UG PROGRAM (4 Years Honors)
CBCS - 2020-21

SUBJECT
BIOCHEMISTRY

Syllabus and Model Question Papers

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Note: BOS is to provide final soft copy in PDF and word formats and four copies of hard copies in bounded form to the office of Dean Academic affairs.

1. Resolutions of the Board of Studies

Meeting held on: 22/01/2021……Time: 10 AM – 4 PM
At: ANUR Convention Centre, Adikavi Nannaya University
Rajahmahendravaram

Agenda:
As per the directions and guidelines/modalities issued by the APSCHE for revising the curriculum framework and updating the syllabus as out-come based B. Sc Bio-Chemistry programme to be effect from 2020-21 academic year under CBCS for implementing in all affiliated colleges of AKNU

Members present:

Dr. D. Kalyani, Assistant Professor, Department of Zoology, Adikavi Nannaya University, Rajahmahendravaram.

Dr. K. Kamalakara Rao, Assistant Professor, Department of Biochemistry, Adikavi Nannaya University, Rajahmahendravaram.

Resolutions:

1. It was resolved to adopt revised common programme structure as per the guidelines issued by APSCHE.

2. Resolved to adopt regulations and scheme of examinations and marks/grading system of the university UG programs.

3. Resolved to prepare model question Courses in the given prescribed format.

4. Resolved to prepare a list of equipments/software required for each lab/practicals.

5. Resolved to give the eligibility criteria of students for joining the course.

6. Resolved to give the eligibility criteria of faculty for teaching the course.

7. Resolved to prepare a list of Course setters/Course evaluators/project evaluators in the given prescribed format.

2. DETAILS OF COURSE TITLES & CREDITS

Sem	Course No	Course Name	Course Type (T/P/L)	Hrs/Week	Credits	Max. Marks	Max. Marks
				Science: 4+2	Science: 4+2	Count/Internal/ Mid Assessment	Sem- End Exam
I	BCH-1	Biomolecules	T	4	4	25	75
		Biomolecules Lab	L	2	1	-	50
II	BCH-II	Analytical Techniques	T	4	4	25	75
		Analytical Techniques Lab	L	2	1	-	50
III	BCH-III	Enzymology, Bioenergetics and Intermediary Metabolism	T	4	4	25	75
		Enzymology, Bioenergetics and Intermediary Metabolism Lab	L	2	1	-	50
IV	BCH-IV	Physiology, Nutritional and Clinical Biochemistry	T	4	4	25	75
		Physiology Nutritional and Clinical Biochemistry Lab	L	2	1	-	50
	BCH-V	Microbiology, Immunology and Molecular Biology	T	4	4	25	75
		Microbiology, Immunology and Molecular Biology Lab	L	2	1	-	50

Note: *Course type code: T: Theory, L: Lab, P: Problem solving

a. Proposed combination subjects: Biochemistry, Biotechnology, Microbiology
Biochemistry, Biotechnology, Chemistry
Biochemistry, Biotechnology, Zoology

b. Student eligibility for joining in the course: + 2/ Intermediate with Bi.P.C. and M.Bi.P.C.

c. Faculty eligibility for teaching the course: M.Sc. (Minimum Qualification)
M.Phil. and Ph.D. are desirable

d. List of Proposed Skill enhancement courses with syllabus, if any
Industrial Biochemistry
Environmental Biochemistry
Pharmaceutical Biochemistry

e. Any newly proposed Skill development/Life skill courses with draft syllabus and required resources

f. Required instruments/software/ computers for the course (Lab/Practical course-wise required i.e., for a batch of 15 students)

Sem. No.	Lab/Practical Name	Names of Instruments/Software/ computers required with specifications	Brand Name	Qty Required
1	Biomolecules	Weighing balance digital and Non digital	Mettler Toledo	2 2
		PH Meter	Coleparmer	2
		Water bath	Kemi	2
		Vortex mixture	Coleparmer	2
		Magnetic stirrer	IKA	2
		Hot plate	Remi	2
		Hot air oven	Remi	2
		Autoclave	Labline	2
		Distillation unit	Accumax India	2
		Refrigerator		2
		Ice flakes machine	Labman	2
2	Analytical Techniques	Homogenizer	Remi	2
		Centrifuge (Refrigerated and Non refrigerated)	Thermo scientific	1
		Gel documentation system	Thermo Fisher	1
		Chromatography chamber		2
		Electrophoresis unit (Horizontal and vertical)	Major science	2
		Colorimeter	Equiptronic	2
		UV Spectrophotometer	Shimadzu	1
3	Enzymology, Bioenergetics and Intermediary metabolism	Soxhlet extractor	Borosilicate	1
		Rotary evaporator	Heidolph	1
		Dessicator	Borosil	1
		Mortar and pestle	Thermo scientific	2
		Glass and micro pipettes	Borosil Thermo scientific	15
		Millipore unit	Merck	1
4	Physiology, Nutritional and Clinical biochemistry	Simple microscope	Olympus	2
		Compound microscope	Leica	2
5	Microbiology Immunology and Molecular biology	BOD Incubator	Kemi	1
		COD Incubator	Thermo Fisher	1
		Orbital shakers	Coleparmer	1
		Laminar air flow	Bionics Scientific	1
		Fume hood	Coleparmer	1
		ELISA reader	Biorad	1
		Neubarrs chamber	Merck	2

g. List of Suitable levels of positions eligible in the Govt/Pvt organizations
Suitable levels of positions for these graduates either in industry/govt organization like., technical assistants/ scientists/ school teachers., clearly define them, with reliable justification

S.No	Position	Company/ Govt organization	Remarks	Additional skills required, if any
1	Scientific assistant	Food Corporation of India	Upgrade their skills and get promoted	Communication skills Language skills Computational skills
2	Scientific assistant	Central ware house corporation	Upgrade their skills and get promoted	Communication skills Language skills Computational skills
3	Food safety officers	State and central government organizations	Upgrade their skills and get promoted	Communication skills Language skills Computational skills
4	Technicians	State and central government institutes and labs	Upgrade their skills and get promoted	Communication skills Language skills Computational skills

a. List of Govt. organizations / Pvt companies for employment opportunities or internships or projects

