Mizoram University

4 Years Degree Course

Bachelor of Science (Biochemistry)

NEP 2020

Submission - April, 2023
Approved by BOS, Biotechnology - 4th May, 2023

Undergraduate Biochemistry Course Structure and Credit Distribution with multiple entry and exit options for Certificate, Diploma and Bachelor Degree (Including Honours and Research)

SEMESTER	COURSE CODE	COURSE NAME	CREDITS
I	BCHEM 100	Introduction to Biochemistry	4
	BCHEM 101	Biomolecules	4
		[Minor course from other disciplines]	4
	BCHEM 102	Biochemistry in Health & Diseases	3
		Language and Communication Skill	3
		Value Added Course	2
	Total Credits		**20**
II	BCHEM 103	Cell & Membrane Biology	4
	BCHEM 104	Enzymology & Bioenergetics	4
		[Minor course from other disciplines]	4
	BCHEM 105	Biochemistry in Health & Diseases	3
		Skill Enhancement Course: Tools and techniques in Biochemistry	3
		Value Added Course	2
	Total Credits		**20**
UG Certificate Course in Biochemistry after securing 40 credits			
III	BCHEM 200	Metabolism - I	3+1
	BCHEM 201	Microbiology	4
		[Minor course from other disciplines]	4
	BCHEM 202	Biochemistry in Health & Diseases	3
		Skill Enhancement Course: Tools and techniques in Biochemistry	3
		Value Added Course	2
	Total credits		**20**

IV	BCHEM 203	Metabolism - II	3+1
	BCHEM 204	Physiological Biochemistry	4
		[Minor course from other disciplines]	4
		Language and Communication Skill	3
		Skill Enhancement Course: Tools and techniques in Biochemistry	3
		Value Added Course	2
			20
UG Diploma in Biochemistry after securing 80 credits			
V	BCHEM 300	Biochemical Techniques	3+1
	BCHEM 301	Clinical Biochemistry	3+1
	BCHEM 302	Immunology	4
		[Minor course from other disciplines]	4
		Language and Communication Skill	2
		Internship	2
	Total credits		**20**
VI	BCHEM 303	Molecular Biology	3+1
	BCHEM 304	Nutritional Biochemistry	3+1
	BCHEM 305	Project/Field based learning	4
	BCHEM 306	Genetic Engineering & Biotechnology	4
		[Minor course from other disciplines]	4
	Total credits		**20**
	UG Degree in Biochemistry after securing 120 credits		

VII	BCHEM 400	Bioinformatics & Biostatistics	3+1
	BCHEM 401	Applied Biochemistry	4
	BCHEM 402	Biophysics & Instrumentation	4
		[Minor course from other disciplines]	4
		[Minor course from other disciplines]	4
	Total credits		**20**
VIII	BCHEM 403	Microbial techniques	3+1
	BCHEM 404	Advance Techniques in Biology	4
	BCHEM 405	Plant Biochemistry	4
	BCHEM 406	Environmental Biochemistry	4
	BCHEM 407	Genetics	4
	Total credits		**20**
	Bachelor's degree in Biochemistry (Honours)		**160**
OR			
VIII	BCHEM 403	Microbial techniques	3+1
	BCHEM 404	Advance Techniques in Biology	4
	BCHEM 408	Research Project/Dissertation	12
	Total credits		**20**
	Bachelor's degree in Biochemistry (Honours with Research)		**160**

Key Points:

1. In teaching all the courses of Biochemistry, S.I. units will be followed.
2. Contact hour per Lecture is 1 hour. For Theory, 1 Contact hour is 1 Credit and for Practical, 2 Contact hours is 1 Credit.
3. Internal Tests/Assignments will be conducted as a part of Internal Assessment as per CGS Regulations (UG) of Mizoram University.

C. Guideline for choosing Minor and Multidisciplinary paper

The permitted combinations of minor and multidisciplinary papers for Biochemistry are as given below:

Sl. No	Major	Minor
1.	Biochemistry	Botany/ Chemistry/ Home Science/Zoology
2.	Botany	Biochemistry/Chemistry/ Home Science/ Zoology
3.	Chemistry	Botany/Biochemistry/ Physics/ Zoology
4.	Electronics	Geology/ Biochemistry/Mathematics/ Physics
5.	Geology	Zoology/ Chemistry/Electronics/Physics
6.	Home Science	Botany/ Biochemistry/ Home Science/ Zoology
7.	Mathematics	Chemistry/ Electronics/Geology/Physics
8.	Physics	Chemistry/Electronics/Geology/Mathematics
9.	Zoology	Biochemistry/ Botany/ Chemistry/ Home Science

D. Examination Pattern

- Internal Tests as per CGS guidelines for UG (MZU)
- In the End Semester examinations, following is the marks distribution and the pattern of setting the questions in Theory and Practical Papers.

PAPER WITH 4 UNITS

SI No.	CATEGORY	TOTAL MARKS	NO. OF QUESTIONS TO SET	NO. OF QUESTIONS TO BE ANSWERD
1.	Multiple Choice Question (1 mark)	15	4 from each unit (provided 3 from 1 unit)	15
2.	Short Answer (3 marks)	12	2 from each unit X 4 = 8	1 from each unit X 4 = 4
3.	Descriptive (12 marks)	48	2 from each unit X 4 = 8	1 from each unit X 4 = 4
4.	**Total**	**75**		

PAPER WITH 3 UNITS

SI No.	CATEGORY	TOTAL MARKS	NO. OF QUESTIONS TO SET	NO. OF QUESTIONS TO BE ANSWERD

1.	Multiple Choice Question	12	4 from each unit x 3 = 12	12

	(1 mark)			
2.	Short Answer (3 marks)	18	3 from each unit X 3 = 9	2 from each unit X 3 = 6
3.	Descriptive (12 marks)	45	2 from each unit X 3 = 6	1 from each unit X 3 = 3
4.	**Total**	**75**		

E. Internal and External Examination

Examination and Assessment: Each Course, shall be evaluated at the scale of 100. For all courses, irrespective of Theory and Practical, there shall be Continuous (internal) Assessment carrying 25 marks and an End-semester examination carrying 75 marks.

1) Continuous Assessment:

The outline for Continuous Assessment activities shall be proposed by the teacher(s) concerned before the commencement of the semester. Some suggested parameters of Continuous Assessment are Class Tests, Seminar, Quiz, Home Assignments, Project, and many other methods. However, there shall be series of tests at regular intervals for each course (paper) incorporating various parameters as given above. Final marks shall be calculated for total 25 Marks.

The scheme of awarding marks in Internal Assessment for Theory courses shall be as below:

Component	**Total marks**
Average of two Continuous Assessment Test	12 marks
Assignment/Seminar/Project etc.	8 marks
Regularity in the class	5 marks

The scheme of awarding marks in Internal Assessment for Practical courses shall be as given below:

Evaluation in the Lab and Record	8 marks
End-semester Test	12 Marks
Regularity in the class	5 Marks

Attendance evaluation for each course shall be as given in below:

Attendance	**Marks**
90% and above	5
85 to 89.9%	4
80 to 84.9%	3
76 to 79.9%	2
75 to 75.9%	1

2) The End-semester Examination

End-semester examination carrying 75 marks shall be conducted for all the courses containing separate theory and practical. Finally, the marks obtained in Internal Assessment and End-semester Examination in the relevant course shall be pooled and the % marks obtained shall be calculated by the Examination Department.

OBJECTIVE OF THE COURSE

Biochemistry, the study of biological phenomena at cellular and molecular level, is studied to gain knowledge about the principles that govern complex biological systems. The primary objective of this course is to give students a solid foundation in biochemical processes; to develop analytical, technical and critical thinking skills and to make them scientifically literate so as to contribute to the discipline after graduation.

SYLLABI AND COURSES

The syllabus pertaining to B.Sc. Biochemistry (4 Year course & 8 Semesters) in the subject of Biochemistry has been framed as per the NEP 2020 curriculum and Credit framework of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills according to the demand of NEP 2020 pertaining to B.Sc. in Biochemistry.

FIRST SEMESTER

INTRODUCTION TO BIOCHEMISTRY

Course Code: BCHEM 100

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to give students basic concepts of biochemistry and its interdisciplinary importance. To let students understand the physical and chemical properties of molecules, and their status of occurrence in biological systems.*

Course outcomes: *On completion of the course, students will be able to understand:*

- *nature of biochemistry*
- *physical and chemical properties of molecules as a linkage to biochemistry*
- *concept and properties of the acid-base relationship*
- *concept of chemical bonding and concentration units*

Unit 1: Overview of Biochemistry

Definition, scope and significance of Biochemistry. History and important discoveries in Biochemistry. An overview of elements, chemical reactions and biomolecules in living organisms.

Unit 2: Physical properties of molecules

Ionic product of water, physical properties of water. Its effect on biomolecules. Hypo, hyper and isotonic solutions. Osmotic pressure , Effects of osmotic pressure on living cells.

Unit 3: Ionic equilibria

Concept of acids and bases. pH and pKa, buffers, Henderson Hasselbalch equation, biological buffers.

Unit 4: Chemical bonding & Concentration units

Ionic bonding, covalent bonding, hydrogen bonding, Van der Waal's forces, hydrophobic interaction. Molarity and molality, equivalent weight, normality, percentage. Safety measures in laboratory.

