MANONMANIAM SUNDARANAR UNIVERSITY

TIRUNELVELI– 627012

M.Sc. Biochemistry Degree

(CHOICE BASED CREDIT SYSTEM)

Learning Outcome Based Curriculum

(Effective from the academic year 2021-2022 onwards)

MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

PG COURSES – AFFILIATED COLLEGES

M.Sc. Biochemistry
(Choice Based Credit System)

(Effective from the academic year 2021-2022 onwards)

1. Vision of the University

To provide quality education to reach the un-reached.

2. Mission of the University

- To conduct research, teaching and outreach programmes to improve conditions of human living.
- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity.
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development.
- To provide quality/inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled.

3. Vision of the Department

Excellent education in Biochemistry to bring forth intellectual, personal and social wellbeing.

4. Mission of the Department

- Provide healthy learning environment to imbibe comprehensive knowledge, skills and values to bridge academia, industries and society.
- Promote research and open scientific platforms that transform students proficient and globally competent.
- Nurture moral values among students and help them grow as socially sensible and responsible persons.

5. Preamble

Biochemistry deals with the study of chemical and physical processes of living systems. Biochemistry holds promises in areas of Medical Science, Health Science and Agriculture. The M.Sc. Degree programme aims at providing inclusive conceptual and practical skills in Biochemistry to reach academic and professional excellence. The Learning Outcome Based Curriculum Framework (LOCF) for M.Sc. Biochemistry programme has been framed as per the guidelines prescribed by University Grants Commission (UGC) under Choice Based Credit System (CBCS).

6. Programme Educational Objectives (PEOs)

The M.Sc. Biochemistry programme is proposed to

PEO1: Impart an advanced and current knowledge prevailing in different branches of Biochemistry.
PEO2: Empower the students with profound knowledge in various field of applications in Industries, Clinical laboratories and Research organizations.
PEO3: Imbibe and infuse the radiance of self confidence in independent research work.
PEO4: Ensure a fair knowledge on the current technological developments.
PEO5: Enable the students from employment view point in the newly emerging fields of research and industrial advancements and for the betterment of society at large.

7. Programme Outcomes (POs)

On completion of M.Sc. Biochemistry programme, the student shall be able to

PO1: Acquire in-depth conceptual knowledge and technical skills to conduct independent research.
PO2: Gather scientific information by means of listening, reading and comprehension and effectively communicate thoughts through writing and oral presentation.

PO3: Develop the capability of analysing, interpreting, discussing and providing valid conclusion by critical evaluation in wide range of scientific studies.

PO4: Attain analytical and cognitive skills and apply the same in solving problems through scientific approach.

PO5: Exhibit skills in advanced analytical techniques in disciplinary and interdisciplinary areas, gain perfect insight into research ethics for production of quality research and publications and acquire research positions such as Analyst, Research scientist, Project associates (JRF, SRF) and Doctoral Research position at India and abroad.

PO6: Effectively work as a team to retrieve information to carryout research investigation and interpretation in stipulated time effectively.

PO7: Imbibe ethical and moral values in all aspects of scientific effort in the contributing areas of academy, industries and in community for a sustainable healthy environment.

8.Programme Specific Outcomes (POs)

On completion of M.Sc. Biochemistry programme, the student shall be able to

PSO1: Apply theoretical knowledge and practical hands-on experience in broad areas of interdisciplinary fields such as Medical Biochemistry, Pharmaceutical Chemistry, Forensic Science, Biotechnology, Agriculture, Clinical Research etc. through integration in academic and industrial opportunities favoring wide range of career options and entrepreneurial ventures.

PSO2: Develop scientific attitude to work in the Biochemistry research field and other fields of their own interest to communicate ideas, concepts and construct arguments scientifically.

PSO3: Prepare for future career in Biochemistry and other fields by enhancing analytical and critical thinking skills in order to relate the chemistry of biological processes which plays vital role in maintaining human health.

PSO4: Accomplish problem solving skills and creativity through assignments, field work and project work in their focused area of study.

PSO5: Employ standard laboratory protocols/procedures in Biochemistry and modern instrumentations to carryout experiments, compile biological information and interpret biological data systematically.

PSO6: Gain leadership qualities, team spirit and good interpersonal skills in team work by means of integrating themselves in cocurricular and extracurricular activities which aid them in their chosen fields with commitment to novelty and distinction.

PSO7: Possess and practice right moral features and be aware of ethical and environmental issues to become responsible and competent professionals so as to translate knowledge of biochemistry for social well-being.

9.Credits

The term credit is used to describe the quantum of syllabus for various programmes in terms of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design. The total number of credits for M.Sc. Biochemistry is 90.

10. Core and elective courses

Every student admitted to M.Sc. Biochemistry shall undertake 25 core courses, including 15 theory papers, 8 practicals, 1 project and 1 Fieldwork. There shall be one elective course which will be an Elective theory paper/Open online course/Study tour programme.

11. Eligibility for admission to the course and examination

Candidates shall be admitted to the course provided if he/she has obtained a Bachelor's degree in Science in Biochemistry /Chemistry / Microbiology / Biotechnology / Medical Lab Technology / Zoology / Botany / Biology / Nutrition & Dietetics / Life Science / Bioinformatics or any other degree that may be considered as equivalent by the M.S. University.

