

**UTTAR PRADESH TECHNICAL UNIVERSITY  
LUCKNOW**



**SYLLABUS**

**BACHELOR OF PHARMACY**

**(B.PHARM.)**

**1<sup>ST</sup> Year and 2<sup>nd</sup> Year**

**(Effective from Session 2013-2014)**

**SEMESTER-I**

S. No.	Course Code	Subject	Periods		Evaluation Scheme					Subject Total	Credit
			L	P	Sessional				ESE		
					CA	TA	EXAM	TOTAL			
THEORY											
1	BOP-111	Pharmaceutical Chemistry-I (Inorganic Pharmaceutical Chemistry)	3	0	5	5	20	30	70	100	4
2	BOP-112	Pharmaceutics-I (General Pharmacy)	3	0	5	5	20	30	70	100	4
3	BOP-113	Anatomy, Physiology and Pathophysiology-I	3	0	5	5	20	30	70	100	4
4	BOP-114	Pharmaceutical Analysis-I	3	0	5	5	20	30	70	100	4
5	BOP-115	Computer Fundamentals	3	0	5	5	20	30	70	100	4
PRACTICAL/PROJECT											
6	BOP-111P	Pharmaceutical Chemistry-I (Inorganic Pharmaceutical Chemistry) Practical	0	4	-	-	-	30	70	100	4
7	BOP-112P	Pharmaceutics-I (General Pharmacy) Practical	0	4	-	-	-	30	70	100	4
8	BOP-113P	Anatomy, Physiology and Pathophysiology-I Project	0	2	-	-	-	30	70	100	2
9	BOP-114P	Pharmaceutical Analysis-I Practical	0	4	-	-	-	30	70	100	4
10	BOP-115P	Computer Fundamentals Practical	0	4	-	-	-	30	70	100	4
TOTAL			15	18						1000	38

CA = Class Attendance, TA = Teacher Assessment.

**SEMESTER-II**

S. No.	Course Code	Subject	Periods		Evaluation Scheme					Subject Total	Credit
			L	P	Sessional				ESE		
					CA	TA	EXAM	TOTAL			
THEORY											
1	BOP-121	Pharmaceutical Chemistry-II (Organic Pharmaceutical Chemistry)	3	0	5	5	20	30	70	100	4
2	BOP-122	Pharmaceutical Chemistry-III (Pharmaceutical Physical Chemistry)	3	0	5	5	20	30	70	100	4
3	BOP-123	Anatomy, Physiology and Pathophysiology-II	3	0	5	5	20	30	70	100	4
4	BOP-124	Pharmacognosy-I	3	0	5	5	20	30	70	100	4
5	BOP-125	Pharmaceutical Biostatistics	3	0	5	5	20	30	70	100	4
PRACTICAL/PROJECT											
6	BOP-121P	Pharmaceutical Chemistry-II (Organic Pharmaceutical Chemistry) Practical	0	4	-	-	-	30	70	100	4
7	BOP-122P	Pharmaceutical Chemistry-III (Pharmaceutical Physical Chemistry) Practical	0	4	-	-	-	30	70	100	4
8	BOP-123P	Anatomy, Physiology and Pathophysiology-II Practical	0	4	-	-	-	30	70	100	4
9	BOP-124P	Pharmacognosy-I Practical	0	4	-	-	-	30	70	100	4
10	BOP-125P	Pharmaceutical Biostatistics Project	0	2	-	-	-	30	70	100	2
		TOTAL	15	18						1000	38

CA = Class Attendance, TA = Teacher Assessment.

**SEMESTER-III**

S. No.	Course Code	Subject	Periods		Evaluation Scheme					Subject Total	Credit
			L	P	Sessional				ESE		
					CA	TA	EXAM	TOTAL			
THEORY											
1	BOP-231	Pharmaceutical Chemistry-III (Heterocyclic & Bioorganic Chemistry)	3	0	5	5	20	30	70	100	4
2	BOP-232	Pharmaceutics-II (Unit Operations)	3	0	5	5	20	30	70	100	4
3	BOP-233	Pharmaceutics-III (Hospital & Community Pharmacy)	3	0	5	5	20	30	70	100	4
4	BOP-234	Anatomy, Physiology & Pathophysiology-III	3	0	5	5	20	30	70	100	4
5	BOP-235	Pharmacognosy-II	3	0	5	5	20	30	70	100	4
PRACTICAL/ PROJECT											
6	BOP-231P	Pharmaceutical Chemistry-III (Heterocyclic & Bioorganic Chemistry) Practical	0	4	-	-	-	30	70	100	4
7	BOP-232 P	Pharmaceutics-II (Unit Operations) Practical	0	4	-	-	-	30	70	100	4
8	BOP-233P	Pharmaceutics-III (Hospital & Community Pharmacy) Practical	0	4	-	-	-	30	70	100	4
9	BOP-234 P	Anatomy, Physiology & Pathophysiology-III Project	0	2	-	-	-	30	70	100	2
10	BOP-235 P	Pharmacognosy-II Practical	0	4	-	-	-	30	70	100	4
	AUC-001/ AUC-002	** Human Value & Professional Ethics/ Cyber Security	2	0	0	15	10	25	50	75*	
		TOTAL	15	18						1000	38

CA = Class Attendance, TA = Teacher Assessment.

\*Human values & Professional Ethics /Cyber Security will be offered as a compulsory audit course for which passing marks are 30% in End Semester Examination and 40% in aggregate.

**SEMESTER-IV**

S. No.	Course Code	Subject	Periods		Evaluation Scheme					Subject Total	Credit
			L	P	Sessional				ESE		
					CA	TA	Total	EXAM			
THEORY											
1	BOP-241	Pharmaceutical Chemistry-IV (Molecular Biology & Biochemistry)	3	0	5	5	20	30	70	100	4
2	BOP-242	Pharmaceutics-IV (Physical Pharmacy)	3	0	5	5	20	30	70	100	4
3	BOP-243	Pharmaceutics-V (Cosmetic Technology)	3	0	5	5	20	30	70	100	4
4	BOP-244	Pharmaceutical Analysis-II	3	0	5	5	20	30	70	100	4
5	BOP-245	Pharmaceutical Jurisprudence	3	0	5	5	20	30	70	100	4
PRACTICAL/ PROJECT											
6	BOP-241P	Pharmaceutical Chemistry-IV (Molecular Biology & Biochemistry) Practical	0	4	-	-	-	30	70	100	4
7	BOP-242P	Pharmaceutics-IV (Physical Pharmacy) Practical	0	4	-	-	-	30	70	100	4
8	BOP-243P	Pharmaceutics-V (Cosmetic Technology) Practical	0	4	-	-	-	30	70	100	4
9	BOP-244P	Pharmaceutical Analysis-II Practical	0	4	-	-	-	30	70	100	4
10	BOP-245P	Pharmaceutical Jurisprudence Project (Case Studies)	0	2	-	-	-	30	70	100	2
	AUC-002/ AUC-001	**Cyber Security/ Human Value & Professional Ethics	2	0	0	15	10	25	50	75*	
		TOTAL	15	18						1000	38

CA = Class Attendance, TA = Teacher Assessment.

\*Human values & Professional Ethics /Cyber Security will be offered as a compulsory audit course for which passing marks are 30% in End Semester Examination and 40% in aggregate.

## FIRST SEMESTER

**BOP-111**

### **PHARMACEUTICAL CHEMISTRY-I (INORGANIC PHARMACEUTICAL CHEMISTRY)**

An outline of methods of preparation, tests of identification and special tests (if any), of the individually mentioned inorganic pharmaceuticals.

#### **Unit I**

Sources of impurities & their control. Limit tests for iron, arsenic, lead, heavy metals, chloride and sulphate.

**Pharmaceutical aids and necessities:** Pharmaceutically acceptable glass. Water (Purified water, Water for injection, Sterile water for injection). Acids and bases (Sodium hydroxide, Phosphoric acid).

#### **Unit II**

**Topical agents:** Protectives (Calamine, Titanium dioxide, Talc, Kaolin). Astringents (Zinc sulphate, Alums). Anti-infectives (Boric acid, Hydrogen peroxide, Iodine, Povidone-Iodine, Potassium permanganate, Silver nitrate).

**Dental products:** Dentifrices, anti-caries agents (Sodium fluoride).

**Gases and vapors:** Inhalants (Oxygen), anesthetics (Nitrous oxide).

#### **Unit III**

**Gastrointestinal agents:** Acidifying agents (Dilute hydrochloric acid). Antacids (Bismuth sub-carbonate, Aluminium hydroxide, Calcium carbonate, Magnesium hydroxide, Magnesium oxide { light and heavy }, Magnesium carbonate { light and heavy }, Combination antacids. Cathartics (Disodium hydrogen phosphate, Magnesium sulphate). Protective and Adsorbents (Activated charcoal, Aluminium sulphate).

**Miscellaneous agents:** Expectorants (Ammonium chloride, Potassium iodide). Antioxidants (Sodium metabisulphite).

#### **Unit IV**

**Major intra and extracellular electrolytes:** Physiological ions, electrolytes used for replacement therapy (Sodium chloride, Potassium chloride, Calcium gluconate, Calcium lactate, Magnesium chloride), physiological acid-base balance (Sodium dihydrogen phosphate, Sodium acetate, Sodium bicarbonate), combination therapy including ORS.