Suggested readings

1. Barrow, G. M (2007). Physical Chemistry Tata McGraw-Hill, India.
2. Kotz, J. C., Treichel, P. M. and Townsend, J. R (2009) General Chemistry Cengage Le arning India Pvt. Ltd.: New Delhi.
3. Douglas, McDaniel and Alexander (1994). Concepts and Models in Inorganic Chemistry, John Wiley, 3rd edition
4. James E. Huheey, Ellen Keiter and Richard Keiter(2013). Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Public, 4th Edition.
5. Pattabhi. V. and Gautham. N (2002). Biophysics. Narosa Publishing House, India. □ Physical Chemistry – Puri, Pathania& Sharma

FIRST SEMESTER

BIOMOLECULES

Course Code: BCHEM 101

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective: *To familiarise the students with major biomolecules, namely carbohydrates, lipids, proteins, and nucleic acids, which are important for the structural organisation and functions of the cells. The course encompasses an overall perspective on the biomolecules, their characteristic properties, and their organisation in carrying out all the living functions that constitute life.*

Course Outcome: *On completion of the course, students will be able to:*

- *assess and relate the concepts of chemistry to biology.*
- *identify the structures of amino acids, their chemical properties, and their organisation into polypeptides and proteins.*
- *understand the structure and functions of fundamental mono, di, and trisaccharides and*
- *relate the basic function of nucleotides, structure of different classes of lipids and their roles in biological systems.*

Unit 1: Carbohydrates

Classification and biological role of carbohydrates; chemistry and reactions of monosaccharides-anomers, epimers, mutarotation, glycoside. Biologically important disaccharides- sucrose, lactose. Homopolysaccharides. Reducing and non- reducing sugars.

Unit 2: Proteins

Amino acids; general structure, classification and properties of amino acids.

Proteins - classification, biological role and general properties. Structural organization of protein - Primary structure, Secondary, tertiary and quaternary structure. Molecular chaperones in protein folding. Denaturation.

Unit 3: Lipids

Fatty acids; general formula, nomenclature and numbering, saturated and unsaturated fatty acids, properties of fatty acids. Essential fatty acids.
Lipid classification & biological role. General structure and functions of - triacylglycerols, phospholipids and steroids.

Unit 4: Nucleic Acids

Structure and functions of nucleotides. Forms of DNA, Watson-Crick model of DNA. Structure and functions of major species of RNA - mRNA, tRNA and rRNA; effect of acid and alkali on DNA.

Suggested readings

1. Satyanarayana, U (2013). *Biochemistry*, (4th ed.). Reed Elsevier India Pvt. Ltd & Books and Allied Pvt Lmt. India. ISBN- 978-81-312-3601-7.

2. Nelson, D.L and Cox, M.M (2008*). Lehninger's Principles of Biochemistry*, Macmillan Pub.
3. Agarwal, O.P (2008). *Fundamentals of Biochemistry*, (11th ed.). Goel Publishing House.
4. Jain, A.I (2004). *Essentials of Biochemistry*, (2nd ed.). S. Chand publications.
5. Anil, K., Sarika, G and Neha, G (2012). *Biochemical Tests – Principles and Protocols*. Vinod Vasishtha Viva Books Pvt Ltd.
6. Boyer, R.F (2012). Biochemistry *Laboratory: Modern Theory and Techniques*, (6th ed.). Boston, Mass: Prentice Hall, 2012, ISBN-13: 9780136043027.

FIRST SEMESTER
BIOCHEMISTRY IN HEALTH & DISEASE
Course Code: BCHEM 102

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to teach students the importance of Biochemistry in our everyday lives and its interdisciplinary nature. To make students understand the concept of Biochemistry in health and wellness.*

Course outcomes: O*n completion of the course, students will be able to understand:*

- *concept of health and diseased conditions*
- *the importance of balanced nutrition*
- *concept of food safety*

Unit 1: Health and Wellness

WHO definition of health, Classification of diseases-Endemic, Epidemic, Pandemic; Professional health hazards. Communicable and non- communicable diseases.

Unit 2: Nutrition

Nutrition and its importance. Concept of balanced diet. Nutritional importance of carbohydrates, fats, proteins and water. Probiotic.

Unit 3: Food Adulteration and Toxicology

Basic concept on Food Adulteration. Intentional and Incidental adulterants. Source, entry in to biological system and toxicity of - lead, mercury, cadmium and arsenic.

Unit 4: Diseased conditions

Acute disease, chronic disease, Incurable disease, Terminal disease. Allergies. Biochemical basis of Addiction. Blood transfusion safety.

Suggested readings

1. Modern Nutrition in Health and Disease, 2006, 10th Edition, Maurice E. Shils, Moshe Shike, A Catharine Ross.
2. Clinical Biochemistry and Metabolic Medicine, 2012, Eighth Edition, Martin Andrew Crook, CRC Press,
3. Nutrition and Health in Developing Countries, 2000, Editors: R. Semba and M.W. Bloem, Humana Press.

SECOND SEMESTER

CELL & MEMBRANE BIOLOGY

Course Code: BIOCHEM 103

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective: *The study of cell biology aims to increase understanding of living systems and to consider the systems in relation to themselves and other organisms in the natural environment. The course describes life activities at the cellular and molecular level and the basic functions of the various cellular compartments and organelles. This course also aims to develop knowledge among the students about the signalling system in cells.*

Course Outcome: *On completion of the course, students shall be able to:*

- *identify and present relevant information from research publications dealing with issues of cell biology.*
- *assess and relate the information to the context of cell biology.*
- *gain knowledge on cell division and regulation*
- *plan and carry out simple experiments on the basis of cells.*

Unit 1: Morphology of cell

Prokaryotes: Cell structure and components, Eukaryotes: Cell structure and subcellular organelles, plants and animal cells-difference in structure and function.

Unit 2: Cytoskeleton

Microtubules, axonemal and cytoplasmic microtubules, Microfilaments: actin and myosin. Role of cytoskeletal elements in the entry of infectious agents.

Unit 3: Cell cycle

Cell division (mitosis and meiosis); Cell cycle and its regulation, key concepts on apoptosis and stem cells. Cancer- salient features and causes.

Unit 4: Biological membrane

Fluid-Mosaic model, fluidity of membranes. Membrane transport- uniport, symport, antiport, active and passive transport.
General overview of cell signaling; Types, signaling molecules and their receptors.

Suggested readings

1. Powar, C.B (2010). Cell Biology. Himalaya Publishing House.
2. Verma, P.S and Agarwal, V.K (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Ltd, New Delhi.
3. Gupta, P.K (2005). Cell and Molecular biology. Rastogi Publications, India. 22
4. Satyanarayana, U (2013). Biochemistry, (4th ed.). Reed Elsevier India Pvt. Ltd & Books and Allied Pvt Lmt. India. ISBN- 978-81-312-3601-7.
5. Nelson, D.L and Cox M.M (2008). Lehninger's Principles of Biochemistry, Macmillan Pub.
6. Voet, D., Voet, J.G and Charlotte, WP (2016). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley ISBN 978-1-118-91840-1.

SECOND SEMESTER

ENZYMOLOGY & BIOENERGETICS

Course Code: BCHEM 104

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective*: The course is designed to enable students to understand enzymes, their properties, mechanisms of action, and the regulation of their activity. To acquaint students with the basic cascades of energy transfer systems and subsequent products in biology. The course will help the students understand the fundamental energetics of biochemical processes, their functionalities.*

Course Outcome: *On completion of the course, students shall be able to:*

- *understand enzymes and how they catalyse reactions, as well as enzyme kinetics.*
- *plan and carry out simple experiments on enzymes and physiology.*
- *Understand mechanism and concept of bioenergetics in cell biology*
- *Clear thermodynamics in relation to biological aspects*

Unit 1: Introduction to enzymes

Definition, Classification and nomenclature of enzymes; Units of Enzyme activity,
Definition with examples of-holoenzyme, apoenzyme, cofactors, prosthetic groups. Coenzymes and their role in enzyme catalyzed reactions. Active site, ES complex formation; Transition state theory.

Unit 2: Enzyme kinetics

Enzyme specificity, Factors affecting enzyme activity: Derivation of Michaelis-Menten equation, Significance of K_m and V_{max}, Line Weaver-Burk plot. Enzyme inhibition-Reversible (competitive, non-competitive and uncompetitive inhibition) and irreversible inhibition, allosteric inhibition.

Unit 3: Bioenergetics-I

Introduction to bioenergetics; Biological oxidation, Redox reactions in biology, Free energy. Laws of Thermodynamics and its application to biological systems. Thermogenesis-Shivering and Non-shivering thermogenesis

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Unit 4: Bioenergetics-II

Electron Transfer Chain, Oxidative and substrate-level Phosphorylation, Inhibitors and uncouplers. ATP synthase.

Suggested readings

1. Nelson, D.L. and Cox, M.M (2008). *Lehninger's Principles of Biochemistry*, Macmillan Pub.
2. Nicholas, C.P (1989). *Fundamentals of Enzymology*, Oxford University Press.
3. Jain, J.L., Sanjay, J and Nitin, J (1997). *Fundamentals of Biochemistry*, (6th ed.). New Delhi: S. Chand & company Ltd.
4. Rastogi, S.C (2006). *Experimental Physiology*, (2nd ed.). New Age Intl. (P) Ltd.

5. Colowick, S.P and Kaplan, N.O (1955). *Methods in Enzymology*, Vol. I and II. New York: Academia Press.
6. Rao, M.A (2006). *Medical Biochemistry*, (Revised 2nd ed.). New Age Intl. (P) Ltd.
7. Plummer, D.T (1993). *An Introduction to Practicals in Biochemistry*. Tata McGraw-Hill.
8. Boyer, R.F. (2005). *Modern Experimental Biochemistry*, (3rd ed.). Pearson-Educations (P) Ltd

SECOND SEMESTER

BIOCHEMISTRY IN HEALTH & DISEASES

Course Code: BCHEM 105

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to teach students the importance of Biochemistry in our everyday lives and its interdisciplinary nature. To make students understand the concept of Biochemistry in health and wellness.*

Course outcomes: O*n completion of the course, students will be able to understand:*

- *concept of health and diseased conditions*
- *the importance of balanced nutrition*
- *concept of food safety*

Unit 1: Health and Wellness

WHO definition of health, Classification of diseases-Endemic, Epidemic, Pandemic; Professional health hazards. Communicable and non- communicable diseases.

Unit 2: Nutrition

Nutrition and its importance. Concept of balanced diet. Nutritional importance of carbohydrates, fats, proteins and water. Probiotic.

Unit 3: Food Adulteration and Toxicology

Basic concept on Food Adulteration. Intentional and Incidental adulterants. Source, entry in to biological system and toxicity of - lead, mercury, cadmium and arsenic.