12. Medium of instruction and examination

The medium of instruction as well as examination will be in English.

13. Theory examination

The external evaluation will be based on the examination to be conducted by the university at the end of each semester.

14. Practical examination

Practical examinations will be conducted at the end of each semester.

15. Evaluation

A. Each paper carries an internal component

B. There is a pass minimum of 50% for P.G. external and overall components

Theory External: Internal Assessment = 75:25
Practical External: Internal Assessment = 50:50
Field Work External: Internal Assessment = 50:50
Elective course External: Internal Assessment = 75:25

C. Internal Assessment

Internal marks for Theory shall be allocated in the following manner.

The average of the best two tests from three compulsory tests	15 Marks
Seminar	05 Marks
Assignment	05Marks
Total	**25 Marks**

Note: Each test will be of one hour duration.

D. Practical

Internal marks for practical shall be allotted in the following manner.

Experimental work	20 Marks
Record	10 Marks
Model Test	20 Marks
Total	**50 Marks**

E. Project Work

Components	Marks
Project Report	75 Marks
Viva -Voce	25 Marks
Total	**100 Marks**

Note: (i)Students should carry out individual project only.

(ii)Project report will be evaluated by Central valuation and Viva-Voce will be conducted by both the External examiner and the Guide at the end of the 4th semester.

F. Open online course

The student shall undertake an optional career-based Open online course in Biochemistry from an UGC approved MOOC platform (e-PG Pathshala/Swayam etc.) during the fourth semester and submit the Certificate at the end of the fourth semester for evaluation by both External and internal guide.

G. The performance of the student is indicated by the Seven Points Scale Grading System as per the UGC norms given below

Grade	Grade point	Percentage of marks	Performance
O	9.5 and above	95-100	Outstanding
E	8.5 and above	85-94	Excellent
D	7.5 and above	75-84	Distinction
A	7 and above	70-74	Very Good
B	6and above	60-69	Good
C	5 and above	50-59	Average
RA	0	Up to 49	Re-Appear

H. The overall performance level of the candidates will be assessed by the following formulae:

Cumulative weighted average of marks = $\frac{\sum(\text{marks} + \text{credits})}{\sum \text{credits}}$

Cumulative weighted average grade points = $\frac{\sum(\text{Grade points} \times \text{credits})}{\sum \text{credits}}$

16. The question paper pattern for all theory papers shall be as follows.

Duration of Exam: 3Hours

Section	Type of questions	Mark
Part-A	Multiple choice question (Two question from each unit compulsory)	1×10=10 Marks
Part-B	Internal Choice questions (One question from each unit: either/or)	5×5=25 marks
Part-C	Internal Choice questions (One question from each unit: either/or)	8×5=40 marks
	Total	**75 Marks**

17. The question paper pattern for all practical papers shall be as follows.

Duration of Practical Exam: 6 hours

1	Major experiment	25
2	Minor Experiment	15
3	Viva – Voce	05
4	Record	05
	Total	**50 Marks**

MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

Model Question Paper
M.Sc. (CBCS) DEGREE EXAMINATIONS
Biochemistry – Main

METABOLISM AND REGULATION

(For those who joined in July 2021and afterwards)

Time: Three hours Maximum: 75 marks

PART A – (1×10 = 10 marks)
Answer ALL questions
Choose the most appropriate answer

Question No.	Questions	Course Outcome	Cognitive level
1	Inner mitochondrial membrane is impermeable to a) H^+ b) K^+ c) OH^- d) all of the above	CO1	K1
2	The P:O ratio for the oxidation NADH +H^+ is a) 1:1 b) 2:1 b) 3:1 d) 1:2	CO1	K2
3	For glycogenesis, glycose should be converted to a) Glucuronic acid b) pyruvic acid c) UDP glucose d) sorbitol	CO4	K2
4	The connecting link between HMP shunt and lipid synthesis is a) Ribose b) NADPH c) Sedoheptulose 7-phosphate d) NADH	CO5	K3
5	Fatty acid synthase complex is a a) monomer b) dimer c) heterotetramer d) tetramer	CO4	K1
6	Long chain acyl CoA penetrates mitochondria in the presence of a) palmitate b) carnitine c) NAD d) Fp	CO6	K2
7	Hyperuricemia is due to the deficiency of a) Xanthine oxidase b) Chorismate synthase c) PRPP synthase d) Arginase	CO3	K2
8	Which of the following sequence is substrate for purine biosynthesis? a) 5- methyl thymidine b) PRPP c) ribose phosphate d) Ara C	CO4	K1
9	Which of the following is not a function of liver? a) formation of bile b) detoxification of drugs c) metabolism of glucose d) storage of vitamin C	CO5	K4
10	Antilipolytic hormone is a) Insulin b) Epinephrine c) Glucagon d) Cortisol	CO2	K4

PART B – (5×5 = 25 marks)

Answer ALL questions choosing either (a) or (b).