**Essential and trace elements:** Iron and haematinics (Ferrous fumarate, Ferrous gluconate, Ferrous sulphate, Ferric ammonium citrate). Mineral supplements (Cu, Zn, Cr, Mn, I).

#### **Unit V**

**Inorganic radiopharmaceuticals:** Radioactivity, units of radioactivity and radiation dosimetry, measurement of radioactivity, hazards and precautions in handling of radiopharmaceuticals, clinical applications of radiopharmaceuticals.

**Co-ordination compounds and complexation:** Co-ordination theory, chelates and their pharmaceutical importance, poison antidotes (Sodium thiosulphate), novel applications of metals in pharmacy.

**BOP-111P**

**PHARMACEUTICAL CHEMISTRY-I**  
**(INORGANIC PHARMACEUTICAL CHEMISTRY) PRACTICAL**

**Suggested Practicals**

1. To perform limit test of chloride, sulphate, iron, heavy metal and arsenic in the given sample.  
Identification tests for acidic and basic radicals.
2. Preparation of following compounds-
  - Boric acid
  - Magnesium sulphate
  - Heavy magnesium carbonate
  - Calcium Carbonate
  - Alum
  - Zinc sulphate.

**BOOKS RECOMMENDED:**

1. Pharmacopoeia of India, 1996 Edition.
2. Block J.H., Roche E., Soine, T. and Wilson, C., Inorganic, Medicinal & Pharmaceutical Chemistry, Lea & Febiger.
3. Atherden L.M., Bentley and Driver's Text Book of Pharmaceutical Chemistry, Oxford University Press.
4. Miessler, G.L. and Tarr, D.A. Inorganic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Svehla, G. and Sivasankar, B. Vogel's Qualitative Inorganic Analysis, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Rao K.S. and Suresh, C.V. Pharmaceutical Inorganic Chemistry, PharmaMed Press.
7. Chenchu Lakshmi, N.V. Pharmaceutical Inorganic Chemistry: Theory and Practice, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).



*BOP-112*

## **PHARMACEUTICS-I (GENERAL PHARMACY)**

### **Unit I**

**History of pharmacy and Pharmacopoeia:** Origin & development of pharmacy, scope of pharmacy, introduction to Pharmacopoeias - IP, BP, USP & International Pharmacopoeia. Introduction to National Formularies and Extra Pharmacopoeia. Typical parts of a monograph of Indian pharmacopoeia. An introduction to contents of the IP.

### **Unit II**

**Prescription:** Definition, types of prescription, handling of prescription, legality of prescription and specific Latin terms used in modern day prescription (sos, od, bd, tid, qid)

**Pharmaceutical additives:** Coloring, flavoring & sweetening agents, co-solvents, preservatives and their applications.

### **Unit III**

**Pharmaceutical calculations:** Posology, calculation of doses for infants; Enlarging and reducing recipes, percentage solutions, alligation method, alcohol dilution, proof spirit, basic concept of isotonicity. Weights and measures, weighing of solids and measurement of liquids.

### **Unit IV**

**Introduction to Pharmaceutical dosage forms:** Classification, formulation methods of powders, mixtures and syrups and elixirs.

**Definitions:** Solutions, spirits, infusions, paints, elixirs, mouth washes, gargles, lotions, liniments, pastes, ointments, creams, inhalations, dusting powders and lozenges.

### **Unit V**

**Size Reduction:** Definition, principles and laws governing size reduction, factors affecting size reduction. Study of hammer mill, ball mill and fluid energy mill. Introduction to sieving methods, laws and factors affecting energy requirements for size reduction, different methods of size reduction.

**Mixing:** Theory of mixing, solid-solid, solid-liquid & liquid-liquid mixing equipments.

***BOP-112P***

**PHARMACEUTICS-I (GENERAL PHARMACY) PRACTICAL**

**Suggested Practicals**

**I:** Preparation of following classes of Pharmaceutical dosage forms (involving the use of calculations in metrology) as official in IP, BP, USP/NF.

a) Aromatic Waters

1. Chloroform Water BP
2. Concentrated Peppermint Water BP
3. Rose Water NF

b) Mixtures

1. Chalk Mixture, Paediatric BP
2. Light Magnesium Carbonate and Kaolin Mixture

c) Syrups

1. Simple Syrup BP/USP/IP
2. Ferrous Sulphate Syrup USP

d) Powders

1. ORS Powder IP
2. Absorbable Dusting Powder USP/N
3. Effervescent Compound Powder (BPC)

**II. Study of the role of pharmaceutical additives in formulations**

- a. Colouring agent:
  1. Compound Sodium Chloride Mouthwash BP
  2. Phenol Gargle BPC
- b. Flavouring agent:
  1. Orange Tincture IP
  2. Potassium Citrate Mixture BP
- c. Sweetening agents:
  1. Simple Elixir IP
- d. Cosolvents:
  1. Camphor Water IP
  2. Compound Iodine Throat Paint IP(Mandl's Paint)

- e. Preservatives:           1. Zinc Sulphate and Zinc Chloride Mouthwash BPC  
  2. Calamine Lotion
- f. Surfactants:               1. Cresol with Soap Solution IP  
  2. Turpentine Liniment BP

**III:** Experiments to illustrate principles of size reduction using Ball Mill.

Effect of size of balls, number of balls and time on the efficiency of ball mill.

**IV:** Experiments to illustrate mixing efficiency. Solid-Solid mixing.

**BOOKS RECOMMENDED:**

1. Pharmacopoeia of India, The Controller of Publications, Delhi.
2. British Pharmacopoeia, Her Majesty's Stationary Office, University Press, Cambridge.
3. Carter S.J., "Cooper and Gunn's Tutorial Pharmacy, CBS Publishers, Delhi.
4. Rawlins E.A., Bentley's Text Book of Pharmaceutics, ELBS Bailliere Tyn dall.
5. Lachman L, Liberman H.A and Kanig J.L., Theory and Practice of Industrial Pharmacy, Lea & Febiger.
6. Cooper and Gunn's Dispensing for Pharmaceutical Students, CBS Publishers, New Delhi.
7. Aulton M.E, Text Book of Pharmaceutics, Vol., I & II. Churchill Livingstone.
8. United States Pharmacopoeia (National Formulary).
9. Remington, The Science and Practice of Pharmacy Vol. I & II. Mack Publishing Co., Pennsylvania.
10. Jain N.K., Modern Dispensing Pharmacy, 2nd Ed.

**ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY- I**

**Unit I**

Introduction to human body and organization of human body.

Functional and structural characteristics of cell.

Detailed structure of cell membrane and physiology of transport process.

Structural and functional characteristics of tissues- epithelial, connective, muscle and nerve.

**Unit II**

**Skeletal system:** Structure, composition and functions of skeleton. Classification of joints, types of movements of joints.

**Muscular system:** Anatomy & physiology of skeletal and smooth muscle, energy metabolism, types of muscle contraction, muscle tone.

**Unit III**

Demography and family planning, medical termination of pregnancy.

**First aid:** Emergency treatment of shock, snake bites, burns, poisoning, fractures and resuscitation methods

**Unit IV**

**Sense organs:** Basic anatomy and physiology of the eye (vision), ear (hearing), taste buds, nose (smell), and skin (superficial receptors).

**Unit V**

**Communicable diseases:** Brief outline, their causative agents, modes of transmission and prevention (Chicken pox, measles, influenza, diphtheria, whooping cough, tuberculosis, poliomyelitis, helminthiasis, malaria, filariasis, rabies, trachoma, tetanus, leprosy).

**BOP-113P**

**ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY -I PROJECT**

**Suggested Practicals**

1. Preparation of charts/ models of the following :
  - A. Joints,
  - B. Sense organs (eye, ear, taste buds, skin, nose)
  - C. Resuscitation methods
  - D. Malaria life cycle
  - E. Neurotransmission
  - F. Structure of cell
  - G. Transport across cell membrane
  - H. Mechanism of muscle contraction
  - I. Human Skeleton
  - J. Structure of neuron
2. Preparation of charts/ models on selected topics from the course content.

**BOOKS RECOMMENDED:**

1. Marieb E.N. Human Anatomy and Physiology, Benjamin Cummings (Pearson Education Inc.).
2. Park K., Preventive and Social Medicine, Banarsidas Bhanot.
3. Seeley R.R., Stephens T.D. and Tate P. Essentials of Anatomy and Physiology, McGraw-Hill.
4. Tortora G.J, and Anagnostikos NP Principles of Anatomy and Physiology, Harper & Row Publishers, New Delhi.
5. Ross & Wilson Anatomy and Physiology in Health and Illness, Churchill Livingstone.
6. Chatterjee C.C. Human Physiology, Medical Allied Agency, Calcutta.
7. Parmar N.S. Health Education and Community Pharmacy, CBS Publishers, Delhi.
8. Keele, C.A., Niel, E and Joels N, Samson Wright's Applied Physiology, Oxford University Press.
9. Dandiya, P.C., Zafer, Z.Y.K., and Zafer, A. Health Education and Community Pharmacy, Vallabh Prakashan.