Unit 4:Diseased conditions

Acute disease, chronic disease, Incurable disease, Terminal disease. Allergies. Concept of Addiction. Blood transfusion safety.

Suggested readings

1. Modern Nutrition in Health and Disease, 2006, 10th Edition, Maurice E. Shils, Moshe Shike, A Catharine Ross.
2. Clinical Biochemistry and Metabolic Medicine, 2012, Eighth Edition, Martin Andrew Crook, CRC Press,
3. Nutrition and Health in Developing Countries, 2000, Editors: R. Semba and M.W. Bloem, Humana Press.

SECOND SEMESTER

SKILL ENHANCEMENT COURSE
TOOLS & TECHNIQUES IN BIOCHEMISTRY

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objectives*: The course will provide students with knowledge of good laboratory practises, the analysis of biological fluids like blood and urine, and their importance in the diagnosis of diseases. The course also introduces students to the microbes around us and provides basic insights on the culturing of microbes for further studies.*

Course outcome: *After successful completion of the course, the students will be able to understand:*

- *Hazards and good practises in the laboratory: preparation and storage of reagents*
- *Basic concepts of microbiology*
- *Composition, collection, and analysis of biological fluids.*

Unit 1: Good Laboratory Practices and Preparation of Solutions

Safety measures and first aid in the laboratory. Preparation and storage of reagents (Normal, molar, percent, stock and standard solution). Preparation of buffer and determination of pH. Principle and applications of UV-Visible Spectroscopy

Exercises:

a) Determination of pH using pH meter.
b) Preparation of buffer using Handerson-Hasselbach equation.
c) Estimation of protein by colorimeter/ Spectrophotometer
d) Estimation of carbohydrates by colorimeter/ Spectrophotometer

Unit 2: Analysis of Biological samples

Biochemistry of blood: ABO blood grouping; Rh factor; Blood cell types ;Haemoglobin-function; Understanding Blood Pressure. Normal values for important constituents in urine.

Exercises:

a) Determination of ABO Blood groups and Rh factor
b) Estimation of blood Haemoglobin
c) Determination of Blood Pressure
d) Collection & Separation of Blood plasma/serum
e) Estimation of Blood Glucose/ Cholesterol
f) Collection of urine and qualitative analysis of normal/ abnormal constituents of urine.

Unit 3: Introduction to microbial world

Basic introduction to different microbes, growth medium for microbes- differential and specific medium. Sterilization and Disinfection.

Exercises:

a) Isolation of bacteria from soil, water or air, counting CFU (Colony forming units).
b) Differential staining techniques.
c) Preparation of hand sanitizers.

Suggested readings

1. Devlin, T.M(2011). *Textbook of Biochemistry with Clinical Correlations*. John Wiley& Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Burtis, Ashwood and TietZ W.B.S (1999).*Textbook of Clinical Chemistry,* (3rded.).
3. Wiley,J.M.,Sherwood,L.M and Woolverton, C.J (2017). *Prescott's Microbiology*,(10th ed.), McGraw Hill Higher Education;ISBN13: 9781259657573.
4. Pelczar, Jr M.J.,Chan,E.C.S and Krieg, N.R(2004).*Microbiology*, (5th ed.).Tata McGraw Hill; ISBN 13: 9780074623206.
5. Upadhya,A., Upadhyay,K and Nath,N (2014). *Biophysical Chemistry: Principles and Techniques*,(4th ed.). Himalaya Publishing House, India.
6. David, P (1988). *A Textbook of Practical Biochemistry*. Tata McGraw-Hill Education.

THIRD SEMESTER
METABOLISM-I
Course Code: BCHEM 200

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25

Objective: *This course aims to develop thorough knowledge among the students about metabolism. To enable students to visualise energy production and utilisation in biological processes. The course gives an overview of the metabolism of different biomolecules that can help students understand chemical pathways in living systems.*

Course Outcome: *On completion of the course, students shall be able to:*

Identify and present relevant information relating to metabolism.
Assess and relate the information to the context of metabolism.
Understand the structure, catabolism, and anabolism of biomolecules
Interrelations, regulation, and malfunction of the pathways associated with carbohydrate and protein metabolism.

Unit 1: Introduction to Metabolism
General features of metabolism; anabolism and catabolism, metabolic principles; methods employed to study metabolism. ATP as energy currency. High energy phosphate compounds.Difference between anaerobic and aerobic ATP production.

Unit 2: Carbohydrate metabolism-1
Overview, reactions, regulations and energetics of Glycolysis and Tricarboxylic acid cycle. Amphibolic nature and anaplerotic reactions of TCA. Alcoholic & lactic acid fermentation

Unit 3: Carbohydrate metabolism-2
Gluconeogenesis-Importance and reactions, regulations and inhibition, Glycogenesis, Glycogenolysis, HMP pathway and its significance.

Unit 4: Amino acid Metabolism
General reaction of amino acid degradation – Salient features and mechanism of Transamination, Deamination and decarboxylation. Metabolism of individual amino acids-phenylalanine, tyrosine and tryptophan. Ketogenic and glucogenic amino acids. Urea cycle, regulation and its significance.

Suggested readings

1. Satyanarayana, U (2013*). Biochemistry*, (4th ed.). Reed Elsevier India Pvt. Ltd & Books and Allied Pvt Lmt. India. ISBN- 978-81-312-3601-7.
2. Nelson, D.L and Cox M.M (2008). *Lehninger's Principles of Biochemistry*, Macmillan Pub.
3. Voet, D.,Voet, J.G and Charlotte, WP (2016).*Fundamentals of Biochemistry: Life at the Molecular Leve*l (5th ed.). Wiley ISBN 978-1-118-91840-1.

THIRD SEMESTER
METABOLISM-I
Course Code: BCHEM 200
Practical

Marks Scale: 100 marks **Credit: 1**
(End Sem.: 75+ Int.: 25)

Objective: *The course explains how to perform the various methods of qualitative testing for proteins and carbohydrates. The course seeks to provide understanding and applied knowledge on enzymes and enzyme-based laboratory tests to understand the significance of enzyme reactions.*

Course Outcome: *On completion of the course, students will be able to:*

equip themselves with the basic biochemistry techniques that can later be applied for their laboratory research and also for many other industrial research projects.
prepare solutions and reagents.
Perform qualitative tests for biomolecules, viz., proteins, carbohydrates.
carry out and understand enzymatic reactions
understand factors affecting enzyme reactions

1. Safety measures in laboratory.
2. Calibration of volumetric glassware's (burette, pipette, measuring cylinder).
3. Calculation, preparation of normal, molar and percentage solutions.
4. Qualitative tests for carbohydrates (Solubility, reducing and non- reducing sugars, Identification of monosaccharides, disaccharides and polysaccharides).
5. Qualitative tests for Proteins (General tests and colour reactions of amino acids)
6. Effect of pH/ temperature on the rate of enzyme reaction.
7. Effect of substrate/ enzyme concentration on enzyme reaction.

THIRD SEMESTER

MICROBIOLOGY

Course Code: BCHEM 201

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objectives: *The course is to introduce the origin of microbiology, and the contributions of various scientists to the origin of microbiology. It will also describe various salient features of microbes. The course describes the diversity of microorganisms and their nutritional requirements. The course also imparts knowledge on the culture technique, which will help students carry out experiments on their own.*

Course Outcome: *At the end of the course, the students will be able to understand:*

- *origin of microbiology*
- *concept of microbial diversity and features*
- *different nutrients needed by microbes*
- *techniques of culture*

Unit 1: History and scope of Microbiology
Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch. Germ theory of disease.

Unit 2: Diversity of microbial world
Introduction to microorganisms- acellular (Viruses, Viroids, Prions) & cellular (Bacteria, Archaea, Fungi, Protozoa, Algae). Morphology, Nutrition, Reproduction of Bacteria

Unit 3: Microbial nutrition and Growth
Basic growth media: Nutrient Broth and Nutrient Agar, types of media
Microbial growth in solid and liquid media, Factors affecting microbial growth

Unit 4: Plating techniques
Methods of sterilization of media, reagents and, control of microbes (Physical and chemical methods): Isolation of Pure culture: Serial dilution, Streaking, Spreading and Pour Plate methods

Suggested readings

1. Pelczar, Jr M.J., Chan, E.C.S and Krieg, N.R (2004). *Microbiology*, (5th ed.). Tata McGraw Hill; ISBN13: 9780074623206.142.
2. Cappucino, J. and Sherman, N. (2013). *Microbiology: A Laboratory Manual*, (10th ed.). Pearson Education Limited; ISBN13: 9780321840226

3. Willey, J.M., Sherwood, L.M and Woolverton, C.J (2017). *Prescott's Microbiology*, (10th ed.), McGraw Hill Higher Education; ISBN13: 9781259657573.

THIRD SEMESTER

BIOCHEMISTRY IN HEALTH & DISEASES

Course Code: BCHEM 202

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to teach students the importance of Biochemistry in our everyday lives and its interdisciplinary nature. To make students understand the concept of Biochemistry in health and wellness.*

Course outcomes: O*n completion of the course, students will be able to understand:*

concept of health and diseased conditions
the importance of balanced nutrition
concept of food safety

Unit 1: Health and Wellness

WHO definition of health, Classification of diseases-Endemic, Epidemic, Pandemic; Professional health hazards. Communicable and non- communicable diseases.

Unit 2: Nutrition

Nutrition and its importance. Concept of balanced diet. Nutritional importance of carbohydrates, fats, proteins and water. Probiotic.

Unit 3: Food Adulteration and Toxicology

Basic concept on Food Adulteration. Intentional and Incidental adulterants. Source, entry in to biological system and toxicity of - lead, mercury, cadmium and arsenic.

Unit 4: Diseased conditions

Acute disease, chronic disease, Incurable disease, Terminal disease. Allergies. Concept of Addiction. Blood transfusion safety.

Suggested readings

1. Modern Nutrition in Health and Disease, 2006, 10th Edition, Maurice E. Shils, Moshe Shike, A Catharine Ross.
2. Clinical Biochemistry and Metabolic Medicine, 2012, Eighth Edition, Martin Andrew Crook, CRC Press,
3. Nutrition and Health in Developing Countries, 2000, Editors: R. Semba and M.W. Bloem, Humana Press.