S.No	Company/ Govt organization	Position type	Level of Position
1	Food Corporation of India	Scientific assistant	Basic (can be upgraded)
2	Central ware house corporation	Scientific assistant	Basic (can be upgraded)
3	State and central government organizations	Food safety officers	Basic (can be upgraded)
4	State and central government institutes and labs	Lab Technicians	Basic (can be upgraded)
5	National Institute of Nutrition	Lab assistant/project assistant	Basic (can be upgraded)
6	Centre for Cellular and Molecular Biology	Lab assistant/project assistant	Basic (can be upgraded)
7	National Centre for Biological Sciences	Lab assistant/project assistant	Basic (can be upgraded)
8	Central Drug Research Institute	Lab assistant/project assistant	Basic (can be upgraded)
9	Central Food Technological Research Institute	Lab assistant/project assistant	Basic (can be upgraded)
10	International Crops Research Institute for the Semi-Arid Tropics	Lab assistant/project assistant	Basic (can beupgraded)
11	Indian Institute of Spices Research	Lab assistant/project assistant	Basic (can be pgraded)
12	Indian Institute of Integrative Medicine	Lab assistant/project assistant	Basic (can be pgraded)
13	National Institute of Virology	Lab assistant/project assistant	Basic (can beupgraded)
14	Institute of Life Sciences	Lab assistant/project assistant	Basic (can be pgraded)
15	National Institute of Immunology	Lab assistant/project assistant	Basic (can be pgraded)
16	Indian Institute of Chemical Biology (IICB)	Lab assistant/project assistant	Basic (can be upgraded)
17	Centre for Chronic Disease Control (CCDC)	Lab assistant/project assistant	Basic (can be upgraded)
18	Indian Institute of Immunologicals (IIL)	Lab assistant/project assistant	Basic (can be upgraded)
19	National Institute of Animal Biology (NIAB)	Lab assistant/project assistant	Basic (can be upgraded)

b. Any specific instructions to the teacher /Course setters/Exam-Chief Superintendent

Course setter may strictly follow the given syllabus

Course evaluators may strictly follow the scheme of evaluation

3. Program objectives, outcomes, co-curricular and assessment methods

B.Sc.	BIOCHEMISTRY

1. Aim and objectives of UG program in Subject:

Biochemistry is the study of biological phenomena at the molecular level. Its aim is to understand the fundamental chemical principles that govern complex biological systems. The program aims to provide an advanced understanding of the core principles and topics of biochemistry and their experimental basis to enable students acquire a specialized biological and chemical knowledge. The program also develops a foundation in the concepts and facts in modern cellular molecular biology and biochemistry and be familiar with various ways of organizing and accessing scientific knowledge

2. Learning outcomes of Subject:

1. Acquire knowledge and understanding of the molecular machinery of living cells;
2. Acquire knowledge and understanding of the principles that govern the structures of macromolecules and their participation in molecular recognition;
3. Enrich with principles and basic mechanisms of metabolic control and molecular signaling
4. Use basic laboratory skills and apparatus to obtain reproducible data from biochemical experiments;
5. Implement experimental protocols, and adapt them to plan and carry out simple investigations
6. Analyze, interpret, and participate in reporting to their peers on the results of their laboratory experiments;
7. Participate in and report orally on team work investigations of problem-based assignments;
8. Build knowledge and understanding in tackling more advanced and specialised courses, and more widely to pursue independent, self-directed and critical learning.
9. Recommended Skill enhancement courses: (Titles of the courses given below and details of the syllabus for 4 credits (i.e., 2 units for theory and Lab/Practical) for 5 hrs class-cum-lab work
   - Industrial Biochemistry
   - Environmental Biochemistry
   - Pharmaceutical Biochemistry
10. Recommended Co-curricular activities:(Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

A. Measurable:

1. Assignments on: Physiology
2. Student seminars (Individual presentation of Courses) on topics relating to: Immunology
3. Quiz Programmes on: Molecular Biology
4. Individual Field Studies/projects: Nutritional Biochemistry
5. Group discussion on: metabolism topics
6. Group/Team Projects on: Enzymology

B **General**

1. Collection of news reports and maintaining a record of Course-cuttings relating to topics covered in syllabus
2. Group Discussions on: New scientific approaches and Discoveries
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
4. Any similar activities with imaginative thinking.
   Organizing exhibitions

Preparation of charts and models
Science fairs
Science clubs
Essay writing

11. Recommended Continuous Assessment methods:
    Slip test
    Oral test
    Assignments
    Seminars

DETAILS OF COURSE WISE SYLLABUS

4. Details of course-wise Syllabus

B.Sc.	Semester - I	Credits: 4
Course: 1	BIOMOLECULES	Hrs/Wk: 4

Aim and objectives of Course (Biomolecules):
The student gains knowledge in the chemistry of biomolecules such as water, carbohydrates, lipids, proteins and nucleic acids which make up all the living organisms including humans.

Learning outcomes of Course
This course will enable the student to understand the importance of biomolecules in living organisms and effects of their alterations in diseases occurring in plants, animals and humans.
The practical will give the expertise to the student for analysis of any biological or non-biological sample for identification of its chemical composition.

3·Detailed Syllabus: (Five units with each unit having 12 hours of class work)

UNIT I: 12 hours
Carbohydrates: Carbohydrates: Classification, monosaccharides, D and L designation, open chain and cyclic structures, epimers and anomers, mutarotation, reactions of carbohydrates (due to functional groups - hydroxyl, aldehyde and ketone. Amino sugars, Glycosides. Structure and biological importance of disaccharides (sucrose, lactose, maltose, isomaltose, trehalose), tri-saccharides (raffinose, melezitose), structural polysaccharides (cellulose, chitin, pectin) and storage polysaccharides (starch, inulin, glycogen). Glycosaminoglycans, Bacterial cell wall polysaccharides. Outlines of glycoproteins, glycolipids and blood group substances.

