

OSMANIA UNIVERSITY

Faculty of Pharmacy

SCHEME OF INSTRUCTION, EXAMINATION AND EVALUATION

(Effective for Batches Admitted from 2016 – 17 Academic Year Onwards)

Program Code: 881 B. Pharmacy (Second Year)

SEMESTER - IV

Course Code	Description	Course Title	Hours/Week			Credits	Marks		Duration of Exam
			L	T	P		Internal	End Exam	
PY.06.881.4.1.T	PS, CORE	Pharmaceutical Chemistry (Chemistry of Natural Products)	4	0	-	4	30	70	3
PY.06.881.4.2.T	PS, CORE	Pharmaceutical Engineering-II	4	0	-	4	30	70	3
PY.06.881.4.3.T	BS, FC	Pharmaceutical Biochemistry	3	0	-	3	30	70	3
PY.06.881.4.4.T	BS, FC	Biostatistics (Pharmacostatistics)	3	0	-	3	30	70	3
PY.06.881.4.5.T	Open Elective	Pathophysiology / Green Chemistry	4	0	-	4	30	70	3
PY.06.881.4.6.P	PS, CORE	Pharmaceutical Chemistry (Chemistry of Natural Products) Ptacticals	0	0	4	2	30	70	4
PY.06.881.4.7.P	PS, CORE	Pharmaceutical Engineering Ptacticals	0	0	4	2	30	70	4
PY.06.881.4.8.P	BS, FC	Pharmaceutical Biochemistry Ptacticals	0	0	4	2	30	70	4
			18	0	12	24	240	560	

**PHARMACEUTICAL CHEMISTRY  
(CHEMISTRY OF NATURAL PRODUCTS)**

**Scheme of Instruction**

Total Duration : 40 hrs  
 Periods / Week: 4  
 Credits : 4  
 Instruction Mode : Lecture  
 Subject Code : PY.06.881.4.1.T

**Scheme of Examination**

Maximum Marks : 100  
 Internal Exam : 30  
 End Semester : 70  
 Exam Duration : 3 Hrs

**Unit – I**

**Poly Functional Natural Products**

**Carbohydrates: Introduction, Definition, Classification, Isolation, General Properties (including isomerism) and Pharmaceutical importance of Carbohydrates, Chemistry (Structure, Nomenclature and Reactions) of glucose, fructose, sucrose, maltose, cellulose and**

starch.

**Oils & Fats: Introduction, Definition, Classification, Isolation, General properties and Pharmaceutical importance of oils and fats. Chemistry (Structure, Nomenclature and Reactions) of Oils and Fats and analyse according to Pharmacopoeial methods**

## **Unit - II**

**Amino Acids and Proteins**

**Introduction, Definition, Classification, Isolation, General properties and Pharmaceutical importance of amino acids and their relationship to proteins and polypeptides.**

**Chemistry of Protein Hormones: Insulin, Oxytocins, Thyroxin and anti-thyroid drugs**

## **Unit - III**

**Flavanoids and Terpenoids**

**Flavonoids: Sources, Uses, chemistry and General methods of structural determination (chemical & spectral analysis) of Amygdalin, arbutin and quercetin**

**Terpenoids: Isoprene rule, Special Isoprene Rule for terpenes, General methods of isolation and. Chemistry of citral, menthol and camphor.**

## **Unit - IV**

**Alkaloids - Purine and Xanthine Derivatives**

**Introduction, Definition, Occurrence, Classification, Isolation, General properties and Pharmaceutical importance of Alkaloids. General methods of extraction, structure elucidation and Chemistry (Structure, Nomenclature and Reactions) of ephedrine, atropine, papaverine and quinine and also Caffeine and nicotinic acid.**

## **Unit - V**

**Steroids**

**Introduction, Definition, Occurrence, Classification, Isolation, General properties and Pharmaceutical importance of Steroids: color reactions of cholesterol, stigmasterol, ergosterol. Importance & general concepts of bile acids. Steroidal saponins: Diosgenin and hecogenin. Androgens, Estrogens, Progestational agents, Steroidal contraceptives. Adrenocorticoids, Deoxycorticosterone, Cortisone, Prednisone, Aldosterone. Cardiac Glycosides of Digitalis other Cardiac drugs, Strophanthus and Squill.**