Question No.	Questions	Course Outcome	Cognitive level
11.a	Outline the concepts of free energy in metabolism.	CO1	K2
11.b	Briefly explain the uncouplers of oxidative phosphorylation.	CO1	K2
12.a	Briefly assess the Bioenergetics of glucose metabolism.	CO4	K5
12.b	Explain the glycogenic pathway.	CO4	K5
13.a	Elaborate the process of α- oxidation of fatty acids.	CO4	K6
13.b	Discuss the reasons for ketogenesis and write the pathway.	CO6	K6
14.a	Outline the degradation of proteins to ammonia.	CO5	K2
14.b	Summarize digestion and absorption of nucleoproteins.	CO3	K2
15.a	Distinguish the metabolic profile of the liver and adipose tissue.	CO6	K4
15.b	Simplify the altered metabolic state of the body during diabetes.	CO2	K4

PART C – (8×5 = 40 marks)

Answer ALL questions choosing either (a) or (b).

Question No.	Questions	Course Outcome	Cognitive level
16.a	Critically analyse the generation of ATP in the mitochondria.	CO1	K4
16.b	Analyse the mechanism of oxidative phosphorylation.	CO1	K4
17.a	Illustrate the Pentose phosphate pathway and its significance.	CO4	K2
17.b	Outline the TCA cycle and mention its importance.	CO4	K2
18.a	Assess the β- oxidation of palmitic acid and tabulate the ATP generated.	CO4	K5
18.b	Explain the biosynthesis of cholesterol.	CO5	K5
19.a	Elaborate how ammonia is detoxified into urea.	CO3	K6
19.b	Discuss the biosynthesis of pyrimidines.	CO3	K6
20.a	Identify and discuss role of enzymes in the regulation of metabolic pathways with examples.	CO6	K3
20.b	Identify the roles of epinephrine, glucagon, cortisol and insulin in metabolic regulation.	CO6	K3

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Programme Structure

Semester	Sub. No	Subject Status	Subject Title	Contact hrs/ week	C Credits
I	1	Core - 1	Chemistry of Biomolecules	6	4
	2	Core - 2	Biophysical and Analytical Techniques	6	4
	3	Core - 3	Molecular Cell Biology	5	4
	4	Core - 4	Genetics	5	4
	5	Core - 5 Practical - 1	Bioanalytical techniques	4	2
	6	Core - 6 Practical - 2	Cell biology and Genetics	4	2
			Subtotal	**30**	**20**
II	7	Core - 7	Enzymes and Enzyme Technology	5	4
	8	Core - 8	Metabolism and Regulation	5	4
	9	Core - 9	Physiology and Nutrition	4	4
	10	Core - 10	Plant Biochemistry	4	4
	11	Core - 11	Field work	4	3
	12	Core - 12 Practical - 3	Enzyme Techniques	4	2
	13	Core - 13 Practical - 4	Enzyme Kinetics	4	2
			Subtotal	**30**	**23**
III	14	Core - 14	Immunology and Immunotechniques	6	4
	15	Core - 15	Clinical Biochemistry	6	4
	16	Core - 16	Biotechnology	5	4
	17	Core - 17	Research Methodology	5	4
	18	Core - 18 Practical - 5	Physiology, Nutrition and Plant Biochemistry	4	2
	19	Core - 19 Practical - 6	Clinical Biochemistry	4	2
			Subtotal	**30**	**20**
IV	20	Core - 20	Molecular Endocrinology	5	4
	21	Core - 21	Molecular Biology	5	4
	22	Core - 22	Pharmacology and Toxicology	4	4
	23	Core - 23 Practical - 7	Immunology and Molecular Biology Techniques	4	2
	24	Core - 24 Practical - 8	Clinical enzymology	4	2
	25	Elective – 1 **(Select any one)**	a. Open Online Course in Biochemistry b. Study Tour c. Muscle Biochemistry and Biomembranes d. Microbial Biochemistry	3	3
	26	Core - 25	Project	5	8
			Subtotal	**30**	**27**
			Total	**120**	**90**

CHEMISTRY OF BIOMOLECULES

L	T	P	C
6	0	0	4

Objective

To understand the structure and functions of macromolecules which emphasizes the reactions and physiological roles of biological molecules and their functional groups.

Total Hours: 90

Unit 1 20 Hrs

Carbohydrates

Structure and biological importance of sugar derivatives, phosphate esters, NTPs, amino sugars, sulphate derivatives, sugar acids, lactones, deoxy sugars and glycosides. Polysaccharides: homopolysaccharides -occurrence, structure and biological functions of cellulose, chitin, starch and glycogen. Heteropolysaccharides-structure and biological role of glycosaminoglycans, proteoglycans, blood group and bacterial cell wall polysaccharides. Glycoproteins: general introduction. O-linked and N-linked oligosaccharides-lectins. General method of investigating the structure of carbohydrates - Methylation method – Purdie, Haworth and Hirst method, Periodate oxidation method – Smith Degradation. A brief account of chitin, mannans, xylans, galactans and galacturonans.

Unit 2 18 Hrs

Amino acids and Proteins

Classification of amino acids and general properties. The peptide bond - Ramachandran plot. Chemical synthesis of peptides - Merrifield method. Classification and biological functions of proteins. Proteins - classification, denaturation and renaturation. Orders of protein structure. Secondary structure- α helix, β pleated sheet and β turns. Protein sequencing. Pauling and Corey model for fibrous proteins. Collagen triple helix. Methods of isolation, characterization and purifications. Protein crystallization. XRD and Maldi Tof Analysis

Unit 3 16 Hrs

Protein Structure

Super secondary structure- helix- loop helix, the hairpin β motif and the β α β motif. Forces stabilizing tertiary and quaternary structure. Conformational study on the structure of Keratin, Collagen and Hemoglobin. Structure of hemoglobin- oxygen binding and changes in conformation. Antifreeze proteins and Metalloproteins-Composition and function, hierarchy of behaviour from metal in metalloprotein. Structure of lysozyme and myoglobin.