UNIT II: 12 hours
Lipids: Classification, saturated and unsaturated fatty acids, structure and properties of fats and oils (acid, saponification and iodine values, rancidity). General properties and structures of phospholipids. Prostaglandins- structure, types and biological role. Lipoproteins- types and functions, Bio-membranes-formation of micelles, bilayers, vesicles, liposomes. Membrane composition and organization - Fluid mosaic model.

UNIT III: 12 hours
Amino Acids: Amino Acids: Classification, structure, stereochemistry, chemical reactions of amino acids due to carbonyl and amino groups. Titration curve of glycine and px values. Essential and non-essential amino acids, non-protein amino acids. Peptide bond -Nature and conformation. Naturally occurring peptides - glutathione, enkephalin.

UNIT IV: 12 hours
Proteins: Proteins Classification based on solubility, shape and function. Determination of amino acid composition of proteins. General properties of proteins, denaturation and renaturation of proteins. Structural organization of proteins- primary, secondary, tertiary and quaternary structures (Eg. Hemoglobin and Myoglobin).

UNIT V: 12 hours
Nucleic acids and porphyries: Types of RNA and DNA. Structure of purines and pyrimidines, nucleosides, nucleotides. Stability and formation of phosphodiester linkages. Effect of acids, alkali and nucleases on DNA and RNA. Structure of Nucleic acids- Watson-Crick DNA double helix structure, denaturation and renaturation kinetics of nucleic acids-, Tm-values and their significance, cot curves and their significance.Structure of porphyrins: Identification of Porphyrins, Protoporphyrin, porphobilinogen properties, Structure of metallo-porphyrins–Heme, cytochromes and chlorophylls.

RECOMMENDED BOOKS:

1. The biochemistry of Nucleic acids; Adams et al., Chapman and Hall, 1986.
2. Proteins: A guide to study by physical & chemical methods, Haschemeyer and Haschemeyer,
3. Proteins: Structure, function and evolution. Dickerson & Geis, 2nd Edn, Benjamin/Cummings.
4. Biochemistry - Zubay C, Addison – Wesley, 1986.
5. Biochemistry, A problem Approach, 2nd Edn. Wood, W.B. Addison Wesley 1981.
6. Biochemistry, Lehninger A.H.
7. Textbook of Biochemistry West, E.S., Todd, Mason & Vanbruggen, Macmillian&Co.
8. Principles of Biochemistry White-A, Handler, Pand Smith E.L. Mc Grew Hill.
9. Organic chemistry, I.L. Finar, ELBS. (1985).
10. Organic Chemistry by Morrison and Boyd (2000) Prentice Hall.
11. Fundamentals of Biochemistry by Donald Voet (1999).

4· Details of Lab/Practical/Experiments/Tutorials syllabus:

B.Sc.	Semester - I	Credits: 1
Course: 1(L)	BIOMOLECULES LAB	Hrs/Wk: 2

List of practical Experiments:

1. Qualitative identification of carbohydrates- glucose, fructose, ribose/xylose, maltose, sucrose, lactose, starch/glycogen.
2. Qualitative identification of amino acids-histidine, tyrosine, tryptophan, cysteine, arginine.
3. Qualitative identification of lipids- solubility, saponification, acrolein test, Salkowski test, Lieberman-Burchard test.
4. Preparation of Osazones and their identification.
5. Absorption maxima of colored substances-p-Nitrophenol, Methyl orange.

12. Recommended Co-curricular activities:(Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

A. Measurable:

1. Assignments on: Amino Acids
2. Student seminars (Individual presentation of Courses) on topics relating to: Syllabus
3. Quiz Programmes on: Nucleic acids and porphyrins
4. Individual Field Studies/projects: relating to Syllabus
5. Group discussion on: Carbohydrates

B. **Group/Team Projects**: qualitative and quantitative Analysis of Biomolecules General

1. Collection of news reports and maintaining a record of Course-cuttings relating to topics covered in syllabus.
2. Group Discussions on: new scientific approaches and Discoveries
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
4. Any similar activities with imaginative thinking.
   Organizing exhibitions
   Preparation of charts and models
   Science fairs
   Science clubs
   Essay writing

13. Recommended Continuous Assessment methods:

- Slip test
- Oral test
- Assignments
- Seminars

B.Sc.	Semester - II	Credits: 4
Course-2	ANALYTICAL TECHNIQUES	Hrs/Wk: 4

Aim and objectives of Course: Analytical Techniques

The knowledge in the analytical techniques will enable the student for isolation, purification and chemical characterization of compounds from plants and microbes which will have medical or commercial importance.

Learning outcomes of Course

1. The student will learn the various analytical techniques and their applications in separation and isolation of cells and tissues for studying their functional abnormalities
2. The practicals will provide the expertise to the student for quantification of electrolytes and other metal ions, hormones and identification of bacteria.
3. The expertise gained by the student in this course can be useful in food industries, pharma industries, clinical and microbiological labs.

UNIT I: 12 hours

Biophysical Concepts & Cell disruption methods: Water as biological solvent, Buffers, measurement of pH, electrodes, Biological relevance of pH, pKa value, Electrical conductivity, analysis of drinking water and pond water, Total dissolved salts (TDS), BOD, COD, soil analysis (texture, organic matter, elements), Methods of tissue homogenization: (Potter-Elvejham, mechanical blender, sonicator and enzymatic).

UNIT II: 12 hours

Microscopy and Centrifugation: Basic principles of light microscopy, phase contrast, electron microscope and fluorescent microscope and their applications. Centrifugation techniques, principles and applications- differential, density gradient. Ultra-centrifugation- preparative and analytical.