**Examination: One question from each unit with internal choice.**

### **Text books**

- 1. Organic Chemistry, Vol.II by I.L. Finar, The English Language Book Society, London.**
- 2. Natural Products Vol.I & II by O.P. Agarwal Goel publications – Meerut.**

### **Reference Books**

- 1. R.T. Morrison and R.N. Boyd, Organic Chemistry, Allyn and Bacon, Inc., Boston**
- 2. Burger's Medicinal Chemistry, M.E. – Wolff, Ed., John Wiley & Sons, New York.**
- 3. F.G.Mann & B. Saunders, Practical Organic Chemistry Longmans Green & Co. Ltd., U.K**
- 4. R. M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, Interscience NY.**

## PHARMACEUTICAL ENGINEERING - II

### Scheme of Instruction

Total Duration : 40 hrs  
Periods / Week: 4  
Credits : 4  
Instruction Mode : Lecture  
Subject Code : PY.06.881.4.2.T

### Scheme of Examination

Maximum Marks : 100  
Internal Exam : 30  
End Semester : 70  
Exam Duration : 3 Hrs

### Unit – I

Size reduction – Objectives, properties of solids, Classification of equipment. Important intermediate crushers & fine grinders, Cutting rolls, disk crushers, edge and end Runner mills, disintegrators, hammer mills, ball mills and their different modifications, colloid mill, impact mills, pin mills, fluid energy mills, particle size classifiers used with grinding mills.

Size separation – I.P.Grades of Powders, Sieves – Standards, materials of construction, sieving of powders – Particle size distribution and its measurement using sieves. Representation on data. Screening equipment for coarse and fine powders. Shifting by gyratory turbulence.

Fluid classification methods – Cyclone separators, air separators, bag filters, scrubbers, air filters, size separation by settling, double cone classifier. Laws of settling, sedimentation, Elutriation.

Leaching and Extraction – Solid liquid Extraction, theory, problems of crude drug Extraction, solvents, properties choice and recovery. Factors affecting choice of Extraction process and efficiency of Extraction. Maceration, percolation and continuous Extraction process. Diffusion batteries Extraction towers.

Liquid extraction – Principles, Small and large scale equipment, pod biel niak extractor. Expression equipment for small and large scale operation.

### Unit – II

Evaporation – General principles, heat supply and vapour removal. Heat transfer, film coefficients, scale formation. Evaporators – Classification, pan, stills, short tube, long tube, vertical forced circulation with internal heating element, film and vapour compression evaporators. Evaporation under reduced pressure.

Distillation and condensation – Different mass transfer operations, theory applied to binary mixtures; Distillation methods – Equilibrium and differential distillations, azeotropic distillation, rectification, sieve plate and packed columns, HEPT. Steam distillation – theory, equipment and applications, Molecular distillation – theory, equipment and applications.

Automatic water stills, steam jacketed kettle, distillation under reduced pressure.

### Unit – III

Drying – Theory of drying, Drying of damp solids, tray, vaccum tunnel, rotary and infrared dryer. Drying of slurries of solution – Drum, spray, freeze drying and fluidized bed drying.

Crystallisation – Importance of crystal purity, size, shape, geometry, habit, forms and types. Solubility curves and calculation of yields. Material and heat balances around Swenson Walker crystalliser. Miers supersaturation theory and its limitations. Nucleation mechanisms, crystal growth. Classification of crystallisers, Tank, agitated batch, Swenson Walker, single vacuum, circulating magma and Krystal crystallizer. Caking of crystals and its prevention.

Gas absorption – Importance in pharmacy. Properties and type of tower packing, Tower construction and other commercial absorbers and their operations, two phase flow through

#### **Unit - IV**

**Mixing – Definition and objectives; Types of mixers; Solid – solid mixing: Selection of mixer; Mixing of viscous masses; Kneading and ban burry mixtures; Ointment mills, triple roller mill.**

**Liquid – liquid and gas liquid mixing equipment: Different types of mixing impellers, their characteristics, operation and application.**

**Absorption and Ion exchange – Ion exchange operations, Ion exchange principles different types of Ion exchangers behaviors of ion exchange resins, applications.**

#### **Unit – V**

**Compaction – Scope, measurement of Punch forces, transmission of force through powders, distribution of forces in powder mass, effect of pressure on relative volume, lubrication of diwall, adhesion and cohesion of particles, factors effecting strength of granules and strength of tablets.**