THIRD SEMESTER

SKILL ENHANCEMENT COURSE
TOOLS & TECHNIQUES IN BIOCHEMISTRY

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objectives*: The course will provide students with knowledge of good laboratory practises, the analysis of biological fluids like blood and urine, and their importance in the diagnosis of diseases. The course also introduces students to the microbes around us and provides basic insights on the culturing of microbes for further studies.*

Course outcome: *After successful completion of the course, the students will be able to understand:*

hazards and good practises in the laboratory: preparation and storage of reagents
basic concepts of microbiology
composition, collection, and analysis of biological fluids

Unit 1: Good Laboratory Practices and Preparation of Solutions

Safety measures and first aid in the laboratory. Preparation and storage of reagents (Normal,molar,percent, stock and standard solution). Preparation of buffer and determination of pH. Principle and applications of UV-Visible Spectroscopy

Exercises:

e) Determination of pH using pH meter.
f) Preparation of buffer using Handerson-Hasselbach equation.
g) Estimation of protein by colorimeter/ Spectrophotometer
h) Estimation of carbohydrates by colorimeter/ Spectrophotometer

Unit 2: Analysis of Biological samples

Biochemistry of blood: ABO blood grouping; Rh factor; Blood cell types ;Haemoglobin-function; Understanding Blood Pressure. Normal values for important constituents in urine.

Exercises:

g) Determination of ABO Blood groups and Rh factor
h) Estimation of blood Haemoglobin
i) Determination of Blood Pressure
j) Collection & Separation of Blood plasma/serum
k) Estimation of Blood Glucose/ Cholesterol
l) Collection of urine and qualitative analysis of normal/ abnormal constituents of urine.

Unit 3: Introduction to microbial world

Basic introduction to different microbes, growth medium for microbes- differential and specific medium. Sterilization and Disinfection.

Exercises:

d) Isolation of bacteria from soil, water or air, counting CFU (Colony forming units).
e) Differential staining techniques.
f) Preparation of hand sanitizers.

Suggested readings

1. Devlin, T.M(2011). *Textbook of Biochemistry with Clinical Correlations*. John Wiley& Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Burtis, Ashwood and TietZ W.B.S (1999).*Textbook of Clinical Chemistry,* (3rd ed.).
3. Wiley,J.M.,Sherwood,L.M and Woolverton, C.J (2017). *Prescott's Microbiology*,(10th ed.), McGraw Hill Higher Education;ISBN13: 9781259657573.
4. Pelczar, Jr M.J.,Chan,E.C.S and Krieg, N.R(2004).*Microbiology*, (5th ed.).Tata McGraw Hill; ISBN 13: 9780074623206.
5. Upadhya,A., Upadhyay,K and Nath,N (2014). *Biophysical Chemistry: Principles and Techniques*,(4th ed.). Himalaya Publishing House, India.
6. David, P (1988). *A Textbook of Practical Biochemistry*. Tata McGraw-Hill Education.

FOURTH
SEMESTER
METABOLISM-II
Course Code: BCHEM 203

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objective: *This course aims to develop thorough knowledge among the students about metabolism. To enable students to visualise energy production and utilisation in biological processes. The course gives an overview of the metabolism of different biomolecules that can help students understand chemical pathways in the living system and various disorders relating to metabolism.*

Course Outcome: *On completion of the course, students shall be able to:*

- *identify and present relevant information relating to metabolism.*
- *assess and relate the information to the context of metabolism.*
- *understand the structure, catabolism, and anabolism of biomolecules*
- *interrelations, regulation, and malfunction of the pathways associated with lipid and nucleic acid metabolism.*
- *understand various disorders relating to metabolism.*

Unit 1: Lipid metabolism-I

Oxidation of fatty acids – α, β and ω types, β-oxidation of even number saturated fatty acids (palmitic acid). Energetics of β-oxidation.

Unit 2: Lipid metabolism -II

Ketone bodies- ketogenesis, utilization and overproduction of ketone bodies. Biosynthesis and regulation of palmitic acid, FAS Complex. Lipoproteins. Outline of cholesterol metabolism.

Unit 3: Nucleotide metabolism

Sources of the atoms in the purine and pyrimidine molecules. *De novo* synthesis of purine and pyrimidine nucleotides and salvage pathways; degradation of purine and pyrimidine nucleotides; Regulation and inhibitors of nucleotide metabolism.

Unit 4: Diseases related to metabolism

Hypo- and hyper-glycemia, Diabetes mellitus. Inborn errors of amino acid metabolism- alkaptonuria, phenylketonuria, albinism. Fatty liver, atherosclerosis, Gout and hyper-uricemia.

Suggested readings

1. Satyanarayana, U (2013*). Biochemistry*, (4th ed.). Reed Elsevier India Pvt. Ltd & Books and Allied Pvt Lmt. India. ISBN- 978-81-312-3601-7.
2. Nelson, D.L and Cox M.M (2008). *Lehninger's Principles of Biochemistry*, Macmillan Pub.
3. Voet, D.,Voet, J.G and Charlotte, WP (2016).*Fundamentals of Biochemistry: Life at the Molecular Leve*l (5th ed.). Wiley ISBN 978-1-118-91840-1.

FOURTH
SEMESTER
METABOLISM-II
Course Code: BCHEM 203
Practical

Marks Scale: 100 marks **Credit: 1**
(End Sem.: 75+ Int.: 25)

Objective: *To acquire confidence, interest, challenge, and discipline in laboratory behaviour in biochemistry. The course is also designed to help the students understand the basic idea of human physiology and various metabolites in our body. The course will help students acquire knowledge on the mechanisms of causation of various diseases based on biochemical tests.*

Course outcome: *On completing this course, the students will be able:*

- *to determine the various blood groups and the Rh status*
- *estimate the level of haemoglobin in the blood*
- *count WBC and RBC in the blood and identify their abnormal concentrations.*
- *separate serum/plasma from whole blood.*
- *estimate the level of glucose, cholesterol in the blood*

1. Determination of ABO blood groups and Rh factor.
2. Estimation of blood Haemoglobin.
3. Counting of WBC using improved Neubauer's Chamber.
4. Counting of RBC using improved Neubauer's Chamber.
5. Collection of blood and separation of serum/plasma.
6. Estimation of blood glucose.
7. Estimation of blood cholesterol.

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FOURTH SEMESTER
PHYSIOLOGICAL
BIOCHEMISTRY
Course Code: BCHEM 204

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective*: To acquaint students with various aspects of the physiological actions of selected organs that can be explained by particular biochemical processes. To understand the fundamental mechanisms underlying the normal function of cells, tissues, organs, and organ systems in the human body.*

Course Outcome: *On completion of the course, students shall be able to:*

- *gain knowledge on how the human body works.*
- *understand the concept of homeostasis and various homeostatic mechanisms and their regulations.*
- *understand the importance of blood and its components and functions*
- *plan and carry out simple experiments based on physiology.*
- *understand the importance of hormones and their interactions during a disease or imbalance.*
- *understand the importance of nerve and muscle physiology*

Unit 1: Homeostasis & Physiology of Blood
Definition of homeostasis. Characteristics and examples of homeostatic mechanisms. Biochemistry of blood, plasma proteins. Blood group substances. Blood clotting and its mechanism. Blood cell types. Biochemical events in transport of CO_2 and O_2 in blood.

Unit 2: Physiology of Excretion
Urinary system. Structure and functions of kidney. Nephron. Formation of urine; glomerular filtration, tubular re- absorption and secretion. Regulation of water balance, electrolyte balance and acid- base balance.

Unit 3:Physiology of Nerve & Muscle
Structure and types of neurons. Action potential, Transmission of nerve impulse across a synapse. Neurotransmitters.
Types of muscles and their structure. Contractile and regulatory proteins of muscle. Sliding filament model of skeletal muscle contraction.

Unit 4: Physiology of Hormones
Definition and classification of hormones. Mechanism of hormone action.
Biochemical functions of the hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads.

Suggested readings

1. Nelson, D.L. and Cox, M.M (2008). *Lehninger's Principles of Biochemistry*, Macmillan Pub.
2. Jain, J.L., Sanjay, J and Nitin, J (1997). *Fundamentals of Biochemistry*, (6th ed.). New Delhi: S. Chand & company Ltd.
3. Rastogi, S.C (2006). *Experimental Physiology*, (2nd ed.). New Age Intl. (P) Ltd.
4. Rao, M.A (2006). *Medical Biochemistry*, (Revised 2nd ed.). New Age Intl. (P) Ltd.
5. H.R.Singh, Neeraj Kumar (2017). *Animal Physiology and Biochemistry,* (Revised 10th ed.). Vishal Publishing Co.
6. Boyer, R.F. (2005). *Modern Experimental Biochemistry*, (3rd ed.). Pearson-Educations (P) Ltd.

FOURTH SEMESTER
SKILL ENHANCEMENT COURSE
TOOLS & TECHNIQUES IN BIOCHEMISTRY

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objectives*: The course will provide students with knowledge of good laboratory practises, the analysis of biological fluids like blood and urine, and their importance in the diagnosis of diseases. The course also introduces students to the microbes around us and provides basic insights on the culturing of microbes for further studies.*

Course outcome: *After successful completion of the course, the students will be able to understand:*

- *hazards and good practises in the laboratory, preparation and storage of reagents*
- *basic concepts of microbiology*
- *composition, collection, and analysis of biological fluids.*

Unit 1: Good Laboratory Practices and Preparation of Solutions
Safety measures and first aid in the laboratory. Preparation and storage of reagents (Normal, molar, percent, stock and standard solution). Preparation of buffer and determination of pH. Principle and applications of UV-Visible Spectroscopy
Exercises:

i) Determination of pH using pH meter.
j) Preparation of buffer using Handerson-Hasselbach equation.
k) Estimation of protein by colorimeter/ Spectrophotometer
l) Estimation of carbohydrates by colorimeter/ Spectrophotometer

Unit 2: Analysis of Biological samples
Biochemistry of blood: ABO blood grouping; Rh factor; Blood cell types ;Haemoglobin-function; Understanding Blood Pressure. Normal values for important constituents in urine.
Exercises:

m) Determination of ABO Blood groups and Rh factor
n) Estimation of blood Haemoglobin
o) Determination of Blood Pressure
p) Collection & Separation of Blood plasma/serum
q) Estimation of Blood Glucose/ Cholesterol
r) Collection of urine and qualitative analysis of normal/ abnormal constituents of urine.