UNIT III: 12 hours

Chromatographic techniques: Chromatography - Principle and applications, Types of chromatographic techniques - Course chromatography- solvents, Rf value, applications; Thin layer chromatography- principle, choice of adsorbent and solvent, Rf value, applications; Gel filtration, Ion- exchange- principle, resins, action of resins, experimental techniques, applications, separation of metal ions; Affinity chromatography.

UNIT IV: 12 hours

Spectroscopy and tracer techniques: Electromagnetic radiation, Beer-Lambert's law. Colorimetry and Spectrophotometry, spectrofluorimetry, flame photometry. Tracer techniques: Radio isotopes, units of radio activity, half-life, β and γ- emitters, use of radioactive isotopes in biology, ELISA.

UNIT V: 12 hours

Electrophoresis: Electrophoresis- principles and applications of Course, polyacrylamide (native and SDS) and agarose gel electrophoresis, isoelectric focusing, immune-electrophoresis-types and applications.

RECOMMENDED TEXT BOOKS:

1. Principles and Techniques of practical Biochemistry. Eds. Williams and Wilson.
2. Techniques in Molecular biology Ed. Walker & Gastra, Croom Helm, 1983.
3. Principles of instrumental analysis, 2nd Ed, Holt-Sanders, 1980.
4. An introduction to spectroscopy for Biochemistry. Ed. Brown S.N., Academic press
5. Analytical Biochemistry, Holmes and Hazel peck, Longman, 1983.
6. An introduction to practical biochemistry. David T. Plummer, Tata Mac Grew-Hill
7. Biophysical chemistry, Edshall & Wyman, Academic press Vol. II & I.
8. A textbook of quantitative inorganic analysis including elementary instrumental analysis, Vogel ELBS.
9. Biochemical calculations Seigel, IH, 2nd Edit, John Wiley & sons Inc., 1983.
10. Analytical Biochemistry by Friefelder David.

B.Sc.	Semester - II	Credits: 1
Course-2(L)	ANALYTICAL TECHNIQUES LAB	Hrs/Wk: 2

Details of Lab/Practical/Experiments/Tutorials syllabus:

List of practical Experiments:

1. Preparation of Buffers
2. Sub cellular fraction using Centrifuge
3. Isolation of RNA and DNA from tissue/culture.
4. Qualitative Identification of DNA, RNA and Nitrogen Bases
5. Isolation of egg albumin from egg white.
6. Isolation of cholesterol from egg yolk.
7. Isolation of starch from potatoes.
8. Isolation of casein from milk.
9. Separation of amino acids by Course chromatography.
10. Determination of exchange capacity of resin by titrimetry.
11. Separation of serum proteins by Course electrophoresis.

1. Recommended Co-curricular activities: (Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

A. Measurable:

1. Assignments on: Microscopy and Centrifugation
2. Student seminars (Individual presentation of Courses) on topics relating to: Tracer techniques
3. Quiz Programmes on: Spectroscopy
4. Individual Field Studies/projects: Chromatographic techniques
5. Group discussion on: Spectroscopy and tracer techniques
6. Group/Team Projects on: Isolation and characterization of compounds from different sources using above techniques.

B. General

1. Collection of news reports and maintaining a record of Course-cuttings relating to topics covered in syllabus
2. Group Discussions on: new scientific approaches and Discoveries
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
4. Any similar activities with imaginative thinking.
   Organizing exhibitions
   Preparation of charts and models
   Science fairs
   Science clubs
   Essay writing

2. Recommended Continuous Assessment methods:
   - Slip test
   - Oral test
   - Assignments
   - Seminars

B.Sc.	Semester - III	Credits: 4
Course: 3	ENZYMOLOGY, BIOENERGETICS AND INTERMEDIARY METABOLISM	Hrs/Wk: 4

Aim and objectives of Course (Enzymology, Bioenergetics and Intermediary Metabolism):
The student will get knowledge in enzymes, their physiological importance and other applications. They also understand the metabolism of biomolecules like carbohydrate, lipid and aminoacids.

Learning outcomes of Course

a) The student will know how the biomolecules such as carbohydrates, lipids and proteins get metabolized for the purpose of energy and other physiological functions in the body.
b) The course will enable the student to understand the pathophysiology of metabolic diseases such as diabetes, atherosclerosis etc. which occur due to alterations in metabolism.
c) The practicals will provide the expertise for quantification of enzymes' activities, glucose, proteins and lipid levels in blood which will have clinical applications

UNIT I: 12 hours

Enzymology: Introduction to Biocatalysis, differences between chemical and biological catalysis. Nomenclature and classification of enzymes. Definition of holo-enzyme, apo-enzyme, coenzyme, cofactor. Active site, Enzyme specificity. Principles of energy of activation, transition state. Interaction between enzyme and substrate-lock and key, induced fit models. Fundamentals of enzyme assay, enzyme units. Outlines of mechanism of enzyme action, factors affecting enzyme activity. Commercial application of enzymes.

UNIT II: 12 hours

Bioenergetics and Biological oxidation: Bioenergetics: Thermodynamic principles – Chemical equilibria; free energy, enthalpy (H), entropy (S). Free energy change in biological transformations in living systems; High energy compounds. Energy, change, oxidation-reduction reactions.Organization of electron carriers and enzymes in mitochondria. Classes of electron-transferring enzymes, inhibiters of electron transport. Oxidative phosphorylation. Uncouplers and inhibitors of oxidative phosphorylation. Mechanism of oxidative phosphorylation.

UNIT III: 12 hours

Carbohydrate Metabolism: Concept of anabolism and catabolism. Glycolytic pathway, energy yield. Fate of pyruvate-formation of lactate and ethanol, Citric acid cycle, regulation, energy yield, amphipathic role. Anaplerotic reactions. Glycogenolysis and glycogenesis. Pentose phosphate pathway. Gluconeogenesis. Photosynthesis- Light and Dark reactions, Calvin cycle, C4 Pathway. Disorders of carbohydrate metabolism- Diabetes Mellitus.