**Automatic process control systems – Process variables (temperature, pressure flow, level and vacuum) and their measurement; Elements of automatic process control and introduction automatic process control systems.**

**Examination : One question from each unit with internal choice.**

#### **Text Books**

- 1. Pharmaceutical Engineering by Prof.K.Samba murthy**
- 2. Introduction to Chemical engineering by W.L.Badger and Banchemo, Macrohill Int. book Co, London.**
- 3. C.V.S. Subrahmanyam, J. Timma Setty, V. Kusum Devi and Sarasija Suresh, Pharmaceutical Engineering, Principles and practices, Vallabh Prakashan, New Delhi, 2007.**

#### **Reference books**

- 1. Unit operations to chemical engineering by W.I.Macebe and J.C.Smith, Macrohill Int. book Co, London**
- 2. The theory and practice of Industrial Pharmacy by L.Lachman, H.Lieberman and J.L.Kanig, Lea and Febiger Philadelphia.**

## PHARMACEUTICAL BIOCHEMISTRY

### Scheme of Instruction

Total Duration : 40 hrs  
Periods / Week: 3  
Credits : 3  
Instruction Mode : Lecture  
Subject Code : PY.06.881.4.3.T

### Scheme of Examination

Maximum Marks : 100  
Internal Exam : 30  
End Semester : 70  
Exam Duration : 3 Hrs

### Unit – I

Biochemical organization of the cell and transport processes across cell membrane.

The concept of free energy, determination of free energy change from equilibrium constant and reduction potential, energy rich compounds, production of ATP and its biological significance.

### Unit – II

Enzymes - Nomenclature & classification, Kinetics, mechanism of action and inhibition, clinical applications of enzymes, isozymes and coenzymes.

Carbohydrate metabolism: - Glycolysis, gluconeogenesis, glycogenolysis, glycogen synthesis, metabolism of galactose, role of sugar nucleotides in biosynthesis; pentose phosphate pathway. TCA cycle, its significance, Anapleurotic reactions, Effects of inhibitor and regulation of TCA cycle, Glyoxalate cycle.

### Unit - III

Lipid metabolism - fate of dietary lipids; beta oxidation, oxidation of unsaturated fatty acids; synthesis of ketone bodies, biosynthesis, of saturated and unsaturated fatty acids, cholesterol metabolism, phospholipids and sphingolipids.

### Unit – IV

Electron transport and biological oxidation. Nitrogen balance, metabolism of amino acids; biosynthesis of purins, pyrimidines and their nucleotides, formation of uric acid.

Integration of carbohydrate, lipid and protein metabolism. Biosynthesis of RNA and DNA, Physical and chemical mutagenesis, DNA repair mechanism, recombinant DNA, mechanism of protein synthesis and its regulation, inborn errors in metabolism.

### Unit – V

Principles involved and methods used in qualitative & quantitative analysis of blood for - SGPT, SGOT, Bilerubin, glucose, urea, cratinine, albumin, alhumini globulin ratio and their clinical significance. Principles involved and methods used in qualitative and quantitative analysis of urine for - glucose, ketone bodies, bile salts, bile pigments and albumin. Product inhibition, feed back inhibition, role of cyclic AMP in enzyme activation, repression and induction and control of enzyme synthesis by regulation of transcription.

Examination : One question from each unit with internal choice.

### Text Books

1. Text Book of Biochemistry, by B.Harrow & A.Mazur, W.B.Saundons Co., Philadelphia.
2. Principles of Biochemistry, A.L.Lehninger, CBS publishers, New Delhi.
3. Text Book of Biochemistry, by Rama Rao.

### Reference Books

1. Outlines of Biochemistry by E.E.Conn and P.K.Stumpf. John Wiley & Sons, New York.
2. Harper's Review of Biochemistry, D.W.Martin, P.A.Mayes & V.M.Redwell, Language Medical Publications

**BIOSTATISTICS**  
**(PHARMACOSTATISTICS)**

**Scheme of Instruction**

**Total Duration** : 40 hrs  
**Periods / Week:** 3  
**Credits** : 3  
**Instruction Mode** : Lecture  
**Subject Code** : PY.06.881.4.4.T

**Scheme of Examination**

**Maximum Marks** : 100  
**Internal Exam** : 30  
**End Semester** : 70  
**Exam Duration** : 3 Hrs

**Unit – I**

Definition and determination of terms Mean, Median, Mode, relation between mean, median, and mode. Standard deviation, histogram, Coefficient of correlation, regression analysis, curve fitting, theory of probability.