**PHARMACEUTICAL ANALYSIS-I**

**Unit I**

Significance of quantitative analysis in quality control different techniques of analysis, preliminaries and definitions, precision and accuracy. Fundamentals of volumetric analysis, methods of expressing concentration, primary and secondary standards.

**Unit II**

**Acid base titrations:** Acid base concepts, role of solvent, relative strengths of acids and bases, ionization, law of mass action, common-ion effect, ionic product of water, pH, hydrolysis of salts, Henderson- Hasselbach equation, buffer solution, neutralization curves, acid base indicators, theory of indicators, choice of indicators, mixed indicators, polyprotic system.

**Unit III**

**Oxidation reduction titrations:** Concepts of oxidation and reduction, redox reactions, strengths and equivalent weights of oxidizing and reducing agents, theory of redox titrations, redox indicators, oxidation reduction curves, iodimetry and iodometry, titrations involving ceric sulphate, potassium iodate, potassium bromate, potassium permanganate.

**Unit IV**

**Precipitation titrations:** Precipitation reactions, solubility products, effect of acids, temperature and solvent upon the solubility of precipitate. Argentometric titrations and titrations involving ammonium or potassium thiocyanate, mercuric nitrate indicators, Gaylussac method, Mohr's method, Volhard's method and Fajan's method.

**Unit V**

**Gravimetric analysis:** Precipitation techniques, solubility products, the colloidal state, supersaturation, coprecipitation, post-precipitation, digestion, washing of the precipitate, filtration, filter papers and crucibles, Ignition, thermogravimetric curves, specific examples like barium as barium sulphate, aluminium as aluminium oxide, organic precipitants.

**PHARMACEUTICAL ANALYSIS- I PRACTICAL**

The students should be introduced to the main analytical tools through demonstration. They should have a clear understanding of a typical analytical balance, the requirements of a good balance, weights, care & use of balance, methods of weighing, and errors in weighing. The students should also be acquainted with the general apparatus requiring various analytical procedures.

1. Standardization of analytical weights and calibration of volumetric apparatus.
2. Acid Base Titrations: Preparation and standardization of acids and bases, some exercises related with determination of acids and bases separately or in mixture form, some official assay procedures, e.g. boric acid, should also be covered.
3. Oxidation Reduction Titrations: Preparation & standardization of some redox titrants e.g. potassium permanganate, potassium dichromate, iodine, sodium thiosulphate etc. Some exercises related to determinations of oxidizing & reducing agents. Exercises involving potassium iodate, potassium bromate, iodine solution and ceric ammonium sulphate.
4. Precipitation Titrations: Preparation and standardization of titrants like silver nitrate and Ammonium thiocyanate, titrations according to Mohr's, Volhard's and Fajan's methods.
5. Gravimetric Analysis: Preparation of Gooch crucible for filtration and use of sintered glass crucible. Determination of water of hydration, some exercise related to gravimetric analysis should be covered.

**BOOKS RECOMMENDED:**

1. Mendham J., Denney R.C., Barnes J.D., Thomas M, Jeffery G.H., Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education Asia.
2. Connors K.A., A Text book of Pharmaceutical Analysis , Wiley Inter-science.
3. Beckett A.H., and Stenlake J.B., Practical Pharmaceutical Chemistry, Vol. I&II. The Atherden Press of the University of London.
4. British Pharmacopoeia, Her Majesty's Stationary Office, University Press, Cambridge.
5. Alexeyev V. Quantitative Analysis. CBS Publishers & Distributors.
6. The Pharmacopoeia of India.

## **COMPUTER FUNDAMENTALS**

### **Unit I**

Definition and overview of computer, computer classification, computer organization, computer code, input devices, output devices, storage devices. Computer software, types of software. overview of computer networks, LAN, MAN, WAN. Internet, network topology. Internetworking: Bridges, repeaters and routers.

### **Unit II**

**Introduction:** Operating system and function, evolution of operating system, batch, interactive, time sharing and real time system. Single user operating system and multi-user operating system. Basics in MS-DOS, internal and external commands in MS-DOS.

### **Unit III**

Introduction to MS-OFFICE-2007, word 2007 document creation, editing, formatting table handling, mail merge. Excel-2007, editing, working retrieval, important functions, short cut keys used in EXCEL.

### **Unit IV**

MS-Power point 2007-Job Profile, elements of Power point , ways of delivering presentation, concept of Four P's (planning, preparation, practice and presentation) ways of handling presentations e.g. creating, saving slides show controls, adding formatting, animation and multimedia effects. Database system concepts, data models schema and instance , database language. Introduction to MS-Access 2007, main components of access tables, queries, reports, forms table handling, working on query and use of database.

### **Unit V**

Computer applications in pharmaceutical and clinical studies, uses of internet in pharmaceutical industry.



**COMPUTER FUNDAMENTALS PRACTICAL**

**Suggested Practicals**

Software Lab to be used for the following:-

1. Windows, Managing Windows, Working with Disk, Folders and files.
2. MS-Office 2003 (MS Word, MS Power point, MS Excel, MS Access).
3. Computer Operating System like DOS and Windows.
4. Internet Features (E-mail, Browser etc.).

**BOOKS RECOMMENDED:**

1. Sinha R.K., Computer Fundamentals, BPB Publications.
2. Raja Raman V., Computer Programming in 'C', PHI Publication.
3. Hunt N and Shelley J., Computers and Common Sense, Prentice Hall of India.
4. Tiwari, N.K., Computer fundamentals with Pharmacy Applications.
5. Rao G.N., Biostatistics and Computer Applications.
6. Mansfield R., Working in Microsoft Office, Tata McGraw-Hill Publishing Company Ltd.
7. Leon M. and Leon A., Fundamentals of Computer Science and Communication Engineering", UBS Publishers Distributors Ltd.
8. Norton, P. Peter Norton's Introduction to Computers, Tata McGraw-Hill.

## SECOND SEMESTER

**BOP-121**

### **PHARMACEUTICAL CHEMISTRY-II (ORGANIC PHARMACEUTICAL CHEMISTRY-I)**

#### **Unit I**

Introduction, classification and nomenclature of organic compounds. Electron displacements in organic chemistry (such as; inductive effect, resonance, hyperconjugation). Reaction intermediates (such as; free radicals, carbocations, carbanions, carbenes and nitrenes).

Stereochemistry including geometrical isomerism, optical isomerism, specification of configuration and conformational analysis.

#### **Unit II**

Introduction to aliphatic organic compounds and some of their characteristic reactions with mechanisms such as; alkanes (free radical substitution), alkenes, alkynes and dienes (electrophilic and free radical additions), cycloalkanes (types of strain including Baeyer strain theory), alkyl halides and alcohols (nucleophilic substitution and nucleophilic elimination), amines, aldehydes and ketones (nucleophilic addition), carboxylic acids and their derivatives.

#### **Unit III**

Introduction to aromatic organic compounds, aromaticity, structure of benzene, electrophilic and nucleophilic substitution, orientation and reactivity in electrophilic aromatic substitution, arenes, phenols. Polynuclear hydrocarbons (naphthalene, anthracene).

#### **Unit IV**

Name reactions including reaction mechanisms and synthetic applications of; Meerwein-Ponndorf-Verley reduction, Oppeneaur oxidation, Beckmann rearrangement, Hofmann rearrangement, Mannich reaction, Diels Alder reaction, Cannizzaro reaction, Aldol condensation, Benzoin condensation.

#### **Unit V**

, - Unsaturated carbonyl compounds. Compounds containing active methylene group and their synthetic importance (acetoacetic ester and malonic ester). Organometallic (organolithium and organomagnesium) compounds and their synthetic importance. Aryl diazonium salts and their synthetic importance.

**BOP-121P**

**PHARMACEUTICAL CHEMISTRY-II (ORGANIC PHARMACEUTICAL CHEMISTRY-I)  
PRACTICAL**

**Suggested Practicals**

1. Identification of elements and functional groups in given sample.
2. Purification of solvents like benzene, chloroform, acetone and preparation of absolute alcohol.
3. Synthesis of compounds involving benzoylation, acetylation, bromination, reduction & oxidation.

Picric acid.

Aniline.

Acetanilide.

Aspirin.

Hippuric acid.

P-Bromo acetanilide.

Iodoform.

Oxalic Acid.

**BOOKS RECOMMENDED:**

1. Morrison R.T., Boyd R.N., and Bhattacharjee, S.K. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.).
2. Finar I.L. Organic Chemistry, Vol. I & II, Pearson Education Ltd.
3. Bruice P.Y. and Prasad, K. J. R. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.
4. Sykes P., A Guidebook to Mechanism in Organic Chemistry, Longman Group Ltd.
5. Singh M.S. Advanced Organic Chemistry: Reactions and Mechanisms, Dorling Kindersley (India) Pvt. Ltd.
6. Jain M.K. Organic Chemistry, Sohan Lal Nagin Chand & Co.
7. Mann F.G, and Saunders, B.C., Practical Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.).
8. Vogel A.I., Elementary Practical Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.).

**PHARMACEUTICAL CHEMISTRY-III (PHARMACEUTICAL PHYSICAL CHEMISTRY)**

**Unit I**

**Atomic structure and chemical bonding:** atomic structure, atomic orbital, molecular orbital, hybridization, covalent (sigma and pi) bond, electrovalent and co-ordinate bond.