UNIT IV: 12 hours

Lipid Metabolism: Catabolism of fatty acids (β- oxidation) with even and odd number of carbon atoms, Ketogenesis, de novo synthesis of fatty acids, elongation of fatty acids in mitochondria and microsomes, Biosynthesis and degradation of triacylglycerol and lecithin. Biosynthesis of cholesterol. Disorders of lipid metabolism.

UNIT V: **12 hours**

Metabolism of Amino acids: General reactions of amino acid metabolism- transamination, decarboxylation and deamination, Urea cycle and regulation, Catabolism of carbon skeleton of amino acids- glycogenic and ketogenic amino acids. Metabolism of glycine, serine, aspartic acid, methionine, phenylalanine and leucine. Biosynthesis of creatine. Inborn errors of aromatic and branched chain amino acid metabolism.

RECOMMENDED BOOKS:

1. Understanding enzymes: Palmer T., Ellis Harwood ltd., 2001.
2. Enzyme structure and mechanism. Alan Fersht, Freeman & Co. 1997
3. Principles of enzymology for food sciences: Whitaker Marc Dekker 1972.
4. Principles of Biochemistry, White. A, Handler, P and Smith.
5. Biochemistry, Lehninger A.L.
6. Biochemistry, Lubert Stryer.
7. Review of physiological chemistry, Harold A. Harper.
8. Text of Biochemistry, West and Todd.
9. Metabolic pathways – Greenberg.
10. Mitochondria, Munn.
11. Biochemistry, 2nd Edition, G. Zubay.

B.Sc.	Semester - III	Credits: 1
Course: 3(L)	ENZYMOLOGY, BIOENERGETICS AND INTERMEDIARY METABOLISM LAB	Hrs/Wk: 2

1. Details of Lab/Practical/Experiments/Tutorials syllabus:

List of practical Experiments:

1. Assay of amylase.
2. Assay of urease.
3. Assay of catalase
4. Effect of pH, temperature and substrate concentration on enzyme activity.
5. Estimation of glucose by DNS method.
6. Estimation of glucose by Benedict's titrimetric method.
7. Estimation of total carbohydrates by Anthrone method.
8. Tests for lipids- Salkowski test, Lieberman-Burchard test.
9. Estimation of amino acid by Ninhydrin method.
10. Estimation of protein by Biuret method.

2. Recommended Co-curricular activities: (Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

C. Measurable:

1. Assignments on: Enzymology**.**
2. Student seminars (Individual presentation of Courses) on topics relating to: Metabolic pathways.
3. Quiz Programmes on: Bioenergetics and Biological oxidation.
4. Individual Field Studies/projects: metabolism of biomolecules in healthy and diseased condition.
5. Group discussion on: Lipid Metabolism
6. Group/Team Projects on: Bioenergetics and Biological oxidation

7. General .

1. Collection of news reports and maintaining a record of Course-cuttings relating to topics covered in syllabus.
2. Group Discussions on: new scientific approaches and Discoveries
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers.
4. Any similar activities with imaginative thinking.

Organizing exhibitions
Preparation of charts and models
Science fairs
Science clubs
Essay writing

8. Recommended Continuous Assessment methods:

Slip test
Oral test
Assignments
Seminars

B.Sc.	Semester - IV	Credits: 4
Course:4	PHYSIOLOGY, NUTRITIONAL AND CLINICAL BIOCHEMISTRY	Hrs/Wk: 4

Aim and objectives of Course (Physiology, Nutritional and Clinical Biochemistry):

The student will get knowledge on different physiological systems and their functions in the human body. By studying blood, its composition and its functions the student will understand the importance of blood.

Learning outcomes of Course:

a) This course will also provide knowledge on hormones, their functions and the diseases occurring due to alterations in the levels of hormones.
b) By studying this course the student will know the nutritional importance of proteins, carbohydrates, lipids, vitamins and minerals.
c) Clinical biochemistry unit along with practicals will enable the student to do diagnostic tests for liver diseases, Gastro intestinal diseases, renal diseases and nutritional deficiencies.

UNIT I: 12hours

Digestion and Blood:Digestion and absorption of carbohydrates, lipids and proteins. Role of enzymes and gastrointestinal hormones in digestion. Composition of blood, Blood groups, coagulation of blood and disorders of blood coagulation (haemophilia). Hemoglobin and transport of gases in blood (oxygen and CO_2). Types of anemias, haemoglobinopathies-sickle cell anemia.

UNIT II: 12hours

Nervous system and excretory system: Introduction to nervous system, general organization of nervous system, Neurons-structure, types, properties and functions; Neurotransmitters, Cerebrospinal fluid-composition and functions, Reflex-types and properties. Introduction to excretory system. Organization of kidney, Structure and functions of nephron, Urine formation, Role of kidneys in maintaining acid-base and electrolyte balance in the body.

Unit III: 12 hours

Endocrinology: Endocrinology- organization of endocrine system. Classification of hormones. Outlines of chemistry, physiological role and disorders of hormones of thyroid, parathyroid, pituitary and hypothalamus. Introduction of gastrointestinal hormones. Mechanism of hormonal action- signal transduction pathways for glucocorticoids and insulin. Adrenalin, estrogen and progesterone.

UNIT IV: 12hours

Nutritional Biochemistry: Balanced diet. Calorific values of foods and their determination by bomb calorimeter. BMR and factors affecting it. Specific dynamic action of foods. Energy requirements and recommended dietary allowance (RDA) for children, adults, pregnant and lactating women. Sources of complete and incomplete proteins. Biological value of proteins. Malnutrition-Kwashiorkor, Marasmus and PEM. Vitamins- sources, structure, biochemical roles, deficiency disorders of water and fat soluble vitamins. Introduction to nutraceutical and functional foods. Bulk and trace elements-Ca, Mg, Fe, I, Cu, Mo, Zn, Se and F.

