 examples of plants from different geographical sources and climatic zones.</i>	3  1
2.2	Factors affecting quality of crude drugs – Exogenous Factors, Environmental Factors and Endogenous factors: Mutation, Polyploidy and Hybridization. Introduction to plant tissue culture and its applications to pharmacognosy. Plant growth regulators and their application to tissue culture, propagation of plants and production of secondary metabolites.	3
<b>3.</b>	<b>Morphological and histological characteristics of crude drugs</b>	<b>12</b>
3.1	Study of ergastic cell contents including calcium oxalate crystals, starch grains and aleurone grains and idioblasts	2
3.2	Study of morphology and histology of monocot and dicot roots, rhizomes, stems, barks, woods, leaves, flowers, fruits and seeds. Details of mountants, clearing agents and microchemical reagents. <i>Self study:</i> <ul style="list-style-type: none"> <li>• <i>Classification of roots, stems, fruits</i></li> <li>• <i>Salient features of monocot, dicot root and stem</i></li> <li>• <i>Different types of inflorescence</i></li> </ul>	6  3
3.3	Identification and significance of morphological & microscopic differences between plants of allied species as exemplified by digitalis, brahmi, cinnamon & tinospora.	1
<b>4</b>	<b>Introduction to Phytoconstituents</b>	<b>6</b>
4.1	Brief introduction to Primary and secondary metabolites in plants with structures. <i>Self Study:</i> <ul style="list-style-type: none"> <li>• <i>Any two examples of each class of phytoconstituents and significance of phytoconstituents for therapeutic application</i></li> </ul>	2 2
4.2	Study of their biosynthetic pathways with structures (Including shikimic acid pathway and acetate hypothesis, polyketides and terpenoids)	2
<b>5</b>	<b>Extraction of phytochemicals</b>	<b>5</b>
5.1	Introduction to general methods of extraction of different classes of phytochemicals from crude drugs viz. maceration, percolation, soxhlet extraction, Dien Stark assembly for moisture content determination and extraction of volatile oil. Introduction to newer	2

	techniques of extraction like microwave assisted extraction, countercurrent extraction and supercritical fluid extraction. <i>Self Study:</i> <ul style="list-style-type: none"> <li>Commercial applications of recent methods of extraction techniques with any two examples.</li> </ul>	2
5.2	General methods of extraction for following classes of phytoconstituents : alkaloids, glycosides & tannins	1
<b>6</b>	<b>Evaluation &amp; Quality Control of drugs of natural origin (DONO)</b>	<b>8</b>
6.1	Introduction & significance of evaluation of DONO. Study of organoleptic, microscopic, physical, chemical and biological methods of evaluation of crude drugs with respect to pharmacopoeias. Introduction to WHO guidelines and monographs of drugs of natural origin.	4
6.2	Quantitative microscopy of crude drugs including lycopodium spore method, leaf constants, camera lucida and diagrams of microscopic objects to scale with camera lucida. Study of adulteration and substitution of crude drugs. <i>Self Study:</i> <ul style="list-style-type: none"> <li>Examples of adulteration and substitution of crude drugs</li> </ul>	2 2
<b>7</b>	<b>Study of Fibres</b>	<b>3</b>
7.1	Study of plant, animal & mineral fibres with respect to their classification, sources, production, chemistry, commercial utility and significance in Pharmaceutical Industry for the following: Absorbent & nonabsorbent cotton, jute, flax, hemp, asbestos, glass wool, silk, wool, rayon, viscose	3
<b>8</b>	<b>Study of carbohydrate containing drugs of natural origin</b>	<b>8</b>
8.1	Detailed study of Carbohydrates with respect to chemistry, sources, preparation, evaluation and commercial utility as Pharmaceutical Aids and Medicines for the following: Cellulose and cellulose derivatives, starches, honey, inulin, alginic acid, malt and malt extract, dextran, pectin, chitin, tamarind kernel powder (TKP).	3
8.2	Plants as sources of gums including tragacanth, acacia, sterculia, xanthan, guar gum, galactomannans. Plants as sources of mucilages including agar, Isapghol and linseed. <i>Self Study:</i> <i>Study of monograph of any two carbohydrate containing drugs as per IP</i>	3 2
<b>9</b>	<b>Proteins and Enzymes</b>	<b>4</b>
9.1	Study of Proteins and Enzymes with respect to sources, preparation and uses - protein hydrolysates, gelatin, casein, thyroid hormones, proteolytic enzymes (Papain, bromelain, serratiopeptidase, urokinase, streptokinase, pepsin). Study of plant lectins with respect to sources, composition and applications for Abrin, ricin. <i>Self study:</i> <ul style="list-style-type: none"> <li>Marketed formulations containing serratiopeptidase and their applications.</li> </ul>	3 1
	Total	<b>60</b>