Unit 4 16 Hrs

Lipids

Essential fatty acids, structure and biological functions of phospholipids, sphingolipids, glycolipids, Composition of lipoproteins. Chemical properties and characterisation of fats. Steroids-structure, properties, functions of cholesterol, Structures of ergosterol, phytosterol, cytosterol, bile acids and bile salts. Prostaglandins, thormboxanes and leukotrienes -Structure and biological role. Role of lipids in cell membrane.

Unit 5 20 Hrs

Nucleic acids

Structure of purines, pyrimidines, nucleosides and nucleotides. DNA - double helical structure. A, B and Z forms of DNA. Triple and quadruple structures. DNA supercoiling and linking number. Properties of DNA: buoyant density, viscosity, Hyperchromic effect, Melting point of DNA, Hydrolysis of nucleic acids, Denaturation and Renaturation of DNA-the cot curve. Occurrence and isolation of nucleic acids,
Chemical and Enzymatic Methods of nucleic acid sequencing (Illumina, Pyrosequencing (454) and ion torrent sequencing. Chemical synthesis of DNA.RNA-major classes and biological role. Structure of tRNA.

References

1. Robert K Murray et. al., Harper's Illustrated Biochemistry, 31st edition-McGraw Hill, 2018.
2. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 7th ed. 2017.
3. Devlin, T.M., John Wiley & Sons, Inc. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., (New York).
4. Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry, 8th ed. Freeman 2015.
5. Garrett, Reginald, and Charles Grisham. Biochemistry. Nelson Education, 2012.
6. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. Fundamentals of biochemistry. NewYork: John Wiley & Sons,5th Edition, 2016.
7. Lippincott Williams and Wilkins; Illustrated Reviews: Biochemistry, 7th edition, 2016.
8. https://biologydictionary.net/polysaccharide
9. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/lipids.htm

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 1: Chemistry of Biomolecules	Cognitive Level
CO1	recall about carbohydrates and its derivatives and summarize the types of polysaccharides and their importance in biological system	K1, K2
CO2	outline the method of investigating the structure of carbohydrates using different methods	K2
CO3	categorize the properties of aminoacids and examine the formation of peptides and their chemical synthesis	K4
CO4	illustrate the orders of protein structure and its sequencing and rephrase the structure of biologically important proteins and their conformational changes	K2, K3
CO5	explain the structure and biological functions of fatty acids and steroids, their biological role	K2
CO6	determine the structure, properties, synthesis and sequencing of nucleic acids and apply in various advanced biological fields	K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 1: Chemistry of Biomolecules														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	2	3	3	3	3	3	3	2	3
2	3	3	3	3	3	3	2	3	3	3	3	3	3	2
3	3	3	3	3	3	3	2	3	3	3	3	3	3	2
4	3	3	3	3	3	2	2	3	3	3	3	3	2	2
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-I/Ppr.2/Core - 2

BIOPHYSICAL AND ANALYTICAL TECHNIQUES

L	T	P	C
6	0	0	4

Objective

To understand the working principles, instrumentation and applications of various techniques for the identification, separation and purification of biomolecules in various fields of biological sciences

Total Hours: 90

Unit1 20 Hrs

Spectroscopic Techniques

Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV and visible spectrophotometry and spectrofluorimetry, luminometry, atomic absorption spectroscopy and flame photometry. Principle and biological applications of NMR and ESR. Principles and applications of Mass spectroscopy - GC-MS, HPLC-MS and LC-MS/MS

Unit 2 16 Hrs

Radioisotope Techniques

Nature and units of radioactivity. Detection and measurement of radioactivity-Geiger-Muller Counter, solid and liquid scintillation counting, quenching and quench correction, scintillation cocktails and sample preparation. Autoradiography. Applications of radioisotopes in biology.

Unit 3 18 Hrs

Electrophoresis, Electrochemical and Blotting Techniques

Electrophoresis - General principles. Electrophoresis of proteins- native PAGE, SDS-PAGE, gradient gels, isoelectric focusing, 2-D PAGE. Electrophoresis of nucleic acids- agarose gel electrophoresis, pulsed field electrophoresis. Electrophoretic mobility shift assay.Blotting techniques - Western, Northern, Southern.
Electrochemical techniques- Basic principles and instrumentation of the pH electrode. Principles and applications of biosensors.

Unit 4 20 Hrs

Chromatography Techniques

General principles of partition and adsorption chromatography. Principle, instrumentation and applications of paper, thin layer and gas chromatography. Principle, procedure, and applications of ion exchange, molecular exclusion, and affinity chromatography. Principle and applications of special forms of affinity chromatography-immuno affinity, metal chelate, dye-ligand and covalent chromatography. HPLC-principle, materials, instrumentation and applications.

Unit 5 16 Hrs

Centrifugation Techniques

Basic principles of sedimentation. Low-speed and high-speed centrifuges. Ultracentrifuges-Analytical ultracentrifuge-instrumentation and applications. Preparative ultracentrifuge-types and applications of preparative rotors. Basic principle and techniques of sub cellular fractionation by differential centrifugation. Density-gradient centrifugation-rate zonal and isopycnic.