**Chemical kinetics:** Zero, first and second order reaction, complex reactions, elementary idea of reaction kinetics, characteristics of homogenous and heterogeneous catalysis, acid base and enzyme catalysis.

**Unit II**

**Distribution law:** Distribution law & application to solvent extraction.

**Matter, properties of matter:** Physical properties (surface tension, parachor, viscosity, rheochor, refractive index, optical rotation, dipole moment) and chemical constituents. Liquid complexes, liquid crystals, glassy state, solids-crystalline, amorphous and polymorphism.

**Unit III**

**Thermodynamics:** Fundamentals, first, second, third and zeroth law, Joule-Thompson's effect, absolute temperature scale, conversion of temperature between different scales.

**Thermo chemistry:** Definition & conventions, heat of reaction, heat of formation, heat of solution, heat of neutralization, heat of combustion, bond energies.

**Unit IV**

**Electro-chemistry:** Faraday's laws of Electrolysis, Electric conductance & its measurement, molar & equivalent conductivity and its variation with dilution. Kohlrausch law, degree of ionization and Ostwald dilution law. Theory of strong electrolytes (Debye Huckle theory).

**Unit V**

**Adsorption:** Definition, types and mechanism of adsorption, difference between physical and chemical adsorption, pharmaceutical applications of adsorption

**Phase equilibria:** Phase, component, degree of freedom, sublimation critical point, phase rule (excluding derivation).

Cooling curves and Phase diagrams for one & two component system involving eutectics, congruent & incongruent melting point (examples-water, sulphur, KI-H<sub>2</sub>O, NaCl-H<sub>2</sub>O).

**PHARMACEUTICAL CHEMISTRY-III (PHARMACEUTICAL PHYSICAL CHEMISTRY)**  
**PRACTICAL**

**Suggested Practicals**

1. Determination refractive index of given liquids.
2. Determination of specific rotation of sucrose at various concentrations and determine the intrinsic rotation.
3. Determination of rate constant of simple reaction.
4. Determination of cell constant, verify Ostwald dilution law and perform conductometric titrations.
5. Determination of surface tension.
6. Determination of partition co-efficient.
7. Determination of viscosity.
8. Determine the parachor value.
9. Determine the rheochor value.
10. pH Determination by different methods.
11. Determination of solubility.

**BOOKS RECOMMENDED:**

1. Engel Thomas Reid Philip. Physical Chemistry, Pearson Education.
2. Tinoco I.J., Sauer K., Wang J.C. and Puglisi J.D. Physical Chemistry principles and applications in biological sciences, Pearson Education.
3. Martin A., Bustamante P. and Chun A.H.C- Physical Pharmacy, Lea & Febiger, Philadelphia.
4. Mark L. Introduction to Physical Chemistry, Cambridge University.
5. Levine Ira N. Physical Chemistry, Tata McGraw-Hill Publishing Company.
6. Barrow G.M. Physical Chemistry, Tata McGraw-Hill Publishing Company.
7. Atkins P. and Paula, J.D. Atkins Physical Chemistry, Oxford University Press.
8. Bhasin S.K. Pharmaceutical Physical Chemistry, Pearson Education.
9. Negi A.S. and Anand S.C. Textbook of Physical Chemistry, Wiley Eastern Ltd.

## **ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY-II**

### **Unit I**

**Central nervous system:** Anatomy of different parts of brain and spinal cord, reflex action, electroencephalogram, specialized functions of the brain. Cranial nerves and their functions.

### **Unit II**

**Autonomic nervous system:** Physiology of the autonomic nervous system. Neuro transmitters, Mechanism of neurohumoral transmission.

### **Unit III**

**Haemopoietic system:** Composition & function of blood & its elements, erythropoiesis, blood groups, blood coagulation, Anemia.

**Lymphatic system:** Composition, formation and circulation of lymph, lymph node and spleen, thymus and pathophysiology of hypersensitivity and allergy.

### **Unit IV**

**Urinary system:** Anatomy & physiology of urinary system, physiology of urine formation, acid- base balance, pathophysiology of renal feature, glomerulonephritis, urinary tract infection

### **Unit-V**

**Digestive system:** Parts of digestive system, their structure and functions. Various gastro-intestinal secretions and their role.

Pathology of Peptic Ulcer, Ulcerative colitis, Crohn's disease, Zollinger- Ellison syndrome, Hepatitis, Cirrhosis of liver, Pancreatitis

**ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY-II PRACTICAL**

**Suggested Practicals**

1. Microscopic study of different tissues.
2. Haematological experiments:
  - A. Estimation of haemoglobin in blood.
  - B. Determination of bleeding time, clotting time.
  - C. R.B.C. Count.
  - D. Total leucocyte count (TLC), Differential leucocyte count ( D.L.C.)
  - E. E.S.R. and blood group
3. Recording of body temperature, pulse rate and blood pressure.

**BOOKS RECOMMENDED**

1. Difore S.H., Atlas of Normal Histology, Lea & Febiger Philadelphia.
2. Tortora, G.J., & Anagnostikos N.P., Principles of Anatomy and Physiology, Harper & Row Publishers, New Delhi.
3. Dipiro J.L., Pharmacotherapy – A Pathophysiological Approach, Elsevier.
4. Seeley R.R., Stephens T.D. and Tate, P. Essentials of Anatomy and Physiology, McGraw-Hill.
5. Guyton A.C., Hall J.E., Text book of Medical Physiology, WB Saunders Company.
6. Ross and Wilson, Anatomy and Physiology in Health and Illness, Churchill Livingstone.
7. Chatterjee C.C. Human Physiology, Medical Allied Agency, Calcutta.
8. Zdanowicz, M. M. Essentials of Pathophysiology for Pharmacy, CRC Press.
9. Chaurasia B.D, Human Anatomy, Regional & Applied Part I, II & III, CBS Publishers & Distributors, New Delhi.
10. Sood, R. Medical Laboratory Technology: Methods and Interpretation, Jaypee Brothers, New Delhi.

**PHARMACOGNOSY– I**

**Unit I**

Definition history, scope & development of pharmacognosy.

**Source of drug:** Biological, marine, mineral and plant tissue culture as source of drugs.

**Classification of drugs:** Alphabetical, morphological, taxonomical, chemical and pharmacological, chemotaxonomy.

**Unit II**

Plant Description: Morphology and anatomy of leaves, woods, barks, inflorescences and flowers, fruits and seeds.

**Unit III**

**Propagation, cultivation, collection, processing and storage of crude drugs**

A. Factors influencing cultivation of medicinal plants, Type of Soils & fertilizers of common use.

B. Pest management and natural pest control agents.

C. Plant hormones and their applications.

D. Polyploidy, mutation and hybridization with reference to medicinal plants.

E. Poly Houses/ Green houses for cultivation.

**Unit IV**

**Quality control of crude drugs:** Adulteration of crude drugs and their detection by organoleptic, microscopic, physical, chemical and biological methods of evaluation including quantitative microscopy.

**Unit V**

**Systematic pharmacognostic study of following-**

**Carbohydrates and derived products:** Agar, Guar-gum, Acacia, Honey, Isabgol, Pectin, Starch, Sterculia and Tragacanth.

**Lipids:** Beeswax, Castor oil, Coca butter, Kokum butter, Hydnocarpus oil, Cod liver oil, Shark liver oil, Linseed oil, Wool fat, Rice-bran oil, Lard and Suet.



**PHARMACOGNOSY-I PRACTICAL**

**Suggested Practicals**

1. Morphological characteristics of plant parts mentioned in theory.
2. Microscopical measurements of cell & cell contents Starch grains, Calcium oxalate Crystals & Phloem fibres.
3. Determination of leaf constants such as stomatal index, stomatal numbers, vein islet numbers, vein termination number and palisade ratio.
4. Identification of crude drugs belonging to carbohydrates and lipids.
5. Preparation of herbarium sheets.

**BOOKS RECOMMENDED**

1. Pharmacopoeia of India, The Controller of publications, Vol. III, Delhi, 2010.
2. Trease G.E. and Evans W.C., Pharmacognosy, Bailliere Tindall East Bourne, U.K.
3. Wallis T.E., Text book of Pharmacognosy, J & A Churchill, Ltd.
4. Wallis T.E., Analytical Microscopy, J & A Churchill Limited, London.
5. Brain K.R. and Turner T D. The Practical Evaluation of Phytopharmaceuticals, Wright, Scientechnica- Bristol.
6. Dutta A.C, Botany, Oxford University Press, 2007.
7. Schewer PJ, Marine Natural Products, Academic Press, London.
8. Wallis T.E. Practical Pharmacognosy, PharmaMed Press, Hyderabad, 2011.
9. Kokate C.K. Practical Pharmacognosy, Vallabh Prakashan, Delhi.

**BOP-125**

**PHARMACEUTICAL MATHEMATICS AND BIOSTATISTICS**

**Unit I**

Limit of functions, differentiation of logarithmic, trigonometric and exponential function (not proof), chain rule, integration as reverse of differentiation, method of substitution.

**Unit II**

Linear differential equation with constant coefficients: complementary function and particular integral ( $e^{ax}$ ,  $x^n$ ,  $\sin ax$ ,  $\cos ax$ ).