Unit 3: Introduction to microbial world
Basic introduction to different microbes, growth medium for microbes- differential and specific medium. Sterilization and Disinfection.

Exercises:

g) Isolation of bacteria from soil, water or air, counting CFU (Colony forming units).
h) Differential staining techniques.
i) Preparation of hand sanitizers.

Suggested readings

1. Devlin, T.M(2011). *Textbook of Biochemistry with Clinical Correlations*. John Wiley& Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Burtis, Ashwood and TietZ W.B.S (1999).*Textbook of Clinical Chemistry,* (3rded.).
3. Wiley,J.M.,Sherwood,L.M and Woolverton, C.J (2017). *Prescott's Microbiology*,(10th ed.), McGraw Hill Higher Education;ISBN13: 9781259657573.
4. Pelczar, Jr M.J.,Chan,E.C.S and Krieg, N.R(2004).*Microbiology*, (5th ed.).Tata McGraw Hill; ISBN 13: 9780074623206.
5. Upadhya,A., Upadhyay,K and Nath,N (2014). *Biophysical Chemistry: Principles and Techniques*,(4th ed.). Himalaya Publishing House, India.
6. David, P (1988). *A Textbook of Practical Biochemistry*. Tata McGraw-Hill Education.

FIFTH SEMESTER
BIOCHEMICAL TECHNIQUES
Course Code: BCHEM 300

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to train the students in biophysics and bioinstrumentation techniques essential for the understanding of life sciences and biotechnology. It is designed to give students an idea of the design of an experiment with the application of biochemical techniques. To make students aware of the indispensability and importance of modern techniques in biochemical research and living systems.*

Course outcome: *On completion of the course, students will be able to understand:*

- *biophysical techniques for carrying out research in the life sciences.*
- *planning of experiments based on biophysical tools.*
- *microscopic observation and technique used in relation to cell biology*

Unit 1: pH and Photometry
pH meter – principle and applications. Electromagnetic spectrum. Principle (Lambert's Law, Beer's Law). Principle and instrumentation of Colorimeter and UV-visible spectroscopy.

Unit 2: Chromatography and centrifugation
Principle and applications of chromatography: Paper Chromatography, Ion-Exchange Chromatography, Thin layer chromatography. Introduction to centrifugation: preparative centrifugation and density gradient centrifugation

4. Unit 3: Electrophoresis and immunoassay
Introduction to electrophoresis. Factors affecting electrophoretic mobility; Principles and applications of agarose gel electrophoresis and SDS-PAGE. ELISA and RIA

Unit 4: Microscopy
Microscopy – principle, components and applications; Light microscopy - bright-field microscopy, dark-Field Light Microscopy, phase Contrast microscopy, fluorescent microscopy. Electron microscopy – transmission electron microscopy and scanning electron microscopy.

Suggested readings

1. Primrose ,S.B and Twyman, R. M (2004). *Principles of Gene Manipulation and Genomics*, (7th ed.). Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
2. Satyanarayana, U. (2008). *Biotechnology*, (4th ed.). Arunabha Sen Books and Allied (P) Ltd. (India). ISBN: 81-87134-90-9.
3. Upadhyay, A., Upadhyay, K and Nath, N (2014). *Biophysical Chemistry: Principles and Techniques*, (4th ed.). Himalaya Publishing House, India.
4. Chawla, H.S (2002). *Introduction to plant Biotechnology*, (2nd ed.). Oxford and IBH Publishing Co. Pvt.Ltd. (India). ISBN: 81-204-1549-3.

5. Michael, R.G and Sambrook, J (2014). *Molecular Cloning: A laboratory manual*, (4th ed.). Cold spring Harbor laboratory press (vol-3.). ISBN: 978-1-936113-42-2.
6. David, P (1988). *A Textbook of Practical Biochemistry.* Tata McGraw- Hill Education.
7. Jayaraman, J. (1981). *Laboratory Mannual in Biochemistry*, (2nd ed.). New Age International Publishers.

FIFTH SEMESTER

BIOCHEMICAL TECHNIQUES

Course Code: BCHEM 300

Practical

Marks Scale: 100 marks **Credit: 1**

(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to offer different applications of biochemical techniques critical to biological research. Students will be able to understand buffering systems. Students will also learn techniques for protein separation and estimation.*

Course Outcome: *At the end of the practical course, students will be able to carry out:*

- *separation of biomolecules using a simple biochemical technique*
- *buffer preparation*
- *estimation of biomolecules*
- *practicals based on microscopic observations.*

1. Preparation of buffers, sodium/ phosphate/ acetate buffers
2. Separation of amino acids by Paper chromatography /TLC.
3. Estimation of proteins by Biuret/Lowry method
4. Estimation of carbohydrates by Anthrone method
5. Culture media preparation
6. Isolation of bacteria from soil/water or air, counting CFU
7. Differential staining techniques

FIFTH SEMESTER
CLINICAL
BIOCHEMISTRY
Course Code: BCHEM 301

Marks Scale: 100 marks **Credit: 3**
(End Sem. 75+ Int. 25)

Objectives: *Students will learn about the normal constituents of urine, blood and their significance in maintaining good health. Students will become aware of the variations in the levels of triglycerides and lipoproteins and their relationship with various diseases. Students will get acquainted with the role of enzymes in the diagnosis of various diseases.*

Course outcome: *At the end of the course, the students will be able to:*

- *gain knowledge about the concepts of clinical biochemistry*
- *understand about the different biological samples, their collection, and their preservation.*
- *develop an insight into the role of enzymes in the diagnosis of certain diseases.*

Unit 1: Collection and preservation of biological samples
Basic concept of clinical biochemistry. Collection and preservation of biological samples (blood, serum, plasma and urine). Chemical analysis of blood and urine. Normal values for important constituents in blood (plasma/serum) and urine.

Unit 2: Diagnostic enzymes
Plasma functional and plasma non- functional enzymes. Isozymes. Important enzymes in diagnosis of diseases- amylase, alkaline and acid phosphatases, GGT, SGOT, SGPT, LDH and CPK.

Unit 3: Diagnostic tests- I
Organ Function Tests –Kidney, Liver.

Unit 4: Diagnostic tests- II
Lipid profile – cholesterol, triglycerides, lipoproteins - HDL and LDL.
Pancreatic Function Tests, Thyroid Function Tests.

Suggested readings

1. Devlin, T.M (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Chatterjee, M.N and Shinde, R (1995). Text book of Medical Biochemistry, (2nd ed.). Jaypee Brothers Medical publishers Private limited, New Delhi.
3. Burtis, Ashwood and TietZ W.B.S (1999). Textbook of Clinical Chemistry, (3rd ed.).

FIFTH SEMESTER
CLINICAL
BIOCHEMISTRY
Course Code: BCHEM 301
Practical

Marks Scale: 100 marks **Credit: 1**
(End Sem.: 75+ Int.: 25)

Objective: *To acquire confidence, interest, challenge, and discipline in laboratory behaviour in biochemistry. The course is also designed to help the students understand the basic idea of normality and abnormal urine. And also to let students know their normal blood glucose level. The course will help students acquire knowledge on the mechanisms of causation of liver, kidney, and other diseases based on biochemical tests.*

Course Outcome: *On completion of the course, students will be able to:*

- *quantitative analysis of the constituents of urine and the level of abnormality*
- *perform enzyme estimation tests for liver and kidney function,*
- *perform tests based on thyroid function.*

1. Qualitative analysis of normal/abnormal constituents of urine
2. Estimation of enzyme amylase
3. Estimation of enzyme ALP
4. Estimation of blood bilirubin
5. Estimation of blood creatinine
6. Estimation of blood urea
7. Estimation of blood T3/T4

FIFTH
SEMESTER
IMMUNOLOGY
Course Code: BCHEM 302

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.:25)

Objectives: *The course is designed to impart the importance of immunology and its theoretical aspects, as well as the principles of immunology and immunotechnology. The application of immunology in medicine is also dealt with in this course. It also explains the various antigen-antibody reactions involved in diseases, stem cell technology, and vaccine development.*

Course outcome: *At the end of the course, the students will have knowledge on:*

- *concept of immunology and components of the immune system*
- *principles and types of antigen-antibody interaction*
- *applications of knowledge of immunology in medicine*
- *disorders and diseases related to the immune system*

Unit 1: Basic concept of Immunology

Introduction to immunity; concept of innate and adaptive immunity. Haemopoiesis - Development of immune cells. Components and cells of the innate immune system- The Complement system, cytokine families, interferons.

Unit 2: Adaptive immune system

Adaptive immune system- Humoral and Cell mediated immune systems; B and T-lymphocytes, T-cell receptors; Immunoglobulins - classes, structures and functions; allotypes and idiotypes.

Unit 3: Antigen-antibody interaction

Antigens-Nature and types; Antigen-antibody interactions-properties, strength and types; Major Histocompatibility Complex (MHC) and antigen processing and presentation

Unit 4: Immunological response

Hypersensitivity, Autoimmunity and autoimmune disorders (Systemic Lupus Erythromatosus, Insulin dependent diabetes mellitus, multiple sclerosis), Transplant rejection, Immunodeficiency-AIDS, Vaccines-introduction and types.