Latest editions of the following books to be adopted

- Trease D. & Evans W. C.: Text Book of Pharmacognosy: W. B. Saunders.
- Tyler V.E., Brady L.R. & Robbers J. E.: Pharmacognosy; LeaFeibger, USA.
- Wallis T. E.;Text Book of Pharmacognosy; CBS Publishers, Delhi.
- Kokate C.K., Purohit A. P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
- Harbone J. B.: Phytochemical Methods: A guide to modern techniques Analysis: Chapman& Hall, London.
- Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
- Vasudevan T.N. & Laddha K.S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
- The Indian Pharmacopeia: The Controller of Publication; Delhi.
- Brain K.R. & Turner T. D.: ThePractical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.
- Iyengar M. A. & Nayak S. G.: Anatomy of Crude Drugs: Manipal Power Press Manipal.

11. Iyengar M. A.: Pharmacognosy of Powdered Drugs; Manipal Power Press, Manipal.
12. Kokate C. K.: Practical Pharmacognosy; Vallabh Prakashan.
13. Wagner, Blatt & Zgainski; Plant Drug Analysis; Springer Verlag.
14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments; Nirali Prakashan, Pune.
15. Vasudevan T. N. and Laddha K. S.: Practical Pharmacognosy; New Vrinda Publishing House, Jalgaon.

**Hospital Pharmacy and Drug Store Management****3 Hrs/week**

<b>Unit</b>	<b>Topic</b>	<b>Hours</b>
<b>1.</b>	<b>Introduction to Hospitals and Hospital Pharmacy</b>	<b>5</b>
1.1	Definition, Classification, Organizational structure of Hospital, administration and functions of hospitals	2
1.2	Definition, History, Development and Current status of Hospital Pharmacy Duties and Responsibilities of Hospital Pharmacist	2
1.3	Layout, space and facilities, Concept of Pharmaceutical care. (self study)	1
<b>2.</b>	<b>Pharmacy and Therapeutics Committee</b>	<b>5</b>
2.1	Objective, Composition and Functions of P and T Committee, Drug Utilization	2
2.2	Review Hospital Formulary: Definition, advantages, limitations, preparation, content, with few	2
2.3	examples, selection of drugs, publication and format 2.3. Hospital Pharmacy procedural manual (self study)	1
<b>3.</b>	<b>Purchasing procedure in hospitals (self study)</b>	<b>3</b>
3.1	Purchasing procedure and storage	1
3.2	Inventory control in hospitals	2
<b>4.</b>	<b>Drug Distribution systems in Hospitals</b>	<b>4</b>
4.1	Dispensing to In – patients, Outpatients, Unit dose dispensing, Prepackaging	2
4.2	Dispensing of controlled substances	2
<b>5.</b>	<b>Central Sterile Supply Services</b>	<b>6</b>
5.1	Advantages, Plan, Location, Layout	1
5.2	Sterilization of surgical dressings – methods of packing, loading and prevention of wetting of dressings. Sterilization of rubber gloves, syringes, needles, catheters, tubings, surgical instruments, mattresses, utensils and bedpans and other accessories	3
5.3	Manufacturing and Bulk compounding of large volume parenterals, Total Parenteral Nutrition and Intravenous additives.	2
<b>6.</b>	<b>Safe use of medication in hospitals (self study)</b>	<b>2</b>
6.1	Medication errors and ASHP Guidelines to prevent errors, Infection control in hospitals	2
<b>7.</b>	<b>Health Accessories (self study)</b>	<b>2</b>
7.1	Wheel chairs, canes, crutches, bedpans, vapourizers, syringes, needles, clinical thermometers, first aid supplies	2
<b>8.</b>	<b>Introduction to Pharmacy Practice</b>	<b>3</b>
8.1	Pharmacy Trade or Profession, Community Pharmacy, Code of Ethics for a pharmacist.	3
<b>9.</b>	<b>Channels of distribution and Forms of Business Organization</b>	<b>5</b>
9.1	Wholesalers and Retailers and their professional role.	2
9.2	Hindu undivided family, Sole Proprietorship, Partnership, Co – operative society and Company	2
9.3	Planning of retail pharmacy and Entrepreneurship.	1
<b>10.</b>	<b>Drug Store Management</b>	<b>5</b>
10.1	Legal aspects, Licenses and Registrations.	1
10.2	Location analysis and layout design.	2
10.3	Sales promotion and Window display.	2
<b>11.</b>	<b>Purchasing and Inventory control in retail trade</b>	<b>3</b>
11.1	Purchasing procedure in retail trade	1
11.2	Inventory control ( Want Book, Systematic Want Book, Open to Buy budgeting, ABC, VED, EOQ analysis), Use of computers for Inventory control	2
<b>12.</b>	<b>Risk Management and Frauds in retail practice</b>	<b>2</b>
12.1	Risk management, Insurance policies and Frauds in retail practice	2
	Total	<b>45</b>