**Unit III**

Methods of collection of data, diagrammatic representation of data (Pie, Histogram, Bar diagram), types of sampling; mean, median, mode and standard deviation.

**Unit IV**

Karl Pearson's coefficient of correlation, regression, method of least square of straight line, t test,  $\chi^2$  test, F test.

**Unit V**

Probability: Simple probability, addition and multiplication of probabilities, binomial, Poisson's and normal distributions.

**PHARMACEUTICAL MATHEMATICS AND BIOSTATISTICS PROJECT**

1. Collection of data by survey methods.
2. Classification and tabulation of data.
3. Frequency distribution table for collected data (discrete and continuous).
4. Calculation of mean, median, mode, standard deviation and coefficient of variation for collected data.
5. Graphical representation of frequency distribution of collected data (histogram, frequency polygram, frequency curve and ogive).
6. Chi-square testing for data analysis.

**BOOKS RECOMMENDED**

1. Blair R.C., Taylor, R.A. Biostatistics for the Health Sciences, Dorling Kindersley India Pvt., Ltd.
2. Gupta S.P. Statistical Methods, Sultan Chand & Sons.
3. Khan I.A. and Khanum, A. Biostatistics for Pharmacy, Ukaaz Publications.
4. Prasad G. Textbook of Differential Calculus, Pothishala Pvt. Ltd.
5. Prasad G. Textbook of Integral Calculus, Pothishala Pvt. Ltd.
6. A Textbook of Mathematics for XI-XII Students, Vol. I-IV, NCERT Publications.

## THIRD SEMESTER

**BOP-231**

### **PHARMACEUTICAL CHEMISTRY-III (HETEROCYCLIC AND BIOORGANIC CHEMISTRY)**

#### **Unit I**

**Heterocyclic compounds:** Nomenclature, chemistry, preparation, properties and pharmaceutical importance of pyrrole, furan, thiophene, pyridine, pyrimidine, imidazole, pyrazole, thiazole, benzimidazole, indole, phenothiazines.

#### **Unit II**

**Carbohydrates:** Classification, reactions, structure elucidation, identification of-  
Monosaccharides- Glucose, fructose.

Disaccharides- Sucrose, lactose, maltose.

Polysaccharides- Starch.

#### **Unit III**

**Amino acids and proteins:** Classification, identification, general methods of preparation and reactions, isoelectric point, peptide bond, types of protein structure, protein separation and purification, end group analysis, introduction to solid phase peptide synthesis.

#### **Unit IV**

**Nucleic acids:** Classification, structures (primary, secondary, tertiary and quaternary) and functions of DNA and RNA, genetic codes.

**Oils, fats and waxes:** Structure and properties, analysis (acid value, iodine value, saponification value, Reichert-Meissl value).

#### **Unit V**

**Vitamins:** Classification, structure elucidation (only individually mentioned compounds) and physiological functions of water and fat soluble vitamins: Thiamine, niacin, ascorbic acid and retinol.

**Polymers and polymerization:** Classification, synthesis, reactions and pharmaceutical applications.

**BOP-231P**

**PHARMACEUTICAL CHEMISTRY-III (HETEROCYCLIC & BIOORGANIC CHEMISTRY)  
PRACTICAL**

**Suggested Practicals**

1. Synthesis of heterocyclic nuclei such as Pyrazole, Imidazole, Thiazole, Indole, Benzimidazole, Phenothiazines.
2. Synthesis of compounds involving name reactions such as; Mannich reaction, Claisen-Schmidt condensation, Schiff's base formation.
3. Identification of carbohydrates by derivative preparation.
4. Identification of proteins by different color reactions.
5. Analysis of oils, fats and waxes (such as; acid value, saponification value, iodine value).
6. Stereomodels of proteins (primary, secondary and tertiary).
7. Determination of molecular weight of compounds (Rast's Camphor Method) polymers (Ostwald's Viscometer Method).

**BOOKS RECOMMENDED**

1. Morrison R.T. and Boyd R.N., Bhattacharjee S.K. Organic Chemistry, 7<sup>th</sup> Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar I.L., Organic Chemistry, 6<sup>th</sup> Edition, Vol.-I, Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
3. Acheson R.M., An Introduction to the Chemistry of Heterocyclic Compounds, 3<sup>rd</sup> Edition, Wiley (India) Pvt. Ltd.
4. Gilchrist T.L., Heterocyclic Chemistry, Pearson Education (Singapore) Ltd.
5. Bansal R.K., Heterocyclic Chemistry, New Age International Publishers.
6. Jain M.K. and Sharma S.C., A Textbook of Organic Chemistry, Shoban Lal and Co. Educational Publishers.
7. Allcock H.R., Lampe F.W. and Mark J.E., Contemporary Polymer Chemistry, Pearson Education (Singapore) Pvt. Ltd.
8. Odian G., Principles of Polymerization, John Wiley and Sons Inc.
9. Mann F.G. and Saunders B.C., Practical Organic Chemistry, 4<sup>th</sup> Edition, Dorling Kindersley (India) Pvt. Ltd.

10. Furniss B.S., Hannaford A.J., Smith P.W.G. and Tatchell A. R., Vogel's Textbook of Practical Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Plummer, David J., An Introduction to Practical Biochemistry, Mc Graw Hill, New Delhi.
12. Ghosh S. K., Advanced General Organic Chemistry- A Modern Approach, Part-I & II, 3<sup>rd</sup> Edition, New Central Book Agency (P) Ltd.
13. Bruice P.Y., Organic Chemistry, 3<sup>rd</sup> Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
14. Jenkins G.L., Hartung W.H., Hamlin K.E. and Data J.B., The Chemistry of Organic Medicinal Products, 4<sup>th</sup> Edition, Pharma Med Press, Hyderabad.

**PHARMACEUTICS-II (UNIT OPERATIONS)**

**Unit-I**

**Stoichiometry:** Introduction, unit processes, material and energy balance, primary and secondary quantities, equilibrium state, rate process, steady and unsteady states, basic laws.

**Automated process control systems:** Process variables, temperature, pressure, flow level and their measurements. Elements of automatic process control and introduction to reactors.

**Unit II**

**Water systems:** Raw water, soft water, purified water, water for injection, quality requirement and treatment of water. Washing, cleaning and standardization of cleaning.

**Filtration and centrifugation:** Theory of filtration, filter aids, filter media, industrial filters including filter press, rotary filter, edge filter. Factors affecting filtration. Principles of centrifugation, industrial centrifugal filters and centrifugal sedimenters.

**Unit III**

**Drying :** Moisture content and mechanism of drying , rate of drying and time of drying calculations, classification and type of dryers , dryers used in pharmaceutical industries: tray dryer, fluidized bed dryer, spray dryer and special drying methods.

**Unit IV**

**Heating, ventilation and AC systems:** Basic concepts and definition, wet bulb and adiabatic saturation temperatures, psychrometric chart and measurement of humidity, application of humidity measurement in pharmacy, equipment for dehumidification operations. Principles and applications of refrigeration and air conditioning.

**Unit V**

**Material of construction:** General study of composition, corrosion, resistance, properties and applications of the materials of construction with special reference to stainless steel and glass.

**Industrial hazards and safety precautions:** Mechanical, chemical, electrical, fire and dust hazards. Industrial dermatitis, accident records.

**PHARMACEUTICS-II (UNIT OPERATIONS) PRACTICAL**

**Suggested Practicals**

1. Study of factors affecting rate of filtration
  - a) Effect of different filter media.
  - b) Effect of viscosity of filtrate.
  - c) Effect of pressure.
  - d) Effect of thickness of cake.
  - e) Effect of filter aids.
2. Study of factors affecting rate of drying
  - a) Surface area.
  - b) Temperature.
3. Determination of rate of drying, free moisture content and bound moisture content.
4. Study of principle of centrifugation for
  - a) Liquid–liquid separation and stability of emulsions.
  - b) Solid–liquid separation and stability of suspension.
5. Determination of dry bulb and wet bulb temperatures and use of psychrometric charts.

**BOOKS RECOMMENDED**

1. Badger W.L. and Banchemo J.T. Introduction to Chemical Engineering, Mc Graw Hill International Book Co., London.
2. Perry R.H. & Chilton C.H. Chemical Engineers Handbook, Mc Graw Kogakusha Ltd.
3. McCabe W.L. and Smith J.C. Unit Operation of Chemical Engineering Mc Graw Hill International Book Co., London.
4. Sambhamurthy K., Pharmaceutical Engineering, New Age Publishers.
5. Brown G. G., Unit Operations, CBS Publishers, New Delhi.
6. Leon Lachman, Herbert A. Liebermann, Joseph Louis Kanig, The Theory and Practice of Industrial Pharmacy, Varghese Publishing House, New Delhi.
7. Carter S.J., Cooper and Gunn's Tutorial Pharmacy, CBS Publishers, New Delhi.
8. Levin M. (Ed), Pharmaceutical Process Scale-Up, 2nd Edition(Special Indian Edition), Taylor & Francis Group, London.
9. Sarma A.M., Safety and Health in Industry A Handbook, BS Publications, Hyderabad.



**PHARMACEUTICS-III (HOSPITAL & COMMUNITY PHARMACY)**

**Unit I**

**Organization and structure:** Organization of a hospital and hospital pharmacy, responsibilities of a hospital pharmacist. Pharmacy and therapeutic committee, Budget preparation and implementation.