**Unit – II**

Nature and Scope of Statistical methods and their limitations, compilation, classification, tabulation and applications in pharma and life sciences; Graphical representation; Measures of Average Stem and Leaf Plots; Box and Whisker Plots, Co-plots; Introduction to Probability Theory and Distributions (Concepts without Derivations), Binomial, Poisson & Normal Distributions (Only definition and Problems)

**Unit – III**

Sampling Methods: Simple, Random, stratified, Systematic and Cluster Sampling Procedures; Data Collection, Data Organization and Data Representation; Bar, Pie, 2-D and 3-D Diagrams; Sampling and Non-Sampling Errors; Sampling Distributions; measure of dispersion.

**Unit – IV**

Interference Concerning Means; Point Estimation - Interval estimation - Bayesian estimation - Tests of Hypothesis; Common Parametric and Non parametric tests employed in testing of significance in biological/pharmaceutical experiments.

**Unit – V**

Tests of significance - T -test, chi-square test, analysis of variance, elements of Anova (one way and two way). Principles of scientific experiments; concept of CRD, RBD and Latin square diagrams.

**Examination:** One question from each unit with internal choice.

**Text and Reference Books**

1. Probability and Statistics by M.R Spiegel Schaum Series
2. Biostatistics: A Foundation for analysis in Health Sciences, by Danial W.W., John Wiley
3. Statistics for Biologists, by Campbell, R.C., Cambridge University Press
4. Practical statistics for experimental Biologists, by Wardlaw, A.C., John Wiley and Sons Inc.,

small scale Preparations, 2<sup>nd</sup> Edition, CBS Publishers & Distributors, New Delhi, 2004.

5. J. Clayden, N Greeves, S Warren and Wothers, Organic Chemistry, Oxford University Press, Delhi, 2001.

6. RT Morrison and RN Boyd, Organic Chemistry, 6<sup>th</sup> Edition, Pearson Education, New Delhi, 2007.

7. J. March, Advanced Organic Chemistry, Reactions, mechanisms and structures, 4<sup>th</sup> Edition, John Wiley & Sons, Singapore, 2003.

Library  
G.Pulla Reddy College of Pharmacy  
Hyderabad

## PATHOPHYSIOLOGY

### Scheme of Instruction

Total Duration	: 40 hrs
Periods / Week:	3
Credits	: 3
Instruction Mode	: Lecture
Subject Code	: PY.06.881.4.5.T

### Scheme of Examination

Maximum Marks	: 100
Internal Exam	: 30
End Semester	: 70
Exam Duration	: 3 Hrs

**Scope:** Path physiology is the study of diseases and reactions of the body to such disease producing causes. This course is designed to impart a thorough knowledge of the relevant aspects of pathology of various conditions with reference to its pharmacological applications and understanding of basic pathophysiological mechanisms. Hence it will not only help to study the syllabus of pathology, but also to get baseline knowledge required to practice medicine safely, confidently, rationally and effectively.

**Objectives :** upon completion of the subject student shall be able to-

1. Describe the etiology and pathogenesis of the selected disease states:
2. Name the signs and symptoms of the disease: and
3. Mention the complications of the disease.

### Course Content:

#### Unit- I

#### Basic principles of Cell injury and application:

- Introduction , definitions , Homeostasis ,components and Types of Feedback systems, causes of cellular injury. Pathogenesis ( Cell membrane damage, Mitochondrial damage, Ribosome damage , Nuclear damage), Morphology of cell injury – adaptive changes ( atrophy, Hypertrophy, hyperplasia, Metaplasia , Dysplasia ) , cell swelling , Intra cellular accumulation, calcification , Enzyme leakage and Cell Death Acidosis & Alkalosis, Electrolyte imbalance.



- **Basic mechanism involved in the process of inflammation and repair:**

Introduction, Clinical signs of inflammation, Different types of Inflammation, Mechanism of Inflammation – Alteration in vascular permeability and blood flow, migration of WBC's, Mediators of inflammation, Basic principles of wound healing in the skin, Pathophysiology of Atherosclerosis

**Unit II**

**10Hours**

- **Cardiovascular System:**

Hypertension, congestive heart failure, ischemic heart disease (angina, myocardial infarction, atherosclerosis and arteriosclerosis)

- **Respiratory system:** Asthma, Chronic obstructive airways diseases.