Suggested readings

1. Kindt, T.L., Goldsby, R.A and Osborne, B.A (2007*). Kuby Immunology*, (6th ed.). W.H Freeman and Company (New York), ISBN: 13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590- 0.
2. Coico, R and Sunshine, G (2009). *Immunology: A Short Course*, (6th ed.). John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

3. Nigam, A and Ayyagiri, A (2008). *Lab Manual in Biochemistry, Immunology & Biotechnology*, Tata McGraw Hill.
4. Willey, J.M., Sherwood, L.M and Woolverton, C.J (2017). *Prescott's Microbiology*, (10th ed.), McGraw Hill Higher Education; ISBN13: 9781259657573.
5. Pelczar, Jr M.J., Chan, E.C.S and Krieg, N.R (2004). *Microbiology*, (5th ed.). Tata McGraw Hill; ISBN13: 9780074623206.142.

FIFTH SEMESTER
INTERNSHIP
Internship/community engagement & service

Marks Scale: 100 marks **Credit: 2**

Course objective: *The purpose of an internship is usually the participation of the students in a professional activity or work experience, or cooperative education activity with other institutions, under the supervision of an expert. It involves working with local industry, government or private organisations, business organisations, etc. to provide opportunities for students to actively engage in on-site experiential learning. It will also provide students with an experience outside the classroom and laboratory in order to gain better practical knowledge and render community engagement and service to society.*

Course outcome: *On completion of the course, students will be able to understand and gain:*

- *experience outside their everyday learning and activities*
- *challenge of basic sciences in life sciences*
- *exposure to socio-economic issues in society*
- *experience real life issues arising from theoretical learning gained in the classroom.*
- *gain on-site experiential learning*

Internship/community engagement & service could help students with on-site experiential learning and induction into actual work situations. It will also open a chance for exposure to socio-economic issues in society so that theoretical learnings can be supplemented by actual life or work experiences.

The work plan based on Biochemistry related curriculum has to be assigned or supervised by teachers in collaboration with other external entities or institutions, and the necessary work has to be completed before End Semester examination.

SIXTH SEMESTER
MOLECULAR BIOLOGY
Course Code: BCHEM 303

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objective: *The course explains the fundamental aspects of gene and genome organisation to give students basic knowledge. It also explains various molecular events in cells so that students can interestingly learn and project molecular status within the cell. The course gives an in-depth insight into the molecular aspects of life—the central dogma.*

Course Outcome: *On completion of the course, students shall be able to:*

- *identify and present relevant information dealing with issues of molecular biology.*
- *get an idea about the principles behind molecular biology, which helps students understand the basic molecular events in the cell.*
- *understand occurrence of errors and the repair system in DNA.*

Unit 1: DNA Replication
Introduction to genome organization;Central Dogma in Molecular Biology. Evidence for DNA as genetic material; DNA replication in prokaryotes and experimental evidence for semi-conservative DNA replication; Mechanism of replication-DNA polymerases.

Unit 2: Transcription & genetic code
Transcription in prokaryotes; RNA polymerase; Promoters; Initiation, elongation and termination of RNA synthesis; Reverse transcriptase; post-transcriptional processing of mRNA in eukaryotes (splicing, capping and polyadenylation) Genetic code - General features.

Unit 3: Translation
Translation in prokaryotes; Ribosome structure; A and P sites, Charged tRNA; Initiator codon; elongation and termination; Formation of 70S initiation complex. Regulation of Gene Expression in Prokaryotes: Operon concept (Lac and Trp operon)

Unit 4: Mutations and repair
Concept of mutation, mutations induced by chemicals, radiation, Types of mutations - transition, transversions, and frame shift mutations.
Replication errors and mismatch repair system. Repair of DNA damage - direct repair, base excision repair.

Suggested readings

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M and Losick, R (2008). *Molecular Biology of the Gene*, (6th ed.). Cold Spring Harbour Lab. Press, Pearson Pub.
2. Nelson, D.L and Cox M.M (2008). *Lehninger's Principles of Biochemistry*, Macmillan Pub.
3. Satyanarayana, U (2008). *Biotechnology*, (4th ed.). Arunabha Sen Books and Allied (P) Ltd. (India). ISBN: 81-87134-90-9.
4. Stryer, L (1995). *Biochemistry*, (4th ed.). W.H. Freeman Press, San Fransisco, USA.
5. Gupta, P.K. (2005). *Cell and Molecular Biology*. Rastogi Publications.
6. Rastogi, S.C (2012). *Cell and Molecular Biology*, (3rd ed.). New age International Publishers, India.
7. Voet, D., Voet, J.G and Charlotte, WP (2016). *Fundamentals of Biochemistry: Life at the Molecular Leve*l (5th ed.). Wiley ISBN 978-1-118-91840-1.

SIXTH SEMESTER

MOLECULAR BIOLOGY
Course Code: BCHEM 303
Practical

Marks Scale: 100 marks **Credit: 1**
(End Sem.: 75+ Int.: 25)

Objectives*: To understand the basics of molecular biology. To learn different methodologies in molecular biology, especially quantification of biomolecules using a sophisticated instrument.*

Course outcome*: At the end of the course, students will be able to conduct:*

- *isolation of DNA from biological samples*
- *quantification of DNA samples*
- *any experiment involving spectrophotometric principles*

1. Estimation of DNA by Diphenyl amine method
2. Estimation of RNA by Orcinol method
3. Isolation and estimation of DNA from plant/animals/microbes.
4. Agarose gel electrophoresis
5. Determination of absorption maxima of nucleic acids
6. Restriction digestion of genomic DNA

SIXTH SEMESTER

NUTRITIONAL BIOCHEMISTRY

Course Code: BCHEM 304

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objectives: *Students will learn about the importance of nutrition, a balanced diet, and their role in the biological system. They will get acquainted with the important biochemical role of vitamins and minerals and their deficiencies.*

Course outcome: *At the end of the course, the students will be able to:*

gain knowledge about the concepts of nutritional biochemistry
understand the importance of nutrients and a balanced diet, carbohydrates, proteins, water, and fats in diet.
gain an understanding of the importance of vitamins and minerals in understanding various physiological conditions

Unit 1: Basic concept of Nutrition
Nutrition and its importance. Nutrients- types and functions. Food groups (ICMR). Concept of balanced diet. RDA. Energy content of foods, BMR, SDA and physical activity. Energy requirement during growth, pregnancy and lactation. Food adulteration.

Unit 2: Biochemical concept of nutrition
Nutritional importance of carbohydrates, fats, proteins and water. Digestion, absorption and transport of - carbohydrates, lipids and proteins. Nitrogen balance. Positive and negative nitrogen balance. Probiotic.

Unit 3:Vitamins
Nutritional importance of vitamins, classification. Vitamins; dietary sources, RDA, biochemical role of Vitamin A, D, E, K, and C. Vitamin B complexes- niacin, biotin and folic acid .

Unit 4: Minerals
Nutritional importance of minerals, classification. Minerals; dietary sources, RDA, biochemical role of calcium, sodium, potassium, iron and iodine.

Suggested readings

1. Devlin, T.M (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Chatterjee, M.N and Shinde, R (1995). Text book of Medical Biochemistry, (2nd ed.). Jaypee Brothers Medical publishers Private limited, New Delhi.
3. Burtis, Ashwood and TietZ W.B.S (1999). Textbook of Clinical Chemistry, (3rd ed.).

SIXTH SEMESTER
NUTRITIONAL BIOCHEMISTRY
Course Code: BCHEM 304
Practical

Marks Scale: 100 marks **Credit: 1**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to provide students with thorough ideas on food analysis and the determination of important minerals and vitamins in the body.*

Course outcome: *On completing this course, the students will be able:*

acquire expertise in the calculation of BMI/BMR
carry out analysis of different food samples
assess important minerals and vitamins
gain knowledge on detecting food adulterants

1. Calculation of BMI/BMR.
2. Qualitative tests for proteins in food samples.
3. Qualitative tests for carbohydrates in food samples.
4. Determination of adulterants in food samples.
5. Assessment of sodium and potassium in food/ blood sample.
6. Estimation of Vitamin D in food/ blood sample.

SIXTH SEMESTER

Project/Field based learning

Course Code: BCHEM 305

Marks Scale: 100 marks **Credit: 4**

Course objective: *The purpose of field-based learning/projects is usually observation for education, experimental research. It will provide students with an outside experience in order to gain better practical knowledge. Students will also be allowed to conduct project work under the supervision of an expert teacher.*

Course outcome: *On completion of the course, students will be able to understand/gain:*

experience outside their everyday learning and activities
challenge of basic sciences in life sciences
importance of research in the development of the global community
the atmosphere of research

Field-based learning/projects could help students gain greater exposure outside of their everyday learning and also create an atmosphere of research under the guidance of teachers, which is to be allotted before the completion of the final semester examination. The work plan based on Biochemistry related curriculum has to be assigned or supervised by teachers, and is to be completed before End Semester examination.

A study tour within or outside the state (Mizoram) may also be organised to be guided by teachers so that the theoretical learnings can be supplemented by actual life experiences, which are to be completed before final semester examination.

SIXTH SEMESTER

GENETIC ENGINEERING & BIOTECHNOLOGY

Course Code: BCHEM 306

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to illustrate the creative use of modern tools and techniques for manipulation and analysis of genomic sequences. It will give students exposure to the application of recombinant DNA technology in biotechnological research, and give them ideas for strategizing research methodologies employing genetic engineering techniques. It will also give an introduction to the various transformation techniques employed in plant systems and the application of genetically modified plants in various fields of science.*

Course Outcome: *On completion of the course, students will be able to understand:*

concept of recombinant DNA technology
tools and techniques used in rDNA technology
identification of cloned genes
application of recombinant DNA technology in various fields

Unit 1: Introduction to recombinant DNA technology
History and scope of recombinant DNA technology, restriction endonucleases, nomenclature of restriction enzymes; restriction modification system, blunt end and sticky ends.

Unit 2: Tools and techniques in genetic engineering
Cloning vectors – characteristic features, plasmid pBR322, M13, YAC and BAC. Basic steps in rDNA technology. Genomic and cDNA library.

Unit 3: Methods of gene transfer
Physical methods – microinjection, electroporation; chemical methods- liposome mediated gene transfer, DAE-Dextran method; Biological method - agrobacterium mediated transformation.