References

1. Wilson and Walker. Principles and techniques of Biochemistry and Molecular Biology.7th ed. Cambridge University Press, 2012.
2. Upadhyay, Upadhyay and Nath. Biophysical Chemistry principles and Techniques. Himalaya Publ., 2010.
3. Boyer, R. Modern Experimental Biochemistry.3rd ed. Addison Weslery Longman, 2000.
4. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 4th ed., 2012.
5. Pavia. Intro to spectroscopy 5th ed., 2015.
6. Bisen, Prakash Singh, and Anjana Sharma, Introduction to instrumentation in life sciences. Crc Press, 2012.
7. Skoog.D, Holler F and Crouch S. Principles of Instrumental Analysis, 7th Edition, Cengage Learning custom publishing, 2016.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 2: Biophysical and Analytical Techniques	Cognitive Level
CO1	analyse and interpret data from various spectroscopic techniques to perform analysis of biomolecular structure	K2, K4
CO2	measure radioactivity, instrument used for detecting and measuring ionizing radiation and uses of autobiography methods available in biological research	K5
CO3	assess the working principles underlying protein and nucleic acid electrophoresis techniques, to apply in research laboratories	K5
CO4	develop knowledge with the theory of chromatographic separation process and apply theoretical knowledge in academic research and industries	K3&K6
CO5	design a suitable method for separation and analysis of biomolecules by learning concepts, fundamentals and types of centrifugation technique	K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 2: Biophysical and Analytical Techniques														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	2	2	3	3	3	3	3	2	2
2	3	3	3	3	3	2	2	3	3	3	3	3	2	2
3	3	3	3	3	3	3	1	3	3	3	3	3	3	1
4	3	3	3	3	3	2	1	3	3	3	3	3	2	1
5	3	3	3	3	3	1	2	3	3	3	3	3	1	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-I/Ppr.3/Core - 3

MOLECULAR CELL BIOLOGY

L	T	P	C
5	0	0	4

Objective

To provide in depth knowledge of the prokaryotic and eukaryotic cells and their molecular mechanisms of membrane transport, cell junctions, Cell cycle and Cell signalling.

Total Hours: 75

Unit 1 15 Hrs

Cell and Tissue organization

Molecular organization of prokaryotic and eukaryotic cells. Structure and function of mitochondria, chloroplasts, endoplasmic reticulum, Golgi apparatus, lysosomes and peroxisomes. The cytoskeleton-microtubles, microfilaments and intermediate filaments - Biological functions. The nucleus: nucleoli, chromatin, nucleosomes, chromosomes.

Unit 2 15 Hrs

Membranes

Physicochemical properties of cell membranes, molecular constituents of membranes-supra molecular architecture of membranes - asymmetrical organization of lipids and proteins.
Membranes assembly- importins and exportins. Membrane transport: Diffusion (passive and facilitated). Active transport-Uniport, symport, antiport, Na+ K+ ATPase and Calcium ATPase, ATP Binding Cassette transporters. Ion gradients, ion selective channels group translocation, porins. Vesicular transport - Endocytosis and exocytosis.

Unit 3 15 Hrs

Cellular communication, Cell cycle, Cell death

Intercellular communication through gap junctions, tight junctions and desmosomes. Brief account of cell division (mitosis and meiosis) and its significance. Cell differentiation.
The cell cycle-phases, regulation by cyclins and cyclin dependent kinases. Cell death - necrosis and apoptosis

Unit 4 15 Hrs

Cell Signaling

Fundamental concepts and definitions of signal, ligands, and receptors, Types of cell signaling - Endocrine, paracrine and autocrine signaling. Receptors and signaling pathways- nuclear receptors and cell surface receptors- Ion channels, G-protein coupled receptors, receptor kinases (tyr,ser/thr).Oncogenes and Oncogenesis; - Ras-raf-Map kinase cascade. Second messengers-cyclic nucleotides, lipids and calcium ions. Crosstalk in signaling pathways. Signal transduction mechanism.

Unit 5 15 Hrs

Techniques in Cell Biology

Microscopy-Basic principles. Light, bright field, phase-contrast, confocal and fluorescence microscopy. Electron microscopy-preparation of specimens. TEM and SEM. Use of Microtome in cytology – steps involved. Staining technique- types and applications. Flow cytometry- applications.