- **Renal system:** Acute and chronic renal failure .

**Unit II**

**10Hours**

- **Haematological Diseases:**

Iron deficiency, megaloblastic anemia (Vit B12 and folic acid), sickle cell anemia, thalasemia, hereditary acquired anemia, hemophilia

- **Endocrine system:** Diabetes, thyroid diseases, disorders of sex hormones

- **Nervous system:** Epilepsy, Parkinson's disease, stroke, psychiatric disorders: depression, schizophrenia and Alzheimer's disease.

- **Gastrointestinal system:** Peptic Ulcer

•

**Unit IV**

**8 Hours**

- **Inflammatory bowel diseases, jaundice, hepatitis (A,B,C,D,E,F) alcoholic liver disease.**

- **Disease of bones and joints:** Rheumatoid arthritis, osteoporosis and gout

- **Principles of cancer:** classification, etiology and pathogenesis of cancer

- **Diseases of bones and joints:** Rheumatoid Arthritis, Osteoporosis, Gout

- **Principles of Cancer:** Classification, etiology and pathogenesis of Cancer

**Unit V**

**7 Hours**

- **Infectious diseases:** Meningitis, Typhoid, Leprosy, Tuberculosis

Urinary tract infections

- **Sexually transmitted diseases:** AIDS, Syphilis, Gonorrhea

**Recommended Books (Latest Editions)**

1. Vinay Kumar, Abul K. Abas, Jon C. Aster; Robbins & Cotran Pathologic Basis of Disease; South Asia edition; India; Elsevier; 2014.
2. Harsh Mohan; Text book of Pathology; 6<sup>th</sup> edition; India; Jaypee Publications; 2010.
3. Laurence B, Bruce C, Bjorn K. ; Goodman Gilman's The Pharmacological Basis of Therapeutics; 12<sup>th</sup> edition; New York; McGraw-Hill; 2011.
4. Best, Charles Herbert 1899-1978; Taylor, Norman Burke 1885-1972; West, John B (John Burnard); Best and Taylor's Physiological basis of medical practice; 12th ed; united states;
5. William and Wilkins, Baltimore; 1991 [1990 printing].
6. Nicki R. Colledge, Brian R. Walker, Stuart H. Ralston; Davidson's Principles and Practice of Medicine; 21<sup>st</sup> edition; London; ELBS/Churchill Livingstone; 2010.
7. Guyton A, John .E Hall; Textbook of Medical Physiology; 12<sup>th</sup> edition; WB Saunders Company; 2010.
8. Joseph DiPiro, Robert L. Talbert, Gary Yee, Barbara Wells, L. Michael Posey; Pharmacotherapy: A Pathophysiological Approach; 9<sup>th</sup> edition; London; McGraw-Hill Medical; 2014.
9. V. Kumar, R. S. Cotran and S. L. Robbins; Basic Pathology; 6<sup>th</sup> edition; Philadelphia; WB Saunders Company; 1997.
10. Roger Walker, Clive Edwards; Clinical Pharmacy and Therapeutics; 3<sup>rd</sup> edition; London; Churchill Livingstone publication; 2003.

#### **Recommended Journals**

1. The Journal of Pathology. ISSN: 1096-9896 (Online)
2. The American Journal of Pathology. ISSN: 0002-9440
3. Pathology. 1465-3931 (Online)
4. International Journal of Physiology, Pathophysiology and Pharmacology. ISSN: 1944-8171 (Online)
5. Indian Journal of Pathology and Microbiology. ISSN-0377-4929.

# GREEN CHEMISTRY

## Scheme of Instruction

**Total Duration** : 40 hrs  
**Periods / Week:** 3  
**Credits** : 3  
**Instruction Mode** : Lecture  
**Subject Code** : PY.06.881.4.5.T

## Scheme of Examination

**Maximum Marks** : 100  
**Internal Exam** : 30  
**End Semester** : 70  
**Exam Duration** : 3 Hrs

**PAGE UNDER  
CONSTRUCTION**

G.Pulla Reddy College of Pharmacy  
Hyderabad

# PHARMACEUTICAL CHEMISTRY PRACTICALS

## (CHEMISTRY OF NATURAL PRODUCTS)

### Scheme of Instruction

Total Duration : 48 Hrs  
Periods / Week: 4  
Credits : 2  
Instruction Mode: Practical