Unit 4: Applications of genetic engineering
Production of recombinant pharmaceuticals - insulin, human growth hormone, factor VIII. transgenic crops (golden rice, Bt crops), ethical concerns.

Suggested readings

1. Brown, T.A (2010). *Gene Cloning and DNA Analysis*, (6th ed.) Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Primrose, S.B and Twyman, R.M (2006). *Principles of Gene Manipulation and Genomics*, (7th ed.). Blackwell publishing (Oxford, UK). ISBN: 13: 978-1-4051-3544-3.
3. Satyanarayana, U. (2008). *Biotechnology*, (4th ed.). Arunabha Sen Books and Allied (P) Ltd. (India). ISBN: 81-87134-90-9.
4. Power, C.B (2013). *Genetic*s, (1st ed.). Himalaya Publishing House (India).

5. Michael, R.G and Sambrook, J (2014). *Molecular Cloning: A laboratory manual*, (4th ed.). Cold spring Harbor laboratory press (vol-3.). ISBN: 978-1-936113-42-2.
6. Freifelder, D (1983). *Molecular Biology: A Comprehensive Introduction to Prokaryotes and Eukaryotes*, (2nd ed.).
7. Chawla, H.S (2002). *Introduction to plant Biotechnology*, (2nd ed.). Oxford and IBH Publishing Co. Pvt.Ltd. (India). ISBN: 81-204-1549-3.

SEVENTH SEMESTER
BIOINFORMATICS & BIOSTATISTICS
Course Code: BCHEM 400

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Objectives: *The course aims to introduce the basic concept of bioinformatics and its relevance in the biological world. Students will come to understand the various biological data and their structural and functional importance in relation to developmental biology. The course is also designed to give information on the concept of biostatistics and its approach to problem solving. Learning and understanding the course will enhance students' abilities in biostatistics calculation. The course is also planned to give ideas and decision-making skills to students in the research field.*

Course outcome*: On completion of the course, students will get to*

know the basic concepts of computer and biological data (databases).
understand status of biological databases accessible through the internet.
acquire knowledge on different biological data and their possible similarity and differences.
carry out project work relating to statistical calculation.
learn various tests that are necessary in project/research work.
have an idea for designing a work plan involving statistics.

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Unit 1: Basic bioinformatics and Biological database
History of internet & search engines (Google, Yahoo). Introduction to Genomics and Proteomics. Biological databases - Nucelotide sequence databases (GeneBank, EMBL), Protein sequence databases (Swiss-PROT Protein sequence database, PROSITE).

Unit 2: Sequence analysis
Sequence alignment; types of sequence alignment – alignment based on sequence number, alignment based on sequence length. BLAST. Multiple sequence alignment. ORF finder – Expasy. Overview of phylogenetic analysis. Dendrogram, Cladogram and phylogram. Methods of construction of phylogenetic trees – UPGMA and maximum likelihood.

Unit 3: Basic biostatistics & measures of central tendency
Importance of statistical analysis in biological data management. Sampling schemes –types of sampling, sampling theory and errors. Measures of central tendency and dispersion: mean, median, mode. Variability, range. Standard deviation.

Unit 4: Test of hypothesis & variance
Tests of significance (F & t test); Chi square tests. Simple linear regression and correlation. Analysis of variance (ANOVA) – definitions, formula and applications. One and two way methods of ANOVA.

Suggested readings

1. Sharma, Munjal and Shakar (2016). A text book of Bioinformatics. RAstogi publications, Meerut-New Delhi.
2. Zhumur G and Bibekanand M (2008). Bioinformatics – Principles and Applications. Oxford University Press.
3. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
4. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
5. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
6. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
7. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
8. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

SEVENTH SEMESTER

BIOINFORMATICS & BIOSTATISTICS

Course Code: BCHEM 400

Practical

Marks Scale: 100 marks **Credit: 1**
(End Sem.: 75+ Int.: 25)

Course objective: *The course is designed to familiarise students with the basic concepts of biological data and their importance in our everyday lives. Understanding the biological databases will cultivate curiosity in students, motivating them for further studies in scientific research.*

Course outcome: *By studying and doing a practical on the stipulated courses, students will*

be able to imagine the status and creation of biological data
be able to access databases through the internet.
be able to utilise the databases to clear their doubts in research

1. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
2. Protein information resource (PIR)
3. Retrieval of nucleotide sequences from selected plant/animal/microorganism.
4. Retrieval of protein sequences from selected plant/animal/microorganism
5. Using various BLAST and interpretation of results.
6. Multiple sequence Alignment using ClustalW
7. Determination of mean, mode and median from a given data

SEVENTH SEMESTER

APPLIED BIOCHEMISTRY

Course Code: BCHEM 401

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.:25)

Objective: *The course is designed to give students an idea of the practical aspects of their Biochemical knowledge and to put these ideas and knowledge to use in solving and making everyday chores easier, as well as imparting their knowledge in helping others, society, and building their own careers.*

Course outcome: *On completion of the course, the student will be able to:*

help students use their biochemical knowledge to solve real world problems.
have ideas on starting their own products like food processing, cosmetic designs, wine production, etc. and venture out as entrepreneurs.
have knowledge about the physiological impacts of substance abuse and also help people overcome such abuse.

Unit 1: Food Technology
Enzymes in foods and beverages – protease, lactase, polygalactouranase. Food supplements – advantages and disadvantages Fermented foods – cheese, yogurt, bread, wine.

Unit 2: Free radicals and antioxidants
Brief introduction to Free radicals, oxidative stress and ageing. Antioxidants in biological system- Nutrient and metabolic antioxidants; Dietary supplementation of antioxidants.

Unit 3: Biochemistry in Cosmeceuticals
Biomolecules commonly used in cosmetics-Cosmetic lipids, cosmetic proteins, cosmetic polysaccharide; Antioxidants used in cosmetic formulations and their actions: Vitamin E, Vitamin C, Niacinamide.

Unit 4: Microbial technology and Bioenergy
Principles of bioreactors and downstream processing. Ethanol and its application in biological system. Bioleaching. Biosorption. Biohydrogen.

Suggested readings

1. Lal, Harbans.Textbook of Applied Biochemistry and Nutrition Dietetics, International Standard Coloured Edition(CBS Publishers & Distributors Pvt Ltd.)
2. Fursule, R.A, Kulkarni ,J.S, Agarkar,P.H. Biochemistry: Basic and Applied.
3. Allan G, Gornall.Applied Biochemistry of Clinical Disorders
4. Satyanarayana,U and Chakrapani,U. Biochemistry. Fourth Edition, Elsevier Publishers.
5. Palmer, Trevor and Bonner, Philip.Enzymes :Biochemistry, Biotechnology, Clinical Chemistry (Second Edition). EWP Private Ltd.

SEVENTH SEMESTER
BIOPHYSICS & INSTRUMENTATION
Course Code: BCHEM 402

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to train the students in biophysics and bioinstrumentation techniques essential for the understanding of life sciences and biotechnology. It is designed to give students an idea of the design of an experiment using biophysical techniques. To make students aware of the indispensability and importance of modern techniques in biophysical research and living systems.*

Course outcome: *On completion of the course, students will be able to understand:*

energy-rich group activities and their importance
biophysical techniques for carrying out research in the life sciences.
planning of experiments based on biophysical tools.
microscopic observation and technique used in relation to cell biology

Unit 1: General biophysics methods
Concept of pH. Radioactive decay, radioactive labelling and counting. Autoradiography

Unit 2: Microscopy
Microscopy – principle, components and applications; Light microscopy, electron microscopy and fluorescent microscopy

Unit 3: Separation and identification of materials
Cell fractionation technique, isolation of sub-cellular organelles and particles. GLC, HPLC. Gel electrophoresis.

Unit 4: Spectroscopy
Instrumentation for measuring the absorbance of visible light, absorption maxima. NMR spectroscopy – principle, experimental technique & instrumentation.

Suggested readings

1. Satyanarayana, U. (2008). *Biotechnology*, (4th ed.). Arunabha Sen Books and Allied (P) Ltd. (India). ISBN: 81-87134-90-9.
2. Upadhyay, A., Upadhyay, K and Nath, N (2014). *Biophysical Chemistry: Principles and Techniques*, (4th ed.). Himalaya Publishing House, India.
3. Chawla, H.S (2002). *Introduction to plant Biotechnology*, (2nd ed.). Oxford and IBH Publishing Co. Pvt.Ltd. (India). ISBN: 81-204-1549-3.
4. David, P (1988). *A Textbook of Practical Biochemistry.* Tata McGraw- Hill Education.
5. Jayaraman, J. (1981). *Laboratory Mannual in Biochemistry*, (2nd ed.). New Age International Publishers.

EIGHT SEMESTER
MICROBIAL
TECHNIQUES
Course Code: BCHEM 403

Marks Scale: 100 marks **Credit: 3**
(End Sem.: 75+ Int.: 25)

Course objective: *The course contents will give students knowledge on the different compositions of media required for the survival of microorganisms, depending on their desires. Students will also learn about the different techniques involved in studying microorganisms, especially bacteria. The research foundation course that is needed for all the young researchers in the microbiological field is also included in the course for the students.*

Course outcome: *at the end of the course, students will*

able to understand the importance of different nutrient media for microorganisms
know the basic concept of practical for the completion of the courses.
able to carry out different experiments on their own.

Unit 1: Microbial nutrition
Basic growth media: Nutrient agar & broth media, Potato dextrose agar, Mac Coukey, Synthetic or defined media, Complex media, Enriched media, Selective media, Differential media. Principle and techniques of sterilization.

Unit 2: Staining techniques
Gram staining, acid fast staining, negative staining, capsule staining, flagella staining and endospore staining, Spirochete stain.

Unit 3: Plating techniques
Isolation of Pure culture: Serial dilution, Streaking, Spreading and Pour Plate techniques. Cultivation of Anaerobic bacteria.

Unit 4: Microbial growth
Microbial growth - definition and measurement methods (turbidity, dry weight, total cell); growth phases; growth yields and kinetics. Effects of physical and chemical factors on microbial growth.