UNIT V: 12hours

Clinical Biochemistry: Plasma proteins in health and disease. Liver diseases-jaundice. Liver function tests- conjugated and total bilirubin in serum, albumin: globulin ratio, Serum enzymes in liver diseases-SGOT, SGPT, GGT, CPK, Acid and alkaline phosphatases. Serum lipids and lipoproteins. Normal and abnormal constituents of urine. Renal function tests-Blood urea, creatinine, GFR, creatinine clearance. GTT and gastric and pancreatic function tests.

RECOMMENDED BOOKS:

1. Essentials of Food and Nutrition, Vol. I & II, M.S. Swaminathan.
2. Text Book of Biochemistry with clinical correlations. Thomas M. Devlin (John Wily)
3. Harper's Review of Biochemistry, Murray et al (Longman).
4. Biochemical aspects of human disease – R.S. Elkeles and A.S. Tavil. (Blackwell Scientific Publications).
5. Clinical chemistry in diagnosis and treatment–Joan F.Zilva and P.R.Pannall (Lloyd-Luke Medical Books, 1988).
6. Varley's Practical clinical Biochemistry – Ed. Alan W. Gowenlock (Heinemann Medical Books, London, 1988).

B.Sc.	Semester - IV	Credits: 1
Course:4(L)	PHYSIOLOGY NUTRITIONAL AND CLINICAL BIOCHEMISTRY LAB	Hrs/Wk: 2

Details of Lab/Practical/Experiments/Tutorials syllabus:

List of practical Experiments:

1.Estimation of calcium by titrimetry
2.Estimation of iron by Wong's method.
3.Estimation of vitamin C by 2, 6 -dichlorophenol indophenol method.
4.Determination of iodine value of an oil.
5.Estimation of hemoglobin in blood.
6.Total count - RBC and WBC. Differential count.
7.Determination of blood group and Rh typing.
8.Visualization of antigen antibody reactions (Ouchterlony technique).
9.Urine analysis for albumin, sugars and ketone bodies.
10.Estimation of urinary creatinine.
11.Estimation of blood Glucose.
12.Estimation of serum total cholesterol.

7. Recommended Co-curricular activities: (Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

A. Measurable:
1. Assignments on: Endocrinology
2. Student seminars (Individual presentation of Courses) on topics relating to: syllabus
B. Quiz Programmes on: Digestion and Blood
1. Individual Field Studies/projects: Clinical Biochemistry
2. Group discussion on: Nutritional Biochemistry
3. Group/Team Projects on: Clinical Biochemistry
C. General
1. Collection of news reports and maintaining a record of Course-cuttings relating to topics covered in syllabus
2. Group Discussions on: new scientific approaches and Discoveries
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
4.Any similar activities with imaginative thinking.
Organizing exhibitions
Preparation of charts and models
Science fairs
Science clubs
Essay writing

23. Recommended Continuous Assessment methods:
Slip test
Oral test
Assignments
Seminars

B.Sc.	Semester - IV	Credits: 4
Course:5	MICROBIOLOGY, IMMUNOLOGY AND MOLECULAR BIOLOGY	Hrs/Wk: 4

Aim and objectives of Course (Microbiology, Immunology and Molecular biology):

a) This course will enable the student to know various microbes such as bacteria, fungi and viruses, their structures and other properties and diseases caused by them.
b) The student will also get knowledge in their commercial applications by making use of their beneficial effects such as fermentation in alcohol production, nitrogen fixation in agriculture etc.

Learning outcome of Course:

a) The student will get knowledge in immune system, vaccines and also understand the pathogenesis of auto immune diseases and immune deficiency diseases.
b) This course will provide knowledge and expertise in molecular biology such as genes, their structure and importance. This will also enable the student to know the applications of PCR in cloning and diagnosis of genetic and viral diseases.
c) The practicals will provide the expertise to the student to work in microbiology laboratory, food and pharma industries, and biotech companies for production of vaccines and other life-saving drugs.

UNIT I: 12hours

Microbiology: Introduction to microbiology and microbial diversity. Classification of microorganisms- prokaryotic and eukaryotic microorganisms. Bacterial structure, growth curve and kinetics of growth. Introduction to viruses-plant and animal viruses, structure, life cycle, Food and dairy microbiology. Nitrogen Fixation Nitrogen cycle, Non-biological and biological nitrogen fixation, photosynthetic and non-photosynthetic systems, Nitrogenase system. Utilization of nitrate ion, Ammonia incorporation into organic compounds

UNIT II: 12 hours

Microbial techniques: Preparation of different growth media, isolation and culturing and preservation of microbes, Gram's staining- Gram positive and Gram-negative bacteria, motility and sporulation, Sterilization techniques -Physical methods, chemical methods, radiation methods, ultrasonic and antibiotic resistance.

UNIT III: 12 hours

Applied Biochemistry : Fermentation Technology: Batch, continuous culture techniques, principle, types of fermentors. Pasteur Effect. Industrial production of chemicals- alcohol, acids (citric acid), solvents (acetone), antibiotics (penicillin), Enzyme Technology: Immobilization of enzymes and cells, industrial applications, enzymes in Bioremediation.

UNIT IV: 12hours

Immunology: Organs and cells of immune system. Innate and acquired immunity, Cell mediated and humoral immunity (T-cells and B-cells). Classification of immunoglobulins, structure of IgG. Epitopes / antigenic determinants. Concept of haptens. Adjuvants. Monoclonal antibodies. Antigen-antibody reactions- agglutination, immunoprecipitation, immunodiffusion. Blood group antigens. Immunodiagnostics- ELISA, RIA. Vaccines and their classification. Traditional vaccines-live and attenuated. Modern vaccines- recombinant and peptide vaccines. Outlines of hypersensitivity reactions.

UNIT V: 12 hours

Molecular biology: Types of RNA and DNA, DNA replication-leading and lagging strands, Okazaki fragments, inhibitors of DNA replication. Genetic code, Protein synthesis-transcription, translation, inhibitors of protein synthesis. Outlines of cloning technology, vectors, restriction enzymes, PCR, applications of cloning in agriculture, industry and medical fields.