Latest editions of the following books to be adopted

1. Hospital Pharmacy, W. E. Hassan, Edition, Lea and Febiger, Philadelphia.
2. A text – book of Hospital Pharmacy, S.H. Merchant and Dr. J.S. Quadry, B.S. Shah Prakashan, Ahmedabad.
3. Hospital Pharmacy, Dr. H. P. Tipnis and Dr. Amrita Bajaj, Career Publication, Maharashtra.
4. Gennaro Alfonso R, Remington – The Science and Practice of Pharmacy”, Lippincott Williams and Wilkins.
5. Principles and methods of Pharmacy Management, Smith, Lea and Febiger, Philadelphia.
6. Drug store management, Nolen and Maynard. McGraw Hill.
7. Drug Store and Business Management, A. P. Battasse, Unique Publication.
8. Text book of Forensic Pharmacy, N. K. Jain, Vallabh Prakashan.

Traditional methods of synthesis to be followed for each of the Unit Operations in addition to specific methods as indicated.

1. Acetylation - Synthesis of aspirin using Microwave Procedure Ref: Green Chemistry V. K. Ahluwalia, pg. no. 7.3. Synthesis of Acetanilide as per Green Chemistry DST Monograph
2. Halogenation – Synthesis of p-bromoacetanilide as per Green Chemistry, DST Monograph
3. Esterification of Ibuprofen using DCC coupling.
4. Oxidation - Synthesis of benzoic by oxidation of toluene **or** benzyl alcohol with alkaline potassium permanganate.
5. Hydrolysis of methyl benzoate.
6. Reduction - ketones: Synthesis of benzhydrol by reduction of benzophenone with zinc and sodium hydroxide) **or** synthesis of m-nitroaniline by partial reduction of m- dinitrobenzene with sodium polysulfide.
7. Nitration: Synthesis of 5-nitrosalicylic acid as per Green Chemistry, DST Monograph.
8. Synthesis of benzimidazole.

**Books**

1. Vogel's A Text book of Practical Organic Chemistry by Vogel, Longman group limited, London.
2. Practical Organic Chemistry by Mann FC & Saunders BC, Longman Group Limited, London.
3. Laboratory Techniques in Organic Chemistry, Ahluwalia V.K. I.K. Publishers.
4. Green Chemistry, V. K. Ahluwalia.
5. New Trends in Green Chemistry, V K Ahluwalia and M Kidwai, KluwerAcademic Publishers
6. Monograph on Green laboratory Experiments, Green Chemistry Task Force Committee, DST.
7. Practical Organic Synthesis: A Student's Guide - Reinhart Keese, Martin Brändle, Trevor Toubé.
8. Advanced practical Medicinal Chemistry by Ashutosh Kar, New Age International Publications.

1. Assay of finished products by **UV spectroscopy, using A (1%, 1 cm)**-minimum assay of 5 formulations to be done.
  - Paracetamol tablets
  - Propranolol tablets
  - Atenolol tablets
  - Hydrochlorothiazide tablets
  - Frusemide tablets
  - Albendazole tablets
  - Rifampicin capsules
2. Assay of drugs using **single point and double point standardization** method by UV spectroscopy. *e.g.* Paracetamol
3. **Colorimetric assays (Construction of calibration curve using linear regression analysis)**
  - Assay of streptomycin injection.
  - Assay of salicylic acid.
4. **Fluorimetric analysis**
  - Assay of quinine sulphate.
  - Effect of different concentrations of iodide ions on fluorescence of quinine sulphate.
5. **Potentiometric titrations using pH meter**
  - Determination of  $pK_a$  and normality of phosphoric acid (Second end-point).
  - Determination of normalities of individual acids in a mixture of acids. (*e.g.*: HCl and  $H_3PO_4$ - Second end point).
6. **Demonstration experiments:**
  - Determination of  $Na^+ / K^+$  by Flame photometry.
  - Working of FTIR and Interpretation of IR spectra of any one drug.