**Hospital formulary:** Contents, preparation and revision of hospital formulary.

**Unit II**

**Drug distribution systems in hospitals:** Out-patient dispensing, methods adopted. Dispensing of drugs to in-patients. Types of drug distribution systems charging policy, labeling, dispensing of drugs to ambulatory patients. Dispensing of controlled drugs.

**Central sterile supply units and their management:** Types of materials for sterilization, packing of materials prior to sterilization, sterilization equipments, supply of sterile materials.

**Unit III**

1. Definition, scope of community pharmacy. Roles and responsibilities of community pharmacist.

2. **Community pharmacy management**

- i. Selection of site, space layout, and design.
- ii. Staff, Materials- coding, stocking.
- iii. Legal requirements.
- iv. Maintenance of various registers.

3. **OTC Medication:** Definition, OTC medication list and counseling.

**Unit IV**

**Pharmacoepidemiology and pharmacoconomics :** Brief introduction.

Communication skills & Patient counseling. Patient information leaflets- content, design, layouts, advisory labels. Patient compliance- definition, factors affecting compliance, role of pharmacist in improving the compliance. Rational drug therapy.

**Unit V**

**Drug information service:** Sources of information on drugs, treatment schedules, procurement of information, computerized services (e.g. MEDLINE), retrieval of information, medication error.

**Records and reports:** Prescription filling, drug profiles, patient medication profile, cases on drug interaction & adverse reactions, idiosyncratic cases etc.

**PHARMACEUTICS-III (HOSPITAL & COMMUNITY PHARMACY) PRACTICAL**

**Suggested Practicals**

1. Sterilization of packaging material.
2. Validation of sterilizing equipment.
3. Designing of patient information leaflet.
4. Preparation of Master Formula Record.
5. Sterilization and evaluation of surgical materials.
6. Sterilization of infusion, eye drops, eye ointments, gels.
7. Categorization and storage of pharmaceutical products based on legal requirements of labeling and storage.
8. Study of OTC medication. List and available brands.
9. Study of first aid treatment methods- fire, shock, and chemical.
10. Study of various pathological reports of blood and urine.

**BOOKS RECOMMENDED**

1. Hasan, Hospital Pharmacy, Lea & Febiger, Philadelphia.
2. Merchant H.S. and Qadry J.S. Text Book of Hospital Pharmacy, B.S. Shah Prakashan, Ahmedabad.
3. Carter S.J. Cooper and Gunn's Dispensing for Pharmaceutical Students, CBS Publishers, Delhi.
4. Ansel H.C., Introduction to Pharmaceutical Dosage Forms, K.M. Varghese & Co., Bombay.
5. Aulton M.E. Pharmaceutics – The Science of Dosage Form Design, ELBS/ Churchill Livingstone.
6. Remington Pharmaceutical Sciences, Mack Publishing Co., Pennsylvania.
7. Indian Pharmacopoeia, Ministry of Health and Family Welfare, Published by Govt. of India.
8. British Pharmacopoeia, Her Majesty's Stationary Office, Cambridge.
9. Thompson J. E., Contemporary Pharmacy Practice, Lippincott Williams & Wilkins.
10. Parmar N.S. Community Pharmacy & Health Education, CBS Publishers.
11. Parthasarathi G., Nyfort-Hansen K. Nahata M. C. A Text Book of Clinical Pharmacy Practice, Orient Longman Pvt Ltd, Chennai.

**ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY-III**

**Unit I**

**Respiratory system:** Anatomy & function of respiratory structures, mechanism of respiration, regulation of respiration, pathophysiology of asthma, pneumonia, bronchitis, emphysema, tuberculosis.

**Unit II**

**Cardiovascular system:** Functional anatomy of heart, conducting system of heart, cardiac cycle, ECG (Electrocardiogram). Pathophysiology of hypertension, angina, CHF, myocardial infarction, cardiac arrhythmias, ischaemic heart disease, arteriosclerosis.

**Unit III**

**Reproductive system:** Male & Female reproductive systems. Menstruation, pathophysiology of sexually transmitted diseases, spermatogenesis, oogenesis, pregnancy.

**Unit IV**

**Endocrine system:** Anatomy & Physiology of pituitary, thyroid, parathyroid, adrenal, pancreas. Control of hormone secretion, pathophysiology of hypo & hyper secretion of endocrine glands & their disorders, e.g.- Diabetes mellitus.

**Unit:V**

**Cell injury:** Causes of cell injury, pathogenesis & morphology of cell injury. Cellular Adaptation- atrophy, hypertrophy, aplasia, metaplasia & dysplasia, pathophysiology of neoplasm.

**Inflammation:** Basic mechanisms involved in the process of inflammation and repair: Alterations in vascular permeability and blood flow, migration of WBCs, mediators of inflammation. Brief outline of the process of repair.

**ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY-III PROJECT**

1. The preparation of charts/ models of following:
  - a. Various parts of respiratory system- nose, pharynx, trachea, lungs etc.
  - b. Parts of cardiovascular system, heart, conducting system of heart etc.
  - c. Cardiac cycle, ECG.
  - d. Male reproductive system.
  - e. Female reproductive system.
  - f. Spermatogenesis.
  - g. Oogenesis.
  - h. Phases of pregnancy.
  - i. Different types of endocrine glands.

**BOOKS RECOMMENDED**

1. Dipiro J.L., Pharmacotherapy: A Pathophysiological Approach, Elsevier.
2. Robbins S.L., Kumar V., Basic Pathology, WB Saunders Company.
3. Ross and Wilson, Anatomy & Physiology in Health and Illness, Churchill Livingstone.
4. Tortora GJ & Anagnostoukos NP, Principles of Anatomy and Physiology, Harper & Row Publishers, New Delhi.
5. Difore S.H., Atlas of Normal Histology, Lea and Febiger, Philadelphia.
6. Chaurasia B.D., Human Anatomy, Regional and Applied Part I, II & III, CBS Publishers & Distributors, New Delhi.
7. Guyton A.C., Hall J.E., Text book of Medical Physiology, WB Saunders Company.
8. Chatterjee C.C., Human Physiology, Medical Allied Agency, Calcutta.
9. Keele, C.A., Niel, E. and Joels N., Samson Wright's Applied Physiology, Oxford University Press.
10. McCorry L.K., Essentials of Human Physiology for Pharmacy, 2<sup>nd</sup> Special Indian Edition, CRC Press (Taylor & Francis Group).

## PHARMACOGNOSY- II

### Unit I

**Introduction to different systems of medicine:** Brief introduction and principles of Ayurvedic, Unani, Siddha and Homeopathic systems of medicine. Introduction to Herbal Pharmacopoeia with special reference to arishtas, asavas, gutikas, tailas, churnas, lehyas and bhasmas.

### Unit II

**Medicinal plants:** Introduction to medicinal plants with biological source, macro and microscopy, chemical constituents and uses of Kalmegh, Aswagandha, Bael, Guggulipid, Ginseng, Tulsi, Neem.

**Pharmaceutical aids:** Study of Pharmaceutical aids like talc, diatomite, kaolin, bentonite, fullers earth, gelatin and natural colours.

### Unit III

**Resins:** Study of drugs containing Resins and Resin Combination like Podophyllum, Cannabis, Capsicum, Shellac, Asafoetida, Balsam of tolu, Balsam of peru, Benzoin, Turmeric, Ginger.

**Enzymes:** Biological sources, preparation, Identification tests and uses of following enzymes– Diastase, Papain, Penicillinase, Hyalluronidase, Streptokinase.

### Unit IV

**Aromatic plants:** Introduction to aromatic plants with biological source, macro and microscopy, chemical constituents and uses of Mentha, Coriander, Clove, Fennel, Geranium oil, Lemon grass, Citronella, Cumin, Eucalyptus, Nutmeg, Cardamom.

**Fibres:** Study of fibers used in pharmacy such as cotton, silk, wool, jute, asbestos.

### Unit V

Classification of pesticides, methods for determination of pesticide residues, maximum limit of pesticide residues for medicinal plant materials. Determination of microorganisms in plant drugs. Study of radioactive contamination in medicinal plant materials.

**PHARMACOGNOSY– II PRACTICAL**

**Suggested Practicals**

1. Microscopic study of plant epidermal trichomes, stomata, veins, endodermis, sclereids, fibers, xylem, phloem.

Measurement of Trichomes, Fibres and Stomata using camera lucida.

2. Identification & morphology of Mentha, Lemongrass, Nutmeg, Turmeric, Ginger, Cannabis.

3. Morphology & microscopy of Coriander, Cinnamon, Fennel, Clove.

4. Chemical evaluation of enzymes.

5. Study of Cotton, Silk and Wool along with their chemical tests.

6. Utilization of Aromatic plants ((Monograph).

**BOOKS RECOMMENDED**

1. Trease G.E. & Evans W.C., Pharmacognosy, Elsevier India Pvt. Ltd.

2. Tyler V.E., Brady L.R. and Robbers J.E. Pharmacognosy, 9<sup>th</sup> Edition, Wolter Kluwer (India) Pvt. Ltd., New Delhi.