References

1. Karp. Cell & Molecular Biology 8 th ed. Wiley, 2016.
2. Lodish et al Molecular Cell Biology 8th ed. Freeman, 2016.
3. Murray et al. Harper’s Illustrated Biochemistry 30th ed. McGraw Hill, 2015.
4. Nelson and Cox. Lehninger. Principles of Biochemistry. Freeman, 7th ed., 2017.
5. De Robertis and De Robertis. Cell and Molecular Biology. Lippincott Williams and Williams 8 th (Paperback), 2017.
6. Alberts et al. Molecular Biology of the cell 6th ed. Garland Sci., 2014.
7. Krebs JE et al. Lewin’s. Genes XII. Jones & Bartlett Publ., 2017.
8. Twyman. Advanced Molecular Biology. BIOS Sci Publ., 2000.
9. Murphy. Fundamentals of light microscopy and Electronic imaging. Wiley-Blackwell, 2nd edition, 2012.
10. Wilson and Walker. Principles and techniques of Biochemistry and Molecular Biology.7th ed. Cambridge University Press, 2012.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core –3: Molecular Cell Biology	Cognitive Level
CO1	recall the basic components of cell and tissues and explain the structure and function	K1&K2
CO2	explain the communications of cells with other cells and to the environment	K2
CO3	elaborate the role of compartmentalization and signaling in cellular biology and its significance	K6
CO4	evaluate and apply knowledge of modern techniques in cellular biology	K3&K5
CO5	create novel methods for analysis of cell and specific cellular components and apply the same in biological research to aid medical diagnosis and treatment	K4&K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core –3 Molecular Cell Biology														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	2	2	3	3	3	3	3	2	2
2	3	3	3	3	2	3	1	3	3	3	3	2	3	1
3	3	3	3	3	2	3	1	3	3	3	3	2	3	1
4	3	3	3	3	2	2	2	3	3	3	3	2	2	2
5	3	3	3	3	3	2	1	3	3	3	3	3	2	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-I/Ppr.4/Core - 4

GENETICS

L	T	P	C
5	0	0	4

Objective

To understand the science of Heredity, Classical and Evolutionary Genetics, Inheritance and Mutation.

Total Hours: 75

Unit 1 15Hours

Introduction to Genetics

Science of Heredity – Historical milestones – Classical, Molecular and Evolutionary Genetics. Preformation, Epigenesis, Pangenesis, Germplasm theory. Cell – Overview, Cell cycle – Stages of Mitosis and Meiosis. Chromosome – Structure, Variation in structure, number of chromosomes (Haploid and Diploid), Variation in number. Mutation and various DNA repair mechanisms.

Unit 2 15 Hours

Classical Genetics

Introduction to Mendelism – discovery and rediscovery of Mendelism. Mendel's experiment – Monohybrid cross- Law of dominance, Principle of segregation, Phenotype and genotype. Dihybrid test – Principle of independent assortment, Polyhybrid cross. Monohybrid Test cross, Dihybrid test cross. Epistasis – dominant and recessive epistasis.

Unit 3 15 Hours

Sex Determination

Chromosome theory of sex determination, X – body, sex chromosome. XO method of sex determination, XY method of sex determination. Sex determination in Drosophila, sex determination in man. Abnormal sexes – Turner's syndrome, Klinefelter's syndrome. Sex linked inheritance - sex linked inheritance in Drosophila – Eye colour, sex linked inheritance in man – colour blindness and haemophilia. Y linked inheritance in man. X linked dominant genes.

Unit 4 15 Hours

Linkage and Crossing over

Coupling and Repulsion. Morgan's experiment. Chromosome theory of Linkage. Crossing over – Mechanism of crossing over – Classical theory, Partial chiasma type theory, Belling Hypothesis, crossing over in maize, crossing over in Drosophila. Factors affecting crossing over. Significance of crossing over.

Unit 5 15 Hours

Population and Evolutionary Genetics

Population and Evolutionary Genetics – Hardy Weinberg equilibrium, natural selection Mutation – Fluctuation test, point mutation (frame shift, back mutation and suppression), chemical Mutagenesis and Ames test, Role of Mutation in evolution & Speciation, Altruism, mimicry, Kin selection & Industrial Melanism.

References

1. Robert Tamrine, Principles of genetics, McGraw Hill Education,7th Edition, 2017.
2. Gardner and Simmons, Principles of genetics, Wiley India, 8th edition, 2015.
3. Lodish et al Molecular Cell Biology 8th ed. Freeman, 2016.
4. De Robertis and De Robertis. Cell and Molecular Biology. Lippincott Williams and Williams 8 th (Paperback), 2017.
5. Krebs JE et al. Lewin's. Genes XII. Jones & Bartlett Publ., 2017.
6. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu., 2013.
7. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3 rd ed. Freeman, 2006.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 4: Genetics	Cognitive Level
CO1	explain the science of heredity, Cell, Chromosome and mutation	K2
CO2	recall the concept of Mendelism, dihybrid tests, monohybrid test and epistasis	K1
CO3	explain the chromosome theory of sex determination and assess the sex-linked inheritance in Drosophila, Y linked inheritance in man and X linked Dominant genes	K2
CO4	explain the Morgan's experiment and discuss crossing over	K2, K6
CO5	interpret and apply mutation and its role in evolution and speciation studies	K2, K3

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 4 Genetics														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	2	3	2	3	3	3	3	2	3	2
2	3	3	2	2	3	3	2	3	3	2	2	3	3	2
3	3	3	2	2	3	2	1	3	3	2	2	3	2	1
4	3	3	3	2	3	2	1	3	3	3	2	3	2	1
5	3	3	2	3	2	3	2	3	3	2	3	2	3	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-I/Ppr.5/Core - 5

Practical 1: BIOANALYTICAL TECHNIQUES

L	T	P	C
0	0	4	2

1. Separation and identification of sugars by paper chromatography
2. Separation and identification of amino acids by paper chromatography
3. Two-dimensional paper chromatography of amino acids
4. Thermal denaturation of DNA
5. Separation of lipids by TLC
6. Separation of proteins by native PAGE
7. Separation of DNA by Agarose gel electrophoresis
8. Estimation of fructose in fruits
9. Isolation and estimation of ascorbic acid from citrus fruit