RECOMMENDED BOOKS:

1. Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGraw Hill.
2. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W. M. T. Brown Publishers.
3. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
4. Fermentation Technology (2nd ed.) Standury (Pergman press)
5. Biotechnology: Textbook of Industrial microbiology 2nd Edit. by Crueger and Crueger (2000).
6. Principles of Biochemistry, White. A; Handler P and Smith.
7. Ivan M. Roitt; Essential Immunology (Latest Edition). Blackwell Scientific Publication
8. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition
9. W.H. Freeman and Company, New York.
10. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
11. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
12. Molecular biology by David Freifelder.

B.Sc.	Semester - IV	Credits: 1
Course:5(L)	MICROBIOLOGY, IMMUNOLOGY AND MOLECULAR BIOLOGY LAB	Hrs/Wk: 2

Details of Lab/Practical/Experiments/Tutorials syllabus:

List of Practical Experiments

1. Biosafety and good laboratory practices (GLP) of Microbiology.
2. Sterilization of microbial media by autoclave.
3. Isolation of pure cultures: (i) Streak plate method. (ii) Serial dilution method.
4. Demonstration of alcohol fermentation.
5. Antibiotic sensitivity by Course disc method.
6. Effect of nitrogen sources on growth of E. coli
7. Immunodiffusion by Ouchterlony method.
8. Blood group analysis.
9. Isolation of DNA from plant tissues.
10. Spotters.

1. Recommended Co-curricular activities:(Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

A .Measurable:. Assignments on: Immunology

1. Student seminars (Individual presentation of Courses) on topics relating to: Microbiology & Molecular Biology.
2. Quiz Programmes on: Molecular biology
3. Individual Field Studies/projects: Microbiology
4. Group discussion on: Applied Biochemistry
5. Group/Team Projects on: Microbial techniques

B. **General**

1. Collection of news reports and maintaining a record of Course-cuttings relating to topics covered in syllabus
2. Group Discussions on: new scientific approaches and Discoveries
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers

5. Any similar activities with imaginative thinking.

Organizing exhibitions
Preparation of charts and models
Science fairs
Science clubs
Essay writing

6. Recommended Continuous Assessment methods:

Slip test
Oral test
Assignments
Seminars

BLUE PRINT FOR MODEL QUESTION COURSE - THEORY

Time: 3 hours **Max marks: 75M**

SECTION A

Answer any 5 questions. Each question carries 5 marks. (5 x 5 =25M)
(Questions 1-5, one question from each unit & questions 6, 7 & 8 can be from any of the 5 units)

1. Unit - I
2. Unit-II
3. Unit-III
4. Unit-IV
5. Unit-V
6.
7.
8.

SECTION B

Answer all the questions. Each question carries 10 marks. (5X10 =50M)

9.a) from unit 1
(OR)
b) from unit 1

11.a) from unit II
(OR)
b) from unit II

12.a) from unit III
(OR)
b) from unit III

13.a) from unit IV
(OR)
b) from unit IV

14.a) from unit V
(OR)
b) from unit V

BLUE PRINT FOR MODEL PRACTICAL COURSE

Experiment/ problem solving: 40 marks (Major/Minor/Principles/Spotters)

Record/report submission: 5 marks

Viva/inter- active questioning in lab exam: 5 marks

MODEL QUESTION COURSE

B. Sc DEGREE EXAMINATION

SEMESTER: I

Course 1: BIOMOLECULES

Time: 3Hrs. **Max. Marks: 75**

SECTION A

Answer any 5 questions. Each question carries 5 marks **5 x 5 =25M**

1. Mutarotation
2. Prostaglandins
3. Enkephalin
4. General properties of proteins
5. Heme
6. Types of RNA and DNA
7. Peptide bond
8. Fluid mosaic model

SECTION B

Answer all the questions. Each question carries 10 marks **5X10 =50M**

9. a) Write about classification of carbohydrates.

(OR)

b) Write about structure and biological importance of disaccharides and trisaccharides

10. a) Write about lipids classification

(OR)

b) Write about prostaglandins- structure, types and biological role.

11. a) Write about amino acid classification

(OR)

b) Write about titration curve of glycine and px values

12. a) Write about protein classification

(OR)

b) Write about structural organization of myoglobin

13. a) Write about Watson-Crick DNA double helix structure

(OR)

b) Write about denaturation and renaturation kinetics of nucleic acids

BIOMOLECULES LAB

MODEL PRACTICAL QUESTION COURSE

Time: 3hrs **Max. Marks: 50M**

Major experiment **15M**

1. Qualitative identification of carbohydrates- glucose, fructose, ribose/xylose, maltose, sucrose, lactose, starch/glycogen

Minor experiment **10M**

2. Absorption maxima of colored substances-p-Nitrophenol, Methylorange

Principles **5M**

3. Qualitative identification of amino acids
4. Lieberman-Burchardtest

Record/report submission **5M**

Viva/inter- active questioning in lab exam **5M**

MODEL QUESTION COURSE

B. Sc DEGREE EXAMINATION

SEMESTER: II
Course 2: ANALYTICAL TECHNIQUES

Time: 3Hrs. **Max. Marks: 75**

SECTION A

Answer any 5 questions. Each question carries 5 marks **5 x 5M =25M**

1. Biological relevance of pH
2. Basic principles of light microscopy
3. Thin layer chromatography
4. Beer-Lambert's law
5. Isoelectric focusing
6. ELISA
7. Gel filtration
8. BOD

SECTION B

Answer all the questions. Each question carries 10 marks **5X10M =50M**

9. a) Write about methods of tissue homogenization

(OR)

b) Write about buffers and their role in maintenance of pH

10. a) Write about ultra-centrifugation and its working principle.

(OR)

b) Write about fluorescent microscope and their applications.

