

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)**

Subject Code : PY.06.881.4.1.T

Periods / Week: 4 credits:4

Sessional : 30

Examination : 70

Nature of Exam : Theory

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: characteristic 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

Subject Code : PY.06.881.4.2.T

Periods / Week: 4 credits:4

Sessional : 30

Examination : 70

Nature of Exam : Theory

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 packed tower. Pressure and Mass Transfer Coefficients; Desorption.

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

Subject Code : PY.06.881.4.3.T

Periods / Week: 4 credits:4

Sessional : 30

Examination : 70

Nature of Exam : Theory

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, Bilirubin, glucose, urea, creatinine, albumin, albumin/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.Saunders 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)

Subject Code : PY.06.881.4.4.T

Periods / Week: 3 credits:3

Sessional : 30

Examination : 70

Nature of Exam : Theory

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, 2nd 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, 6th Edition, Pearson Education, New Delhi, 2007.

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

Library
G.Pulla Reddy College of Pharmacy
Hyderabad

PATHOPHYSIOLOGY

Scheme of Instruction

Total duration: 60 hrs

Periods / Week: 4 credits: 4

Instruction Mode : Lecture

Subject Code : PY.06.881.4.5.T

Scheme of Examination

Maximum Marks: 30

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, thalassemia, 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; 6th edition; India; Jaypee Publications; 2010.
3. Laurence B, Bruce C, Bjorn K. ; Goodman Gilman's The Pharmacological Basis of Therapeutics; 12th 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; 21st edition; London; ELBS/Churchill Livingstone; 2010.
7. Guyton A, John .E Hall; Textbook of Medical Physiology; 12th edition; WB Saunders Company; 2010.
8. Joseph DiPiro, Robert L. Talbert, Gary Yee, Barbara Wells, L. Michael Posey; Pharmacotherapy: A Pathophysiological Approach; 9th edition; London; McGraw-Hill Medical; 2014.
9. V. Kumar, R. S. Cotran and S. L. Robbins; Basic Pathology; 6th edition; Philadelphia; WB Saunders Company; 1997.
10. Roger Walker, Clive Edwards; Clinical Pharmacy and Therapeutics; 3rd 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	: 45 hrs
Periods / Week:	: 4
Credits	: 4
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

Course objectives

To familiarize students about environmental benign chemical synthesis. To make students familiarize with principles and importance of various green chemical synthesis. To provide adequate knowledge regarding green reactions, green solvents and other alternative green approaches. To impart adequate information regarding environment pollution, contributing factors and the concerns.

Course outcomes

Upon completion of this course, the students should be able to: Explain the environment pollution factors. Understand the different greener approaches along with their principles.

UNIT – I

Introduction to Green Chemistry

- Inception of green chemistry: history and development
- Principles of green chemistry: description with examples
- Synthetic approaches of green chemistry: In water, solvent less, photochemical, microwave, ultrasonic, catalytic and electrochemical synthesis.

UNIT – II

In water and solvent less organic reactions

- In water reactions: Principle and process involved in the Michael reaction and Wurtz synthesis
- Solvent less organic synthesis:
- Alternative solvents used in green chemistry strategies.

UNIT – III

Microwave and ultrasonic mediated reactions

- Microwave reactions: Principle and process involved in the Fries rearrangement, Diels Alder reaction and Metal halide reduction
- Ultrasonic reactions: Principle and process involved in the Strecker and Reformatsky reactions.

UNIT – IV

Catalytic and solid supported reactions

- Catalytic reactions: Principle and process involved in the reactions catalyzed by metal catalysts, phase-transfer catalysts, ionic liquids (Knovenegel condensation) and bio catalysts (Villegier reaction)
- Solid supported reactions: Principle and process
- Alternative reagents used in green chemistry strategies.

UNIT – V

Greener synthesis of pharmaceuticals: Principle and procedure of the following synthesis

- Nicotinic acid, Ibuprofen, Paracetamol, Aspirin.

Future trends in green chemistry

P-82
7/17
20

References

1. Paul T Anastas, John Charles Warner. Green chemistry: theory and practice. Oxford university Press, 1988
2. Ahluwalia V.K, Green chemistry: environmentally benign reactions. 2nd edn, All Books Pvt Ltd. New Delhi, 2012.
3. Ahluwalia V.K, M. Kidwai, New trends in Green chemistry. 2nd edn, Anamaya Publishers, New Delhi, 2004.

PHARMACEUTICAL CHEMISTRY PRACTICALS
(CHEMISTRY OF NATURAL PRODUCTS)

Subject Code : PY.06.881.4.6.P

Periods / Week: 4 Credits : 2

Sessional : 25

Examination : 50

Nature of Exam: Practicals

Exam Duration : 4 Hrs

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, 6th Edition, Pearson Education, New Delhi, 2003.
2. O.P Agarwal, Organic Chemistry: Natural Product, Vol – I & II, 13th 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, 5th Edition, Longman Singapore publishers, Singapore, 1996.
4. M.A Iyenger, Study of Crude Drugs, 12th Edition, Mainpal Press Ltd, Mainpal, 2004.
5. C B Powar and CB Chatwal, Biochemistry, 4th 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

Subject code: : PY.06.881.4.7.P

Periods / Week: 4 Credits : 2

Sessional : 25

Examination : 50

Nature of Exam: Practicals

Exam Duration : 4 Hrs

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

Subject Code : PY.06.881.4.8.P

Periods / Week: 4 Credits : 2

Sessional : 25

Examination : 50

Nature of Exam: Practicals

Exam Duration : 4 Hrs

List of Experiments

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, 4th Edition, Replika Press Ltd, India, 2006.
2. U Satyanarayana and U Chakrapani, Biochemistry, 3rd 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, 25th Edition, Lange Medical Publications, 2000.

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