References

1. T. N. Pattabiraman, Laboratory Manual and Practical Biochemistry, All India Publishers & Distributors, 4th edition,2015.
2. J. Jayaraman, Laboratory Manual in Biochemistry - New Age International Publishers, 2nd edition, 2011.
3. S. Sadasivam, A. Manickam, Biochemical Methods - New Age International (P) Limited, 3rd edition, 2018.
4. David T. Plummer. An Introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, 3rd edition, 2017.
5. Boyer, R. Modern Experimental Biochemistry.3rd ed. Addison Weslery Longman, 2000.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core –5; Practical 1: Bioanalytical Techniques	Cognitive Level
CO1	apply the concept of spectrophotometric principles in academic research and industries	K3
CO2	interpret the migration of macromolecules during electrophoresis available for research laboratories	K2, K5
CO3	develop analytical techniques for DNA denaturation for studying the biophysical characteristics of DNA molecules	K5
CO4	analyse and design chromatographic techniques for separation and analysis of biomolecules beneficial to scientific research	K4, K6
CO5	adapt a broad range of analytical tool for isolation and separation of DNA	K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core –5; Practical 1: Bioanalytical Techniques														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	3	1	3	3	3	3	3	3	1
2	3	3	3	3	3	3	2	3	3	3	3	3	3	2
3	3	3	3	3	3	3	1	3	3	3	3	3	3	1
4	3	3	3	3	3	3	2	3	3	3	3	3	3	2
5	3	3	3	3	3	3	2	3	3	3	3	3	3	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-I/Ppr.6/Core - 6

Practical 2: CELL BIOLOGY AND GENETICS

L	T	P	C
0	0	4	2

1. Isolation of DNA from animal tissue
2. Identification of cell division by mitosis from onion root tip
3. Microscopic examination of epithelial cells, plant cells
4. Staining techniques – Simple and differential staining
5. Estimation of proteins by Lowry et al method/Bradford method
6. Estimation of DNA by Diphenylamine method
7. Estimation of RNA by Orcinol method
8. Estimation of phosphorous content of nucleic acids by Fiske and Subbarao method
9. UV absorption spectra of nucleic acids

References

1. J. Jayaraman, Laboratory Manual in Biochemistry - New Age International Publishers, 2nd edition, 2011.
2. S. Sadasivam, A. Manickam, Biochemical Methods - New Age International (P) Limited, 3rd edition, 2018.
3. T. S. Work and E. Work., (Ed) 1969. Vol I & II, Elsevier. Laboratory techniques in Biochemistry and Molecular biology, Copyright 2017.
4. Manash Pratim Sarma and Minakshi Bhattacharjee, Laboratory Techniques in Biological Sciences, 24by7 Publishing, 2020.
5. K. V. Chaitanya, Cell and Molecular Biology: A Lab Manual, ISBN-13: 978-8120348004, PHI Publishers, 2013.
6. Whitney Hable, Cell Biology Lab Manual, Kendall Hunt Publishing; 1st edition, 2009.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core –6; Practical 2: Cell biology and Genetics	Cognitive Level
CO1	experiment with DNA to study genetic cause of disease and for the development of diagnostics and drugs	K3
CO2	identify and differentiate various stages in cell division and analyse mechanism involved with loss of control of in cancer state	K3, K4
CO3	develop detailed knowledge of the structure and function of cell and tissues	K6
CO4	recall the major roles of phosphorus in biological processes and analyse the phosphorus content	K1, K4
CO5	determine the concentration of a specific protein or an array of different proteins in biological samples	K5
CO6	evaluate the RNA for various molecular biology studies	K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core –6; Practical 2: Cell biology and Genetics														
CO	PO							PSO						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	3	3	3	3	2	3	2	3	3	3	3	2	3	2
2	3	2	3	2	3	3	2	3	2	3	2	3	3	2
3	3	3	3	3	3	3	1	3	3	3	3	3	3	1
4	3	3	3	3	2	3	2	3	3	3	3	2	3	2
5	3	2	3	3	3	3	2	3	2	3	3	3	3	2
6	3	2	3	3	3	3	2	3	2	3	3	3	3	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-II/Ppr.7/Core - 7

ENZYMES AND ENZYME TECHNOLOGY

L	T	P	C
5	0	0	4

Objective

To understand the basic principles of enzymology and to understand a mechanistic overview of enzyme catalysis, its regulation in cell and the use of enzymes in biological industries

Total Hours: 75

Unit 1 15 Hrs

Introduction to Enzymes

Enzymes–Definition and function, Holoenzyme, Apoenzyme, Coenzymes, Cofactors and their general characteristics, classification and nomenclature. Methods of enzyme assay, Enzyme units, Katal, specific activity and turnover number. Active site- investigation of active site structure. A brief account of non-protein enzymes- ribozymes. Methods of enzyme isolation and purification.

Unit 2 15 Hrs

Enzyme kinetics

Introduction, Effect of pH, temperature, enzyme and substrate concentration. Michaelis-Menten plot, linear transformation, Lineweaver-Burk plot, Eadie-Hofstee plot, and Hanes Woolf equations, Significance of Km and Vmax. King –Altman procedure.
Kinetics of allosteric enzymes-MWC and KNF models. Hill's equation and co-efficient. Sequential and non-sequential bi substrate reactions.

