

Gujarat Technological University

B.Pharm Semester-I

Structure for First Semester of Degree Pharmacy Course

Sr. No	Subjects	Teaching Scheme		
		Theory	Practical	Credits
1	Elementary (Remedial) Mathematics	2	-	2
2	Basic Computer Applications	2	3	5
3	Pharmaceutical Engineering	3	3	6
4	Pharm Chemistry-I	3	3	6
5	Pharmaceutics –I (Unit Operations -I)	3	3	6
6	Anatomy Physiology & Health Education (APHE-I)	3	2	5
	Total	16	14	30

Gujarat Technological University

B.Pharm Semester-I

Elementary (Remedial) Mathematics

Theory(2 Hours / Week; 2 Credits)

- 1. Algebra:**
Equation reducible to quadratic, simultaneous (linear & quadratic), Determinants, properties of solution of simultaneous equations by Cramer's rule, matrices, definition of special kind of matrices, arithmetic operations on matrices, pharmaceutical applications of determinants & matrices, Evaluation of E_{n1} , E_{n2} & E_{n3} mensuration & its pharmaceutical applications.
- 2. Measures of dispersion:**
Range, average deviation, standard deviation, probability & probability distribution.
- 3. Permutation ,combination, AP GP, Binomial theorem**
- 4. Trigonometry:**
measurement of angle, T-ratios, addition subtraction & transformation formulae, T-ratios of multiple sub- multiple, allied & certain angles. Application of logarithm in pharmaceutical computation.
- 5. Analytical plans geometry:**
Certain co-ordinates, distance between two points, areas of triangle, a locus point, straight line slope & intercept from double-intercept form, normal (perpendicular form), slope point & two point form, general equation from first degree.
- 6. Calculus:**
Differential: Limits & functions, definitions of differential coefficient differentiations of standard functions, including a function of a function (chain rule). Differentiation of implicit faction, logarithms differentiation, parametric differentiation, successive differentiation.
Integral: Integration as inverse of differentiation, indefinite integrals of standard forms, integration by parts, substitution & partial fractions, formal evaluation of definite integrals.

Differential equation of first order & first degree, V.S. method, homogeneous & linier differential equation, pharmaceutical application on differential equation.

Books Recommended

1. Remedial Mathematics by Gupta & Prabhakar ; Pragati Prakashan
2. Remedial Mathematics for Pharmacy by R.C.Kachot; Mahajan Prakashan
3. College Mathematics by Kai L. NILSON, Barnes & Noble inc.

Basics of Computer Applications

Theory(2 Hours / Week; 2 Credits)

1. **Computer Fundamentals:** **3hrs**
Definition, characteristics, history, computer terminology, computer organization, input & output devices, storage devices (including latest devices), classifications of computers (including current computer systems), binary conversions and ASCII code, application of computers in pharmacy, introduction to computer virus.

2. **Operating Systems:** **3hrs**
 - a. Definition, functions of an operating system, types of operating systems and their characteristics.
 - b. **DOS**
Introduction, basic DOS commands such as creating directory, copying creating files, backup, restore, autoexec.bat file, config.sys file, etc. internal and external commands for file and directory management.
 - c. **Windows:**
Desktop, start-menu, control panel, accessories, my computer, my documents, recycle bin, printer and mouse settings, maximizing, minimizing, restoring and closing of windows, windows explorer

3. **MS Word:** **6hrs**
Word Essentials, the word workplace, Parts of MS Word screen, Typing and Editing, Finding and Replacing, Autocorrect and Autotext, Reusing Text and Graphics, use of spellcheck & grammer, thesaurus and scientific symbols, viewing of document by various ways Editing Tools, Formatting Text Formatting Text Character, Formatting Paragraphs, Formatting and Sorting Lists, Page Design and Layout, Page Setup : Margins, Page Numbers, and Other Items, Newspaper -style Columns, Working with Tables Creating and formatting of tables and sorting, merging etc. of data in tables. Inserting, deleting and sizing of rows and columns in tables, Opening, Saving and Protecting Documents, Locating and Managing Documents Printing, Assembling Documents with Mail Merge,

4. **MS Excel:** **6hrs**
Introduction to EXCEL worksheet, calculations in EXCEL, preparation of templates for application in pharmaceutical chemistry, pharmaceutical technology, pharmacology and pharmacognosy (statistical treatment of data for Beers Lamberts curve, solution of problems based on physical chemistry, pharmaceutical engineering, stability study, area under the curve, bio-assay, bioequivalence study, extraction, Rf value, etc.) Special attention must be given to arithmetic expressions. Hierarchy of operation, library functions such as logarithm, squareroot, standard deviation, sum, average, t-test, ANOVA etc. Drawing graphs in EXCEL line graph, histogram, pie-chart- At least one graph for each discipline of chemistry, pharmaceutical technology, pharmacology and pharmacognosy -Editing chart features such as annotation, labeling of axis, changing legends etc.