3. Bruneton J., Pharmacognosy Phytochemistry Medicinal Plants, Lavoisier Publishing Inc.

4. Indian Herbal Pharmacopoeia, Vol. I and II, Indian Drug Manufacturers Association.

5. Wallis, T.E., Text Book of Pharmacognosy, J&A Churchill Ltd, London.

6. Atal C.K. and Kapur B.M., Cultivation & Utilization of Medicinal Plant, RRL, Jammu.

7. Pharmacopoeia of India, The Controller of Publications, Vol. III, Delhi.

8. Dutta A.C., Botany, Oxford University Press.

9. Wallis T.E., Practical Pharmacognosy, PharmaMed Press, Hyderabad.

10. Kokate, C.K., Practical Pharmacognosy, Vallabh Prakashan, Delhi.

11. Purohit S.S. and Prajapati N.D., A Handbook of Indian Medicinal Plants, Agro Bios (India).

12. Sukh Dev, A Selection of Prime Ayurvedic Plants Drugs, Anamaya Publishers.

## FOURTH SEMESTER

**BOP-241**

### **PHARMACEUTICAL CHEMISTRY-IV (MOLECULAR BIOLOGY & BIOCHEMISTRY)**

#### **Unit I**

Introduction and scope of molecular biology. Introduction to micromolecules and macromolecules with their biological significance. Covalent and weak non-covalent bonds in macromolecules. Protein conformation and dynamics. Biological membranes, membrane proteins, conjugated proteins, membrane lipids and glycans with their biological functions. Cell signaling.

#### **Unit II**

**Enzymes:** Nomenclature, enzymes-kinetics and mechanism of action, mechanism of inhibition of enzymes, isoenzymes in chemical diagnosis, cofactors.

**Nucleic acids:** Biosynthesis of purine and pyrimidine nucleotides (*De Novo* and Salvage pathway).

#### **Unit III**

Central dogma of molecular biology, DNA replication, transcription. DNA damage and repair mechanisms. Components of protein synthesis, translation, post translational modifications and inhibition of protein synthesis. Regulation of gene expression (Prokaryotes and Eukaryotes). Cell cycle and its regulation.

#### **Unit IV**

Biosynthesis of nutritionally non-essential amino acids, catabolism of amino acid nitrogen, catabolism of carbon skeleton of amino acid (Aromatic: Tyrosine, Tryptophan; Aliphatic: Histidine, Asparagine, Glutamine, Glycine). Conversion of amino acids to specialized products (Epinephrine, GABA, Creatinine, Glutathione).

#### **Unit V**

Cholesterol biosynthesis. Regulation of carbohydrate & lipid metabolisms. Role of sugar in nucleotides biosynthesis, biosynthesis of ketone bodies and their utilization. The respiratory chain, its role in energy capture and control. Mechanism and energetic of oxidative phosphorylation.

**PHARMACEUTICAL CHEMISTRY-IV  
(MOLECULAR BIOLOGY & BIOCHEMISTRY) PRACTICAL**

**SUGGESTED PRACTICALS**

1. Separation of amino acids by chromatography (paper and thin layer chromatography).
2. Separation of lipids by TLC.
3. Titration curve for amino acids.
4. Quantitative estimation of proteins using UV-Visible spectrophotometer.
5. Quantitative estimation of glucose using glucose oxidase enzyme.
6. Enzymatic hydrolysis of glycogen by and amylases.
7. Effect of temperature on the activity of amylase.
8. Qualitative analysis of inorganic as well as organic constituents of urine.
9. Estimation of glucose in blood and urine samples.
10. Estimation of cholesterol in blood samples.
11. Estimation of urea in blood samples.
12. Estimation of ketone bodies in blood samples.
13. Estimation of various components using semi-autoanalyzer.

**BOOKS RECOMMENDED**

1. Murray R.K. and Granner D.K., Harper's Illustrated Biochemistry, Lange Medical Publication.
2. Nelson D.L. and Cox M.M., Lehninger Principles of Biochemistry, Macmillan Worth Publishers.
3. Voet D., Voet J.G., Pratt C.W. Fundamentals of Biochemistry, John Wiley and Sons Inc.
4. Champe P.C., Harvey R.A., Ferrier D.R. Lippincott's Illustrative Reviews: Biochemistry, Lippincott Williams and Wilkins.
5. Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
6. Dugas H., Bioorganic Chemistry: A Chemical Approach to Enzyme Action, 3<sup>rd</sup> Edition, Springer (India) Private Limited, New Delhi.
7. Lodish H., Berk A., Matsudaira P., Kaiser C.A., Krieger M. and Scott M.P. Molecular Cell Biology, W. H. Freeman and Company, New York.
8. Becker W.M., Kleinsmith L.J. and Hardin J. The World of the Cell, Pearson Education.



9. Conn E.E. and Stumph P.K., Outline of Biochemistry, John Wiley & Sons, New York.
10. Stryer L. and Berg J.M., Biochemistry, W.H. Freeman and Company, New York.
11. Harrow B. and Mazur A., Text book of Biochemistry, W.B. Saunders Co., Philadelphia.
12. Plummer D.J., An Introduction to Practical Biochemistry, Mc Graw Hill, New Delhi.
13. Jayaraman J., Laboratory Manual in Biochemistry, Wiley Eastern Limited.
14. Singh S.P., Practical Manual to Biochemistry, CBS Publisher, New Delhi.
15. Boyer R.F. Modern Experimental Biochemistry, Dorling Kindersley (India) Pvt. Ltd.
16. Verley H. Practical Clinical Biochemistry, CBS Publishers and Distributors. New Delhi.
17. Deb A.C. Comprehensive Viva and Practical Biochemistry, New Central Book Agency (P.) Ltd.  
London.
18. Vyas S.P. and Kohli D.V., Pharmaceutical Biochemistry, 1st Edition, CBS Publishers & Distributors,  
New Delhi.

## **PHARMACEUTICS-IV (PHYSICAL PHARMACY)**

### **Unit I**

**Drug stability:** Degradative pathways, influence of temperature, light, solvent, catalytic species and other factors on drug stability, accelerated stability study, expiration dating.

**Buffers:** Buffered isotonic solutions, measurements of tonicity, calculations and methods of adjusting isotonicity.

### **Unit II**

**Micromeritics and powder rheology:** Particle size and distribution, average particle size, number and weight distribution, methods for determining particle volume, optical microscopy, sieving, sedimentation, measurement, particle shape, specific surface, methods for determining surface area (air permeability and adsorption method), derived properties of powders, porosity, packing arrangement, densities, bulkiness and flow properties.

### **Unit III**

**Surface and interfacial phenomenon:** Liquid interface, surface and interfacial tension, surface free energy, measurement of surface and interfacial tension, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB classification, solubilization, detergency, adsorption at solid-liquid interfaces, complex films, electrical properties of interface and applications.

### **Unit IV**

**Viscosity and rheology:** Newtonian systems, law of flow, kinematic viscosity, factors affecting viscosity of formulations, non-Newtonian systems: Pseudoplastic, dilatant, plastic and thixotrophy, determination of viscosity by falling sphere, rotational viscometers.

### **Unit V**

#### **Dispersion systems**

**Colloidal dispersions:** Brief introduction to colloids: types and application in pharmacy.

**Suspensions:** Settling in suspensions, theory of sedimentation, effect of Brownian movement, sedimentation of flocculated particles, sedimentation parameters, wetting of particles, controlled flocculation, flocculation in structured vehicles, rheological considerations.

**Emulsions:** Theories and physical stability.

**PHARMACEUTICS-IV (PHYSICAL PHARMACY) PRACTICAL**

**SUGGESTED PRACTICALS**

1. Determination of particle size, Particle size distribution and surface area using various methods of particle size analysis.
2. Determination of derived properties of powders like density, porosity, compressibility, angle of repose etc.
3. Determination of surface/ interfacial tension, HLB value and critical micellar concentration of surfactants.
4. Study of rheological properties of various types of systems using different Viscometers.
5. Studies of different types of colloids and their properties.
6. Preparation of various types of suspensions and determination of their sedimentation parameters.
7. Preparation and stability studies of emulsions.
8. To study the influence of various factors on the rate of reaction.
9. Accelerated stability testing, shelf-life determination and expiration dating of pharmaceuticals.
10. Experiments involving tonicity adjustments.

**BOOKS RECOMMENDED:**

1. Martin A, Bustamante P. & Chun A.H.C- Physical Pharmacy, Lea & Febiger, Philadelphia.
2. Shotten E & Ridgeway K, Physical Pharmaceutics, Oxford University Press, London.
3. D.V.Derle , Essentials of Physical Pharmacy.
4. Modern Pharmaceutics, Banker and Rhodes.
5. Aulton, M.E, Pharmaceutics, The Design and Manufacture Of Medicines, Churchill Livingstone.
6. Hajare, A. Physical pharmacy, New Central Book Agency Pvt. Ltd., Kolkata.

**PHARMACEUTICS-V (COSMETIC TECHNOLOGY)**

**Unit I**

Introduction to cosmetics, classification of cosmetics.

**Functional excipients:** Colorants, plasticizers, humectants, thickeners, perfumes.

Brief study of skin structure, dermal/ percutaneous absorption.

**Unit II**

Toxicity studies on cosmetic products; corrosiveness, skin irritation, repeated dose toxicity, carcinogenicity, photo-induced toxicity.