Suggested readings

1. Willey, J.M., Sherwood, L.M and Woolverton, C.J (2017). *Prescott's Microbiology*, (10th ed.), McGraw Hill Higher Education; ISBN13: 9781259657573.
2. Pelczar, Jr M.J., Chan, E.C.S and Krieg, N.R (2004). *Microbiology*, (5th ed.). Tata McGraw Hill; ISBN13: 9780074623206.142.
3. Cappucino, J. and Sherman, N. (2013). *Microbiology: A Laboratory Manual*, (10th ed.). Pearson Education Limited; ISBN13: 9780321840226.

EIGHT SEMESTER
MICROBIAL
TECHNIQUES
Course Code: BCHEM 403
Practical

Marks Scale: 100 marks **Credit: 1**
(End Sem.: 75+ Int.: 25)

Course objective: *The course offers different techniques involved in microbial technology. Students are expected to be able to understand the theory behind the practical. From this course content, students are also expected to be able to understand the need and importance of microbiological research with respect to their daily lives.*

Course outcome: *By studying and doing a practical on the stipulated courses, students will*

be able to carry out pure culture preparation
be able to perform a serial dilution technique
Be able to understand the importance of physical and chemical factors on bacterial growth

1. Screening of microbes for production of catalase and oxidase enzymes
2. Microbial culture by using serial dilution technique
3. Preparation of pure culture by streaking method
4. Microbial growth curve
5. Effects of physical factors on microbial growth curve
6. Effects of chemical factors on microbial growth curve

EIGHT SEMESTER
ADVANCE TECHNIQUES IN BIOLOGY
Course Code: BCHEM 404

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Course objective: *The course is designed to give students a basic understanding of the concept of molecular biology and the techniques used for identifying queries. This course is designed for students to understand the theoretical aspects of nucleotide sequences. The in-vitro DNA manipulation studies in the course will be able to enrich students reproducibility knowledge on molecular biology. It will also empower students points of view on the concept of antibody generation.*

Course outcome: *At the end of the course, students will*

be able to understand the importance and application of molecular markers for studying different samples in research.
able to understand the in-vitro DNA manipulation system, which will help in better conceptualizing nucleic acid sequence arrangement.
able to learn the technique for antibody production

UNIT-1: Molecular techniques
Molecular markers- RAPD, RFLP, microsatellite. DNA finger printing. Gene therepy – ex-vivo & in-vivo and its applications.

Unit 2: Nucleic acid hybridization
Principle of Nucleic acid hybridization, Principle and procedure of Southern, Northern and Western blotting, Eastern blotting. Autoradiography.

Unit 3: Amplifying DNA and sequencing techniques
PCR technology – principle, components and applications; DNA sequencing – Maxam-Gilbert, and Sanger-coulson methods, microarray. Next generation sequencing. Human genome project.

Unit 4: Hybridoma technology
Principle for creation of hybridoma cells; monoclonal antibodies; mycelium cell fusion, selection of hybrids, HAT-medium, screening assay, purification and application of monoclonal antibodies.

Suggested readings

1. Satyanarayana, U. (2008). *Biotechnology*, (4th ed.). Arunabha Sen Books and Allied (P) Ltd. (India). ISBN: 81-87134-90-9.
2. Power, C.B (2013). *Genetic*s, (1st ed.). Himalaya Publishing House (India).
3. Chawla, H.S (2002). *Introduction to plant Biotechnology*, (2nd ed.). Oxford and IBH Publishing Co. Pvt.Ltd. (India). ISBN: 81-204-1549-3.
4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M and Losick, R (2008). *Molecular Biology of the Gene*, (6th ed.). Cold Spring Harbour Lab. Press, Pearson Pub.

EIGHT SEMESTER

PLANT BIOCHEMISTRY

Course Code: BCHEM 405

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Course objective: *The course is designed to introduce the basic structure of plant cells so as to acquire the knowledge necessary to understand the biochemistry of plant cells. The course aims to provide a biochemical cascade of energy transfer and food production. It is expected that students acquire knowledge on plant development and phytochemical sources.*

Course outcome: *at the end of the course, students will*

came to know the pant cell structural organisation

know the energy transfer system in plants

learn the mechanisms of plant photosynthesis and their developmental changes.

Unit 1: Introduction to plant cell structure

Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes

Unit 2: Photosynthesis-I

Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation

Unit 3: Photosynthesis-II

Dark reaction – calvin cycle, C4 cycle (Hatch and Slack pathway), Photorespiration. Calvin cycle and regulation, Crassulacean acid metabolism (CAM)

Unit 4: Regulation of plant growth

Introduction to plant hormones and their effect on plant growth and development. Secondary metabolites. Regulation of plant morphogenetic processes by light

Suggested readings

1. Bowsher, C., Martin, S and Alyson, T (2008). *Plant Biochemistry, Garland science*. ISBN 978-0-8153-4121-5.
2. Verma, V (2011). *Text Book of Plant Physiology*. Ane Books Pvt Ltd, New Delhi.
3. Dey, P.M and Harborne, J.B (1997). *Plant Biochemistry*. Publisher: Academic Press. ISBN-10:0122146743, ISBN-13:978-0122146749.
4. Nelson, D.L and Cox, M.M (2013). *Lehninger: Principles of Biochemistry*, (6th ed.). Freeman and Company (New York), ISBN: 13:978-1-4641-0962-1.
5. Satyanarayana, U (2013). *Biochemistry*, (4th ed.). Reed Elsevier India Pvt. Ltd & Books and Allied Pvt Lmt. India. ISBN- 978-81-312-3601-7.

EIGHT SEMESTER

ENVIRONMENTAL BIOCHEMISTRY

Course Code: BCHEM 406

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective: *The course gives an introduction to the various aspects of environmental Biochemistry and explains the various applications of biochemistry in the management and conservation of the environment. It also tries to explain the various environmental problems in terms of their biochemical processes.*

Course Outcome: *On completion of the course, the students will:*

obtain knowledge on the basic principles and technologies of various contaminants and their management by means of biological approaches.
know about the principles underpinning the application of biosciences to the environment.

Unit 1: Types of Environmental pollutions

Biochemical effects of - air, water and soil pollution. Greenhouse gases and global warming.

Unit 2: Physiological effects of pollutants/ pollution

Toxic compounds in foodstuffs and water, Heavy metal poisoning, radioactive hazards, Endocrine disrupting chemicals, antibiotic resistance.

Unit 3: Biological remedies for fighting pollution

Sewage treatment, phytoremediation, bioremediation, Green alternatives for fuels- biogas, biofuels, Green fertilizers – bio fertilizers, composting.

Unit 4: Physiological response to pollution

Plant response to heavy metals, microbial tolerance of heavy metals, mammalian detoxification of organic chemicals, tolerance to temperature change.

Suggested readings

1. Satyanarayana, U (2008). Biotechnology, (4th ed.). Arunabha Sen Books and Allied (P) Ltd. (India). ISBN: 81-87134-90-9.
2. Verma, P.S and Agarwal, V.K (2012). Environmental Biology (Principles of Ecology). S. Chand & Company Ltd, New Delhi.
3. Dubey, R.C (2014). A text book of Biotechnology. S.Chand Publications.
4. Environment, (6th ed.). Shankar IAS Academy book publications. ISBN: 978-81-934226-0-1

EIGHT SEMESTER

GENETICS

Course Code: BCHEM 407

Marks Scale: 100 marks **Credit: 4**
(End Sem.: 75+ Int.: 25)

Objective: *The course is designed to explain the basic principles of Mendelian, population genetics, and heredity and give an overview of classical genetics: linkage & crossing over, alleles, cytogenetics, and evolutionary genetics.*

Course outcome: *At the end of this course, students will be able to understand:*

concept of Mendelism and inheritance
linkage, crossing over, and cytogenetics
genetics problems and allelic variations
physiological change due to genetic disorder

Unit 1: Mendelism & Chromosome Theory
Mendel's principles, applications of Mendel's principles, Chromosome Theory of Inheritance; Dominance; pleiotropism; allelism; epistatis .

Unit 2: Linkage and crossing over
Linkage -kinds of linkage, Crossing over-types of Crossing over, significance of Crossing over.

Unit 3: Inheritance pattern in human
Inheritance pattern in humans (Sex-linked and Autosomal); characteristics of dominant and recessive inheritance. Pedigree analysis

.**Unit 4: Human Genetic Disorders**
Types of genetic disorders, Common genetic disorders: Autosome linked disorders- Phenyl Ketonuria and Sickle-Cell Anemia; Sex-linked disorders- Colour blindness and Haemophilia. Chromosomomal disorders- Down's syndrome, Klinefelter's syndrome, Turner's syndrome.

Suggested readings

1. Tamarin, R (2010). *Principles of Genetics*, (7th ed.). Tata Mcgraw Hill Education.
2. Strickberger, W.M (2008). *Genetics*, (3rd ed.). Phi Learning publishing.
3. Simmons, M.J., Snustad, D.P and Gardner, E.J (2006). *Principles of Genetics*. Wiley publishing.
4. Lewin, B (2010*). Genes IX*. Jones & Bartlett Learning.
5. Paul, A (2007). *Text Book of Cell and Molecular Biology*, (2nd ed.). Books and allied (p) Ltd.
6. Kingston, H.M (2002). *ABC of Clinical Genetics*, (3rd ed.). BMJ Books.
7. *Genes and Disease* (1998). Bethesda (MD): National Centre for Biotechnology Information (US).

EIGHT SEMESTER

RESEARCH/DESERTATION

Course Code: BCHEM 408

Marks Scale: 100 marks **Credit: 12**

Practical/Project

Objective: *In order to gain practical knowledge on the theory they have studied, students will be allowed to conduct project work under the supervision of an expert teacher. A work plan will be made in which students will carry out experiments according to the objective of the project.*

Course outcome: *On completion of the course, students will be able to understand:*

the atmosphere of research
challenge of basic sciences in life sciences
literature review of a research paper
importance of research in the development of the global community

Project work based on Biochemistry to be assigned or supervised by teachers, and is to be completed before the end semester examination.