Gujarat Technological University

B.Pharm Semester-I

5. **MS PowerPoint** **3hrs**
Creating and viewing a presentation, adding animations and managing slide shows etc.
6. **Introduction to MS Access and Outlook** **3hrs**
7. Introduction to softwares for viewing pdf documents **3hrs**
(ADOBE reader, ACROBAT), drawing simple chemical structures (CHEMDRAW, etc.)
8. **Networking & Internet:** **3hrs**
Computer networks, networking technology, components of network. Internet – Basic terms, software and hardware requirement for internet, process of internet working, internet tools, Email- components and working, study of pharmaceutical web sites and search engines, searching through pharmaceutical data bases, study of patent websites.

Practicals (2 Hours / Week; 3 Credits)

Practical exercises should be based on theoretical topics. Exercise to familiarize students with the use of various DOS commands and WINDOWS environment. Exercises on word processing to execute various commands in preparing and editing documents, preparation of pharmaceutical documents and practical tables of pharmacognosy, pharmaceutical chemistry, pharmaceuticals and pharmacology in MS Word. Preparing and editing worksheets in MS EXCEL, drawing graphs, inserting formulas etc. Demonstration of softwares for viewing .pdf documents (ADOBE reader, ACROBAT), drawing simple chemical structures (CHEMDRAW, etc.)

Demonstration of pharmaceutical web sites including educational, government, commercial & search engines working with E-mail & e-mail software, patent Web-site.

Books Recommended:

1. Windows Vista: Step by Step, Joan Preppernau and Joyce Cox, Prentice Hall of India, New Delhi, 2007.
2. Windows Vista: Plain & Simple, Jerry Joyce, and Marianne Moon, Prentice Hall of India, New Delhi, 2007.
3. DOS commands in easy steps, Harshad Kotecha, Dreamtech Press, New Delhi, 2000.
4. WORD 2000, Guy Hart Davis, BPB Publications, New Delhi, 1999.
5. WORD 2000:fast & easy, Diane Koers, BPB Publications, New Delhi, 2000.
6. Microsoft WORD 2000:Training Guide, Maria Reid, BPB Publications,

Gujarat Technological University

B.Pharm Semester-I

New Delhi, 2000

7. Exploring Microsoft Office XP, John Breeden and Michael Cheek, BPB Publications, New Delhi, 2001.
8. MS Office by Pierce, Prentice Hall of India, New Delhi, 2007
9. MS Office: Plain & Simple, Jerry Joyce, and Marianne Moon, Prentice Hall of India, New Delhi, 2007.
10. MS Office: Step by Step, Joyce Cox, Prentice Hall of India, New Delhi, 2007.
11. Pharmaceutical Statistics, S.Bolton, Marcel Dekker Inc. – 3rd Edition – 1997.
12. Common Statistical Tests - 1st edition - M.B.Kulkarni, S.B.Ghatpande & S.D.Core, Satyajeet Prakashan, Pune.
13. Taxali R.K., P.C. Software for Windows 98 made simple – 8th Edition – 2002 – Tata Mc, New Delhi.
14. MS – Office by Ed. Bott. & Woddy Leohad, Prentice Hall of India, New Delhi, 1999
15. An Introduction to Medical Statistics – 2nd Edition – Martin Bland – Published by ELBS – Oxford University – Great Britain – 1995
16. Accessing and Analysing Data with MS EXCEL, Cornell, Prentice Hall of India, New Delhi, 2007.
17. Manuals available with the software.