**Formulation and evaluation of following cosmetics:** Cold cream, vanishing cream, lotions, cleansing lotion, moisturizers, powders, face wash, face pack. Role of exfoliating agents, anti ageing and SPF.

**Baby care products:** Soaps, shampoo, creams, lotion, powder.

**Unit III**

**Formulation development of cosmetic products:** Shampoo, conditioners, hair colors, depilatories, nail lacquers, kohl, mascara, eye liner, eye shadow, toothpowder, toothpaste, lipstick, lip balm.

**Shaving preparations:** Skin conditioners, beard softeners, lather preparations, aerosol foams, after shave lotions, balms and creams.

**Unit IV**

Safety evaluation of finished cosmetic product: Stability, physical and chemical characteristics, microbial quality.

**Anti perspirants and deodorants:** Introduction and types.

**Unit V**

**Herbal cosmetics:** Brief study of natural depigmentation agents and antioxidants. Formulations of herbal creams, powders, gel, shampoo, hair color, conditioners, face pack, face wash, lip balm, hair oils, soaps for cosmetic use.

**PHARMACEUTICS- V (COSMETIC TECHNOLOGY) PRACTICAL**

**Suggested Practicals**

To prepare and evaluate the following cosmetics-

- |                   |                        |
|-------------------|------------------------|
| 1. Cold cream     | 2. Vanishing cream     |
| 3. Body lotion    | 4. Face powder         |
| 5. Body Powder    | 6. Liquid shampoo      |
| 7. Tooth powder   | 8. Tooth paste         |
| 9. Shaving cream  | 10. After shave lotion |
| 11. Nail lacquers | 12. Lipstick           |

Preparation of the following herbal products-

1. Shampoo
2. Cream
3. Face pack
4. Lip balm
5. Soap

**BOOKS RECOMMENDED**

1. Harry R.G., Reiger M.M., Harry's Cosmeticology, Chemical publishing company. Newyork
2. Balsam M.S., Sagarin E., Cosmetics: Science and Technology. Wiley Interscience. Newyork
3. Rao Y.M., Shayeda, Cosmeceuticals, Pharma Med Press. Hyderabad
4. Paye M., Basel A.O., Maibach H.I., Handbook of Cosmetic Science & Technology, Informa Healthcare. Newyork
5. Sharma P.P., Cosmetics Formulation, Manufacturing and Quality control, Vandana Publication Pvt. Ltd. Delhi
6. Poucher W.A., Butler H., Poucher's Perfumes, Cosmetic & Soaps, Springer India Pvt. Ltd. New Delhi.
7. Nanda S., Nanda A., Cosmetic Technology, Birla Publication, Delhi.
8. SCCS's Notes of Guidance for the Testing of Cosmetic Ingredients and their Safety Evaluation, 7th Revision. European Commission.
9. Indian Pharmacopoeia 2014(7<sup>th</sup> edition), Ministry of Health and Family Welfare, Published by Govt. of India.

## **PHARMACEUTICAL ANALYSIS- II**

Theoretical considerations and application in drug analysis and quality control by the following analytical techniques (assays included in the Indian Pharmacopoeia)-

### **Unit I**

**Non-aqueous titrations:** Basic concepts, types of solvents, leveling and differentiating solvents, titrations of weakly acidic and weakly basic compounds (assay of drugs like nitrazepam, chlorpromazine and ethosuccimide).

**Complexometric titrations:** Principle, complexing agents, indicators, masking and demasking, types of complexometric titrations, assay of some drugs like alum, calcium gluconate injection and determination of hardness of water.

### **Unit II**

Introduction, dielectric cell, electrode potential, Nernst equation, salt bridge, standard potential, reference and indicator electrodes.

Potentiometry: General principles, instrumentation, types of potentiometric titrations, advantages and applications.

Conductometry: General principles, effect of dilution, conductance measurement, types of conductometric titrations, merits, demerits, instrumentation and applications.

### **Unit III**

General principles (adsorption and partition), classification and theories (plate and rate) of chromatography. Retardation factor, selection of stationary and mobile phase, development of chromatogram and its visualization.

**Paper chromatography:** Introduction, types (ascending, descending, ascending-descending, radial and two dimensional), applications.

**Thin layer chromatography (TLC):** Introduction, types and techniques of TLC, applications. Introduction to high performance thin layer chromatography (HPTLC).

### **Unit IV**

**Column chromatography:** Introduction, selection and preparation of column, flash chromatography, applications.

**High performance thin layer chromatography (HPLC):** Introduction, instrumentation (sample injection system, pumps, columns and guard columns, detectors) and applications. Reverse Phase-High Performance Liquid Chromatography (RP-HPLC).

Introduction to gas liquid chromatography (GLC).

#### **Unit V**

**Miscellaneous methods of analysis:** Diazotization titrations, Kjeldahl method of nitrogen estimation, Karl- Fischer titration. Radioassays (RIA, ELISA, Autoradiography).

**Polarography:** Principles, instrumentation and applications.

**Amperometry:** Principles, instrumentation and applications including amperometric titrations.

**PHARMACEUTICAL ANALYSIS- II PRACTICAL**

**Suggested Practicals**

1. Preparation and standardization of perchloric acid by non-aqueous titration.
2. Preparation and standardization of sodium/potassium methoxide solutions by non-aqueous titration.
3. Preparation and standardization of EDTA/Dimethylglyoxime solution.
4. Assay of magnesium hydroxide/ magnesium sulfate by complexometric titrations.
5. Determination of hardness of water by complexometric titration.
6. Preparation and standardization of sodium nitrite by diazotization titration method.
7. Assay of sulfa drugs by diazotization titration method.
8. To determine moisture content in drug by Karl Fischer method.
9. Determination of end point in acid base titration and oxidation reduction titration by potentiometric technique.
10. Determination of end point in acid base titration by conductometric methods.
11. Exercises based on paper, column and thin layer chromatography.
12. Demonstration of HPLC.

**BOOKS RECOMMENDED:**

1. Beckett A. H. and Stenlake, J.B., Practical Pharmaceutical Chemistry, Vol, I & II, CBS Publishers, New Delhi.
2. Pharmacopoeia of India, Published by The Controller of Publications, Delhi.
3. British Pharmacopoeia, Her Majesty's Stationary Office, University Press, Cambridge.
4. Mendham J., Denny R.C., Barnes, J.D. Thomas M.J.K., Vogel's Text Book of Quantitative Chemical Analysis, Pearson Education Asia.
5. Connors K.A., A Textbook of Pharmaceutical Analysis, Wiley Intescience, New York.
6. Synder L. R., Joseph. J., K., Dolan J. W. Introduction to Modern Liquid Chromatography, 3<sup>rd</sup> Edition, Wiley Publications.
7. Sethi P.D., HPLC-Quantitative Analysis of Pharmaceutical Formulations, CBS Publishers, New Delhi.



8. Sethi P.D., HPTLC-Quantitative Analysis of Pharmaceutical Formulations, CBS Publishers, New Delhi.
9. Stahl E., Thin Layer Chromatography- A Laboratory Handbook, Springer-Verlag.
10. Braun R.D., Introduction to Instrumental Analysis, PharmaMed Press, Hyderabad.

**BOP 245**

**PHARMACEUTICAL JURISPRUDENCE & INTELLECTUAL PROPERTY RIGHTS**

**Unit I**

Introduction to pharmaceutical jurisprudence. Pharmaceutical legislations- a brief review. Drugs and pharmaceutical industry- a brief review. Pharmaceutical education-a brief review. Pharmaceutical Ethics. Poisons Act 1919. Drugs Price Control Order 1995.

**Unit II**

An elaborate study of the following: Pharmacy Act 1948. Drugs and Cosmetics Act 1940 and Rules 1945.

**Unit III**

Narcotic Drugs and Psychotropic Substances Act 1985 and Rules. Medicinal and Toilet Preparations (Excise Duties Act 1955). Prevention of Cruelty to Animals Act 1961. Drugs and Magic Remedies (objectionable advertisements) Act 1954.

**Unit IV**

A brief study of the following with special reference to the main provisions.

Patents act 1970. Indian Copyright Act 1957

**Unit V**

A brief study of: The Trademarks Act 1999. The Designs Act 2000. The Geographical Indication of Goods (registration and protection) Act 1999.

Note : The teaching of all the above Acts should cover the latest amendments.

***BOP 245P***

**PHARMACEUTICAL JURISPRUDENCE PROJECT (CASE STUDIES)**

The students shall study cases based on the acts mentioned in theory syllabus.( for example-cases of revoked patents in India; cases of evergreening ; patent of basmati, haldi, neem; schedule M and revised schedule M, trademark infringement and so on). Further, different cases shall be assigned to the students, based on the acts mentioned in the theory syllabus, on which the projects shall be prepared.

**BOOKS RECOMMENDED**

1. Mittal B.M., Textbook of Forensic Pharmacy, National Book Centre, Calcutta.
2. Relevant Acts and Rules Published by the Govt. of India.
3. Jain N.K., A Textbook of Forensic Pharmacy, Vallabh Prakashan, New Delhi.
4. Singh, H., History of Pharmacy in India-Vol.-I, II & III, Vallabh Prakashan.
5. Bare Acts, Published by The Government of India, New Delhi.