11. a) Write about affinity chromatography

(OR)

b) Write about ion- exchange chromatography

12. a) Write about radio-isotopes and their use in biology

(OR)

b) Write about spectrofluorimetry

13. a) Write about immune-electrophoresis-types and applications.

(OR)

b). Write about isoelectric focusing

ANALYTICAL TECHNIQUES Lab

MODEL PRACTICAL QUESTION COURSE

Time:3hrs **Max. Marks:50M**

Major experiment **15M**

1. Separation of amino acids by Course chromatography

Minor experiment **10M**

2. Determination of exchange capacity of resin by titrimetry

Principles **5M**

3. Isolation of cholesterol from egg yolk
4. Isolation of casein from milk

Record/report submission **5M**
Viva/inter- active questioning in lab exam **5M**

MODEL QUESTION COURSE

B. Sc DEGREE EXAMINATION

SEMESTER: III

Course 3: ENZYMOLOGY, BIOENERGETICS AND NTERMEDIARY METABOLISM

Time: 3Hrs. Max. Marks: 75

SECTION A

Answer any 5 questions. Each question carries 5 marks 5 x 5 =25M

1. Enzyme specificity
2. Enthalpy (H)
3. Diabetes Mellitus
4. Lecithin
5. Urea cycle
6. Cholesterol
7. C4 Pathway
8. Inhibitors of electron transport

SECTION B

Answer all the questions. Each question carries 10 marks 5X10 =50M

9.a) Write about nomenclature and classification of enzymes

(OR)

b) Write about lock and key, induced fit models

10. a) Write about high energy compounds.

(OR)

b) Write about mechanism of oxidative phosphorylation

11. a) Write about pentose phosphate pathway

(OR)

b) Write about citric acid cycle

12. a) Write about disorders of lipid metabolism.

(OR)

b) Write about catabolism of fatty acids (β- oxidation) with even number of carbon atoms

13. a) Write about inborn errors of aromatic and branched chain amino acid metabolism.

(OR)

b) Write about catabolism of glycogenic amino acids

ENZYMOLOGY, BIOENERGETICS AND INTERMEDIARY METABOLISM Lab
MODEL PRACTICAL QUESTION COURSE

Time: 3hrs **Max. Marks: 50M**

Major experiment **15M**

1. Estimation of amino acid by Ninhydrin method

Minor experiment **10M**

2. Assay of amylase

Principles **5M**

3. Estimation of glucose by DNS method
4. Assay of catalase

Record/report submission **5M**

Viva/inter- active questioning in lab exam **5M**

MODEL QUESTION COURSE

B. Sc DEGREE EXAMINATION

SEMESTER: IV

Course 4: PHYSIOLOGY, NUTRITIONAL AND CLINICAL BIOCHEMISTRY

Time: 3Hrs. **Max. Marks: 75**

SECTION A

Answer any 5 questions. Each question carries 5 marks 5 x 5 =25M

1. Sickle cell anemia.
2. Neurotransmitters
3. Gastrointestinal hormones
4. Kwashiorkor
5. SGOT
6. BMR
7. Physiological role of hormones
8. Role of kidneys in acid-base balance

SECTION B

Answer all the questions. Each question carries 10 marks 5X10 =50M

9. a) Write about blood coagulation

(OR)

b) Write about Digestion and absorption of carbohydrates

10. a) Write about nephron.

(OR)

b) Write about Cerebrospinal fluid-composition and functions

11. a) Write about Classification of hormones

(OR)

b) Write about signal transduction pathways for glucocorticoids

12. a) Write about recommended dietary allowance (RDA) for children and adults.

(OR)

b) Write about sources, structure, biochemical roles of vitamins.

13. a) Write about Liver function tests

(OR)

b) Write about pancreatic function tests

Physiology, Nutritional and Clinical Biochemistry Lab
MODEL PRACTICAL QUESTION COURSE

Time: 3hrs **Max. Marks. 50M**

Major experiment **15M**

1. Determination of blood group and Rh typing

Minor experiment **10M**

2. Estimation of calcium by titrimetry

Principles **5M**

3**.** Estimation of hemoglobin in blood

4. Estimation of serum total cholesterol

Record/report submission **5M**

Viva/inter- active questioning in lab exam **5M**

MODEL QUESTION COURSE

B. Sc DEGREE EXAMINATION

SEMESTER: IV
Course 5: MICROBIOLOGY, IMMUNOLOGY AND MOLECULAR BIOLOGY

Time: 3Hrs. **Max. Marks: 75**

SECTION A

Answer any 5 questions. Each question carries 5 marks **5 x 5 =25M**

1. Nitrogenase system.
2. Gram's staining
3. Enzymes in Bioremediation
4. Haptens
5. Okazaki fragments
6. RIA
7. Pasteur effect
8. Antibiotic resistance.

SECTION B

Answer all the questions. Each question carries 10 marks **5X10 =50M**

9.a) Write about non-biological and biological nitrogen fixation.

(OR)

b) Write about bacterial growth curve and kinetics of growth.

10. a) Write about Physical methods and chemical methods of Sterilization.

(OR)

b) Write about isolation culturing and preservation of microbes.

11. a) Write about industrial production of antibiotics

(OR)

b) Write about Immobilization of enzymes.

12. a) Write about Vaccines and their classification.

(OR)

b)Write about Classification of immunoglobulins

13. a) Write about DNA replication in prokaryotes

(OR)

b) Write about PCR

MICROBIOLOGY, IMMUNOLOGY AND MOLECULAR BIOLOGY LAB
MODEL PRACTICAL QUESTION COURSE

Time: 3hrs **Max. Marks. 50M**

Major experiment	**15M**
1. Isolation of DNA from plant tissues.	
Minor experiment	**10M**
1. Antibiotic sensitivity by Course disc method	
Spotters	**5M**
Record/report submission	**5M**
Viva/inter- active questioning in lab exam	**5M**