Gujarat Technological University

B.Pharm Semester-I

Pharmaceutical Engineering

Theory(3 Hours / Week; 3 Credits)

- 1 **Introduction:** **3hrs**
Pharma engineering and its significance, unit operations and unit processes. Unit systems, SI unit, CgS unit, gas constant and conversion of units. Physical quantities, dimensions and units, dimensional equations, dimensional analysis and dimensionless groups. Different types of graphical representation.
- 2 **Stoichiometry:** **8hrs**
General principles, material balance-tie substances, chemical reactions and molal units, rate process, steady, unsteady and equilibrium state, laws of combining weights, applications of gas laws, energy balance, fuels and combustion, etc., Mathematical problems.
- 3 **Fluid Flow:** **8hrs**
Type of steady flow, Reynold number & its significance, types of pressure, viscosity, concept of boundary layers, total energy balance and total mechanical energy balance, losses in mechanical energy of fluids, basic equations of fluid flow, valves, flow meters, manometers. Mathematical problems.
- 4 **Material handling systems:** **10hrs**
Solids handling- storage, conveyers, vacuum & pneumatic conveying. Liquid handling- storage, pumps Gases- Fans, blowers and compressors. Colour coding of Pipelines, use of forklifts and pallets, store design in pharmaceutical industries.
- 5 **Heat Transfer:** **10hrs**
Modes of heat transfer. Conduction- Fourier's law, resistances in series and parallel, use of mean area and mean temperature difference. Convection-Concept of film, overall coefficient, heat transfer by forced convection in laminar and turbulent flow, condensing vapours, evaluation of individual film coefficients. Radiation-Black body, absorptivity & emmissivity. Heating of fluids, steam as heating medium, properties and uses of steam, steam traps, study of steam table. Heat exchange equipments-Heat exchangers, condensers, boilers, extended surface scraped and surface equipments etc. applications of heat transfer in industrial processes. Mathematical problems.
- 6 **Mass Transfer:** **3hrs**
Principle, streams in mass-transfer operations, solid/fluid and fluid/fluid mass transfer, influence of mass transfer on unit operations.
- 7 **Materials of Pharmaceutical Plant Construction:** **3hrs**
General study of composition, corrosion resistance, properties, factors affecting the selection of material of pharmaceutical plant construction with special reference to stainless steel and glass. Corrosion-types, causes, theories of corrosion and its prevention.

Gujarat Technological University

B.Pharm Semester-I

Practical (3 credits):

Practicals related to topics in pharmaceutical engineering theory should be carried out. Experiments to demonstrate stoichiometry and tie substances in chemical reactions, Study of various flowmeters and ejector pump, Experiment on Reynolds number, Determination of overall heat transfer coefficient, Demonstration of corrosion resistance of various materials.

Introduction to engineering drawing – demonstration of orthographic and isometric projections, demonstration of AUTOCAD, interpretation of pharmaceutical building drawings, pharmaceutical machinery drawings. Flowcharting- drawing of simple flowcharts for pharmaceutical processes.

Books Recommended

- 1 Elementary Chemical Engineering - Max S. Peters, Published by McGraw Hill Book Company, New York, 1954
- 2 Perry's Chemical Engineer's Handbook - Robert H Perry, Green D.W., Maloney J.O. 7th Edition, 1998, McGraw – Hill Inc., New York.
- 3 Tutorial Pharmacy by Cooper & Gunn, ed. S.J.Carter, CBS Publishers & Distributors, Delhi, 6th Edition, 2000.
- 4 Unit Operations of Chemical Engineering, 5th edition - McCabe, Smith & Harriott, McGraw – Hill Inc., New York.
- 5 Pharmaceutical Engineering – K.Sambamurthy, 2002 NAI (P) Ltd., Delhi.
- 6 Pharmaceutics : The Science of Dosage Form Design - M.E. Aulton.
- 7 The Theory & Practice of Industrial Pharmacy – Lachman L., Lieberman H.A. & Kanjig J.L., 3rd edition, 1990 Varghese Publishing House, Bombay.
- 8 Alfonso G. Remington: The Science & Practice of Pharmacy. Vol.I & II. Lippincott, Williams & Wilkins Philadelphia.
- 9 Pharmaceutics I (Pharmaceutical Engineering), Jani G. K., B. S. Shah Prakashan, Ahmedabad.
- 10 Pharmaceutical Engineering : Principles and Practice, Subramanyam C.V.S., Thimma J, Suresh S.S. et. al., 2002, Vallabh Prakashan, Delhi.
- 11 A Textbook of Engineering Drawing Vol. I and II, P.J.Shah, 6th Edition, 2003, Ahmedabad
- 12 Engineering Drawing, 34th edition, N.D.Bhatt Charutar Publishing House, 1994
- 13 Engineering Drawing & Graphic Technology, 13th edition by Thomas E. French, Charles J. Vierch, Rebot J. Foster, McGraw Hill International Edition, New Delhi, 1972
- 14 Introduction to Chemical Engineering by Walter L. Badger & Julius T. Banchemo, Mc graw Hill International edition, New Delhi, 1955.