Latest editions of books to be adopted

- 1 Indian Pharmacopoeia, The Indian Pharmacopoeia Commission, Ghaziabad, Government of India.
- 2 G. D. Christian, Analytical Chemistry, John Wiley & Sons, Singapore, reprint by Wiley India Pvt. Ltd.
- 3 A. H. Beckett and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I and II, CBS Publishers and Distributors, India.
- 4 United States Pharmacopoeia.
- 5 J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education Ltd.
- 6 D. G. Watson, Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists, Churchill Livingstone Elsevier.
- 7 R. M. Silverstein, F. X. Webster and D. J. Kiemle, Spectrometric identification of organic compounds, John Wiley & Sons, Inc. (Indian edition), New Delhi.



1. A ) Evaluation of Excipients-Bulking agents- At least one excipient in Conventional and Directly Compressible form for : Flow properties , Bulk density, Compressibility and Particle size and Discussion of Observations.
1. B ) Evaluation Of Excipients-Disintegrating Agents for their swelling Index and Discussion of Observations.
1. C) Evaluation Of Excipients of tablets-Lubricants and Glidants-Influence on flow properties of granules, Results and discussion.
2. Granulation for Soluble Aspirin Tablets IP and Evaluation.
3. Granulation, Compression and evaluation of Riboflavin Tablets IP 96.
4. Granulation, Compression and evaluation of Chewable Antacid Tablets.
5. Granulation Compression and evaluation of Paracetamol Tablets IP 96.
6. Preparation and evaluation of orodispersible tablet for low dose drug.
7. Dissolution Test of Paracetamol Tablet IP
8. Evaluation of Capsule shells, filling of Ampicillin trihydrate capsule and their evaluation.
9. Introduction to different devices for inhalation and demo of evaluation of a suitable commercial product for simple test related to spray and weight / drug content per discharge

**Books**

All books listed in the theory syllabus as well as current editions of IP, BP and USP.

1. Quantitative microscopy (Estimation of Leaf constants *i.e.* Stomatal Index, Vein islet number and Vein termination number, Palisade ratio)
2. Evaluation of Cinnamon powder or Nux vomica powder by Lycopodium Spore method.
3. Determination of alcohol soluble and water soluble extractives, Total ash value and acid insoluble ash and water soluble ash value for any one crude drug as per IP.
4. Microscopical Studies of basic tissues both monocot and dicot stem, leaves, roots, bark, seed, fruits.
5. Study of different types of starch grains, calcium oxalate crystals, Trichomes and stomata
- 6 Identification of Fibres and Minerals based on chemical tests as covered in theory. Tests for detection of honey, starch, tragacanth, acacia, guar gum, agar.
- 7 Extraction and detection of starch/pectin from any one source.
- 8 Morphological identification of any twenty crude drugs and their salient morphological features:  
Acacia tears, Agar strips, Sterculia lumps, Cinnamon, Cassia, Tinospora, Isapghul, Senna, Potato, Pyrethrum, Tragacanth ribbons, Bael, Tamarind, Rhubarb, Squill, Colchicum corm, Senna pod, Any one inflorescence, Hibiscus, Red sandalwood.

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1. Trease D. & Evans W.C.: Text Book of Pharmacognosy:W. B. Saunders.
2. Tyler V. E., Brady L. R. & Robbers J. E.: Pharmacognosy; LeaFeibger, USA.
3. Wallis T. E.;Text Book of Pharmacognosy; CBS Publishers, Delhi.
4. Kokate C. K., PurohitA.P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
5. Harbone J. B.: Phytochemical Methods:A guide to modern techniques Analysis: Chapman& Hall, London.
6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
7. Vasudevan T. N. & Laddha K. S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
8. The Indian Pharmacopeia: TheController of Publication; Delhi.
9. Brain K. R. & Turner T. D.: The Practical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.
10. Iyengar M. A.& Nayak S. G.: Anatomy of Crude Drugs: Manipal Power Press Manipal.
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14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments; Nirali Prakashan, Pune.
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