### Scheme of Examination

Maximum Marks : 100  
Internal Exam : 30  
End Semester : 70  
Exam Duration : 4 Hrs

Subject Code : PY.06.881.4.6.P

### List of experiments

1. Qualitative analysis of carbohydrates
2. Qualitative analysis of proteins
3. Qualitative analysis of amino acids
4. Qualitative analysis of alkaloids
5. Qualitative analysis of triterpenoids & steroids.
6. Determination of acid value
7. Determination of saponification value
8. Determination of peroxide value
9. Determination of iodine value
10. Estimation of Atropine
11. Estimation of Ephedrine.

### Reference Books

1. I.L. Finar: Organic chemistry, Vol.2: Stereochemistry and the Chemistry of Natural Product, 6<sup>th</sup> Edition, Pearson Education, New Delhi, 2003.
2. O.P Agarwal, Organic Chemistry: Natural Product, Vol – I & II, 13<sup>th</sup> Edition, Goel Publishing House, Meerut, 2006.
3. B.S Furniss, A.J Hannaford, PWG Smith and AR Tatchell, Vogel's Text book of Practical Organic chemistry, 5<sup>th</sup> Edition, Longman Singapore publishers, Singapore, 1996.
4. M.A Iyenger, Study of Crude Drugs, 12<sup>th</sup> Edition, Mainpal Press Ltd, Mainpal, 2004.
5. C B Powar and CB Chatwal, Biochemistry, 4<sup>th</sup> Edition, Himalaya Publishing House, Mumbai, 2003.
6. Indian Pharmacopoeia , Volume - I & II, Controller of Publications, Delhi,1996.
7. British pharmacopoea, 2008.

## PHARMACEUTICAL ENGINEERING – II PRACTICALS

### Scheme of Instruction

Total Duration : 48 Hrs  
Periods / Week: 4  
Credits : 2  
Instruction Mode: Practical  
Subject Code : PY.06.881.4.7.P

### List of Experiments

4. Determination of Reynolds number
  5. Determination of heat transfer coefficient by mechanisms.
  6. Determination of humidity of air by psychrometry & dew point method
  7. Verification of Stokes Law
  8. Efficiency of size reduction using different size reducing equipment.
  9. Determination particle size distribution by sieve analysis
  10. Rate of Drying of solids
  11. Purification by simple distillation.
  12. Drawing of symbols for unit operations
  13. Drawing of equipment used in unit operations (for scale up/scale down)
- Flow sheet Industries for manufacturing procedures of drugs.

### Reference Books

1. C.V.S. Subrahmanyam, J. Thima Sety, V. Kusum Devi, and Sarasija Suresh, Laboratory Manual of Pharmaceutical Engineering (Unit Operations), Vallabh Publications, New Delhi, 2006.
2. M. Momin and Tejal Shah, Practical Manual of Pharmaceutical Engineering, B.S. Shah Prakashan, Ahmedabad, 2008.

## PHARMACEUTICAL. BIOCHEMISTRY PRACTICALS

### Scheme of Instruction

Total Duration : 48 Hrs  
Periods / Week: 4  
Credits : 2  
Instruction Mode: Practical  
Subject Code : PY.06.881.4.8.P  
List of Experiments

### Scheme of Examination

Maximum Marks : 100  
Internal Exam : 30  
End Semester : 70  
Exam Duration : 4 Hrs

1. Qualitative reactions for carbohydrates, proteins and amino acids.
2. Estimation of blood cholesterol, Glucose, Urea, Creatinine.
3. Liver function test.
4. Qualitative determination of normal and abnormal constituents of urine
5. Quantitative Estimation of Glucose and uric acid in urine.

### Reference Books

1. L.N David and M.C Michael, Lehniger Principles of Biochemistry, 4<sup>th</sup> Edition, Replika Press Ltd, India, 2006.
2. U Satyanarayana and U Chakrapani, Biochemistry, 3<sup>rd</sup> Edition, Arunbha Sen books and Allied Pvt Ltd, Kolkata, 2006.
3. K.M Robert, K.G Daryl, A.M Peter and W.R Victor, Harper's Biochemistry, 25<sup>th</sup> Edition, Lange Medical Publications, 2000.