Gujarat Technological University

B.Pharm Semester-I

Pharmaceutical Chemistry – I (Pharmaceutical Inorganic Chemistry)

Theory(3 Hours / Week; 3 Credits)

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| 1. | Introduction to Pharmaceutical Chemistry. | 1hrs |
| 2. | Impurities in Pharmaceuticals: Sources of impurities, tests for purity and identity, limit tests for iron, arsenic, lead, heavy metals, chloride, sulphate. | 4hrs |
| 3. | An outline of method of preparation, uses, special tests if any, of the following class of inorganic pharmaceuticals included in the current pharmacopoeia: | 3hrs |
| | a) Acids and Bases: Buffers, Waters | 4hrs |
| | b) gastrointestinal agents: Acidifying agents, Antacids, Protective and Adsorbents, Cathartics. | 4hrs |
| | c) Major intra and extra-cellular electrolytes: physiological ions, Electrolytes used for replacement therapy, acids-base balance and combination therapy. | 5hrs |
| | d) Essential and trace elements: Transition elements and their compounds of pharmaceutical importance: Iron and haematinics, mineral supplements. | 3hrs |
| | e) Topical agents: Protective, Astringents and Anti-infectives. | 3hrs |
| | f) Gases and Vapors: Oxygen, Anesthetics and Respiratory Stimulants. | 2hrs |
| | g) Dental products: Dentifrices, Anti-caries agents. | 3hrs |
| | h) Complexing and Chelating agents used in therapy. | 2hrs |
| | i) Miscellaneous agents: Sclerosing agents, Expectorants, Emetics, Poisons and Anti-dotes, Sedatives etc. | 4hrs |
| | j) Pharmaceutical Aids used in pharmaceutical industry : Anti-oxidants, Preservatives, Filter aids, Adsorbents, Diluents, | 6hrs |
| | k) Inorganic Radio pharmaceuticals: Nuclear radiopharmaceuticals, reactions, Nomenclature, Methods of obtaining their standards and units of activity, measurements of activity, clinical applications and dosage, hazards and precautions. | 3hrs |

Practical (3 credit)

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| 1) | The backgrounds and systematic qualitative analysis of Inorganic mixture of up to 4 radicals. Six mixtures to be analyzed, Preferably by semi-micro methods. | 18hrs |
| 2) | All identification tests for pharmacopoeial inorganic pharmaceuticals and qualitative tests for cations and anions should be covered. | 6hrs |
| 3) | Limit tests for Cl, SO ₄ , As, Heavy metals and Lead along with a Few modifications. | 9hrs |
| 4) | Volumetric Analysis of few important compounds covered in theory. | 12hrs |

Gujarat Technological University

B.Pharm Semester-I

Books Recommended:

1. Inorganic Medicinal and Pharmaceutical Chemistry : J. H. Block, E. B. Roche, T. O. Soine, C. O. Wilson, Varghese Publishing House, First Indian Reprint, 1986.
2. Bentley and Driver's Textbook of Pharmaceutical Chemistry: Revised by L. M. Atherden, Oxford University Press, 8th Ed. 1969.
3. The Indian Pharmacopoeia, Latest Edition, Controller of Publications, Delhi.
4. Practical Pharmaceutical Chemistry edited by A. H. Beckett, J. B. Stenlake, CBS Publishers, and First Indian edition 1987.
5. Vogel's Qualitative Inorganic Analysis Revised by G. Svehla, Longman Gr. Ltd., 7th Ed. 1996.

Gujarat Technological University

B.Pharm Semester-I

Pharmaceutics I (Unit Operations I)

Theory(3 Hours / Week; 3 Credits)

1. **Filtration** **8hrs**
Theory and mechanism of filtration process, factors affecting rate of filtration, filter media, filter aids, types of filters, operation of filters, industrial filters-leaf filter, filter press, rotary filter, edge filters, cartridge filters, membrane filters, optimum cleaning cycle in batch filters, etc. Mathematical problems on filtration.
2. **Centrifugation:** **4hrs**
Principle and theory of centrifugation, industrial centrifuges-perforated basket centrifuge, sedimentation type centrifuge, continuous centrifuges etc. Applications in pharmacy.
3. **Evaporation:** **8hrs**
Basic concept of phase equilibria, factors affecting evaporation, heat transfer in evaporators, Duhring's Rule and Raoult's law, evaporators- natural circulation forced circulation & film evaporators, single effect and multiple effect evaporators, mathematic problems.
4. **Distillation:** **8hrs**
Physical concepts, vapour liquid equilibrium relationship, volatility & relative volatility, simple steam and flash distillations, batch and continuous distillation, rectification, distillation columns (packed, plate) and their efficiency, McCabe Thiele method for calculation of number of theoretical plates, azeotropic, molecular & steam distillation, mathematical problems.
5. **Drying:** **9hrs**
Principle, Moisture content, loss on drying, theory & mechanism of drying, drying rate and time calculations, classification of dryers, factors affecting selection of dryers, dryers used in pharmaceutical industries - tray, vacuum, fluidized bed, spray, freeze, tunnel, Microwave, Infra Red(IR), rotary dryers. Mathematical problems on drying.
6. **HVAC(Humidity Ventilation and Air Conditioning):** **8hrs**
Definitions of various terms, wet bulb and adiabatic saturation temperatures, psychrometric chart and determination of humidity, equipments for humidification and de-humidification operations, applications of humidity control in various pharmaceutical processes. Basic concepts and types of refrigeration cycles, air conditioning, applications in pharmacy. Design of HVAC systems.

Gujarat Technological University

B.Pharm Semester-I

Practical(3 Hours / Week; 3 Credits)

Practicals related to topics in theory should be carried out. Experiments on filtration, factors affecting rate of filtration, demonstration of centrifuge, experiments on evaporation, rectification, determination of HETP, comparison of efficiency of packed and plate columns, steam distillation, experiments to determine EMC of various pharmaceutical raw materials, preparation of drying curves and calculation of rates, demonstration of tray dryer, vacuum dryer, fluid bed dryer, Experiments on determination of humidity and related parameters using DBT/WBT and Dew point methods, demonstration of sling psychrometer, dial type and digital humidity measuring instruments.

Books Recommended

- 1 Elementary Chemical Engineering - Max S. Peters,
Published by McGraw Hill Book Company, New York, 1954
- 2 Perry's Chemical Engineer's Handbook - Robert H Perry,
Green D.W., Maloney J.O.7th Edition, 1998, McGraw – Hill Inc., New York.
- 3 Tutorial Pharmacy by Cooper & Gunn, ed. S.J.Carter, CBS Publishers &
Distributors, Delhi, 6th Edition, 2000.
4. Unit Operations of Chemical Engineering, 5th edition – McCabe, Smith &
Harriott, McGraw – Hill Inc., New York.
- 5 Pharmaceutical Engineering – K.Sambamurthy, 2002 NAI (P) Ltd., Delhi.
- 6 Pharmaceutics : The Science of Dosage Form Design - M.E. Aulton.
- 7 The Theory & Practice of Industrial Pharmacy – Lachman L.,
Lieberman H.A. & Kanjig J.L., 3rd edition, 1990
Varghese Publishing House, Bombay.
- 8 Alfonso G. Remington: The Science & Practice of Pharmacy.
Vol.I & II. Lippincott, Williams & Wilkins Philadelphia.
- 9 Jani G. K., Pharmaceutics II (Unit Operations), B. S. Shah Prakashan,
Ahmedabad.
- 10 Subramanyam C.V.S., Thimma J, Suresh S.S. et. al.,
Pharmaceutical Engineering : Principles and Practice, 2002,
Vallabh Prakashan, Delhi.
- 11 Introduction to Chemical Engineering by Walter L. Badger & Julius
T. Banchemo, Mcgraw Hill International edition, New Delhi, 1955.
- 12 Filtration in Pharma. Industry by Theodore H. Meltzer, Marcel Dekker Inc.,
New York, 1987.

Gujarat Technological University

B.Pharm Semester-I

Anatomy physiology and Health education

Theory(3 Hours / Week: 3 Credits: 45 hours)

- 1. Introduction and Scope** of Anatomy and Physiology. **2hrs**
Structural and functional organization of various organ systems. Definitions of various terms used in Anatomy.
- 2. Structure and function of cell** and its components with **7hrs**
Special emphasis on molecular structure of cell membrane, transporter mechanisms, mitochondria and nucleus. Cell cycle and its significance. Mechanism of protein synthesis By cell organelles.
- 3. Elementary tissues of the body.** Various elementary tissues **3hrs**
and their subtypes: epithelial tissue, muscular tissue, connective tissue and nervous tissue.
- 4. Osseous system:** Structure and function of skeleton. Histology **5hrs**
of bone Classification of joints and their function. Joint disorders.
- 5. Muscular system:** Gross anatomy of skeletal muscles. Names, **5hrs**
position, attachments and functions of various muscles. Neuromuscular junction. Physiology of muscle contraction and its components. Properties of skeletal muscles and their significance in health disorders.
- 6. Haemopoietic system:** Composition and functions of blood **6hrs**
and its components. Blood groups. Mechanism of blood coagulation. Haemopoiesis. Brief information regarding disorders of blood.
- 7. Lymph and lymphatic system:** Composition, Formation, and **3hrs**
circulation of lymph. Extra-cellular, Tran-cellular and intra-cellular fluids and their composition. Basic physiology of spleen and serosal cavities. Disorders of lymphatic system.
- 8. Body defense Mechanisms & Immunity:** Basic principles of **3hrs**
immunity, innate immunity, adaptive immunity, immune interactions, immunotherapy, acquired immunity, Reticulo-endothelial System.
- 9. Local Hormones, Inflammation & Allergy:** Functional **5hrs**
importance of histamine, 5-hydroxytryptamine (5-HT), Eicosanoids, Platelet-activating factors (PAF) & peptides with specific reference to their role in inflammation & allergy.
- 10. Digestive system;** Gross Anatomy of the Gastrointestinal **6hrs**
tract. Structure and functions of various organs of alimentary canal and associated organs like Liver, pancreas and gall bladder. Physiology of digestion and absorption. Brief overview of disorders.

Gujarat Technological University

B.Pharm Semester-I

Practical(2 Hours / Week: 2 Credits)

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| 1. Study of the human skeleton. | 2hrs |
| 2. Study with the help of charts and models of the Digestive and Muscular System and organs | 2hrs |
| 3. Histology of elementary tissues and organs of alimentary canal and associated organs | 2hrs |
| 4. Hematology experiments
Use & Care of Microscope
Study of Haemocytometry
Hemoglobin estimation
Total WBC count
Total RBC count
Differential WBC count
Determination of clotting time and bleeding time of blood,
Erythrocyte sedimentation rate (ESR) and Blood Groups
Effect of Osmosis on RBC | 6hrs |
| 5. Amphibian Experiments for Study of Properties of Skeletal Muscle using either demonstrations or computer simulated experiments. | 3hrs |

Books Recommended (Latest Editions)

- 1 William J. Larsen: Anatomy – Development, function, Clinical Correlations– Saunders (Elsevier Science)
- 2 Guyton A.C. and Hall J.E. : Textbook of Medical Physiology – 10th Edition– W.B.Saunders
- 3 Seeley R.R., Stephens T.D. and Tate P.: Anatomy and Physiology 2000– McGraw Hill Co.
- 4 Waugh A. and Grant A.: Ross and Wilson's Anatomy and Physiology in Health & illness — Churchill Livingstone
- 5 Sobotta : Atlas of Human Anatomy (2 Volumes) –Edited by Putz and R. Pabst, Lippincott, Williams and Wilkins
- 6 Anne M.R. Agur & Ming J. Lee: Grant's Atlas of Anatomy –Lippincott, Williams and Wilkins
- 7 Gosling T.A., Harris P.F., Whitmore I., William, Human Anatomy: Color Atlas and Text — Mosby
- 8 Bullock B.L. & Henze R.L., Focus on Pathophysiology –Lippincott
- 9 Martini, F. Fundamentals of Anatomy and Physiology (Prentice Hall)

Gujarat Technological University

B.Pharm Semester-I

- 10 West, J.B. Best and Taylor's physiological Basis of Medical Practice (Williams and Wilkins, Baltimore)
- 11 Tortora G.J. and Anagnodokos, N.P. Principles of Anatomy and Physiology (Harper and Colling Publishers, New York)
- 12 Derasari and Gandhi's Elements of Human Anatomy, Physiology & Health Education Eds R. K. Goyal et. al. (B.S.Shah Prakashan, Ahmedabad)
- 13 Joshi, Vijaya D. Preparatory Manual for Undergraduates Physiology (B.I. Churchill Livingstone) –
- 14 Chatterjee, C.C.Human Physiology (Medical Allied Agency, Calcutta) –
- 15 Goyal, R.K. et al.: Practical Anatomy Physiology and Biochemistry (B.S. Shah Prakashan, Ahmedabad)
- 16 Garg K. et al. A Text Book of Histology (CBS Publishers, New Delhi)
- 17 Lesson, C.R. et al.: Text Book of Histology (W.B.Saunders Company)