Unit 3 15 Hrs

Enzyme inhibition

Enzyme inhibition - Irreversible and reversible competitive, noncompetitive and uncompetitive, mixed inhibition, Kinetic differentiation and graphical methods.
Mechanism of enzyme action-acid base catalysis, covalent catalysis, strain, proximity and orientation effects. Mechanism of action of lysozyme, chymotrypsin, DNA polymerases, RNase.

Unit 4 15 Hrs

Enzyme regulation

Coenzymes, multienzyme complexes- PDH and FAS complex. Metal dependent and metallo enzymes- Carbonic anhydrase and SOD. Isoenzymes.
Enzyme regulation: General mechanism of enzyme regulation, feedback inhibition and feed forward stimulation. Enzyme repression, induction and degradation, control of enzyme activity by products and substrates. Zymogens.

Unit 5 15 Hrs

Enzyme Technology

Enzyme electrodes, enzyme biosensors and their applications, ELISA, EMIT. Immobilization of enzymes and their applications. Enzyme engineering.
Enzymes of industrial and clinical significance, sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, pectic enzymes, lipase proteolytic enzymes in meat and leather industry, detergents and cheese production.
Enzymes as thrombolytic agents, anti-inflammatory agents, debriding agents, digestive aids therapeutic use of enzymes.

References

1. Palmer T. Understanding enzymes. Prentice Hall, 2004.
2. Pandey et al. Enzyme Technology. Springer, 2010,
3. Nelson, Cox. Lehninger Biochemistry. 7th ed. Freeman, 2017.
4. Dixon and Webb. Enzymes, 3rd ed. Longmans, 1979.
5. Berg, Tymoczko, Stryer, Biochemistry, 8th ed. Freeman, 2015.
6. Balasubramanian et al. Concepts in Biotechnology. Univ Press, 2004.
7. Buchholz et al., Biocatalysts and Enzyme Technology. 2nd ed. Wiley-Blackwell, 2012.
8. Ratledge and Kristiansen. Basic Biotechnology 3rd ed. Cambridge Univ. Press, 2006.
9. Whitehurst R J. Enzymes in Food Technology. CRC Press, 2001.
10. Uhlig H. Industrial enzymes and their applications. John Wiley, 1998.
11. Maragoni AG. Enzyme Kinetics - A modern approach., John Wiley and sons 2002.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 7: Enzymes and Enzyme Technology	Cognitive Level
CO1	recall the nature, properties and importance of enzymes	K1
CO2	explain the mechanism of enzyme action and elaborate why enzymes work on specific substrates	K1, K2, K6
CO3	demonstrate that enzymes functions by lowering the activation energy and apply methods for rapid biochemical reactions	K2, K3
CO4	analyse the kinetics of enzyme catalysed reaction to optimize the conditions for the maximum enzyme activity	K4
CO5	assess the importance of enzyme regulation and its relation to metabolic pathways	K5
CO6	predict and exploit the enzymes and its biochemical role for development of therapeutic products and manufacture of several important bioproducts at effective cost	K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 7: Enzymes and Enzyme Technology														
CO	PO							PSO						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	3	3	3	3	3	3	2	3	3	3	3	3	3	2
2	3	3	3	3	3	2	2	3	3	3	3	3	2	2
3	3	3	3	3	3	2	2	3	3	3	3	3	2	2
4	3	3	3	3	3	2	2	3	3	3	3	3	2	2
5	3	3	3	3	3	3	2	3	3	3	3	3	3	2
6	3	3	3	3	3	3	1	3	3	3	3	3	3	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-II/Ppr.8/Core - 8

METABOLISM AND REGULATION

L	T	P	C
5	0	0	4

Objective

To learn the metabolism of biomolecules and integrate the various aspects of metabolism & their regulatory pathways

Total Hours: 75

Unit 1 15 Hrs

Bioenergetics

Concepts of free energy enthalpy and entropy, free energy change and standard free energy changes, significance of free energy changes, effect of temperature on ΔGo, relations between Keq and ΔGo. Enzymes involved in redox reactions. The electron transport chain-organization and role in electron capture- Mechanism.
Oxidative phosphorylation – electron transfer reactions in mitochondria. F_1F_0 ATPase - structure and mechanism of action. The chemiosmotic theory.
Inhibitors of respiratory chain and oxidative phosphorylation-uncouplers, ionophores. Regulation of oxidative phosphorylation.
Mitochondrial transport systems-ATP/ADP exchange, malate/glycerophosphate shuttle.

Unit 2 15 Hrs

Carbohydrate metabolism

Glycolysis and gluconeogenesis-pathway, key enzymes and co-ordinate regulation. Role of Fructose 2,6 diphosphate in liver and muscle, Pyruvate dehydrogenase complex and its regulation. Inhibition by products. The citric acid cycle and regulation. The pentose phosphate pathway and its significance. Metabolism of glycogen and regulation. cAMP and coordinated control in Glycogenesis and Glycogenolysis. Phosphorylase activation and in activation, Role of Ca^{2+}. Glucuronic acid pathway.

Unit 3 15 Hrs

Lipid metabolism

Oxidation of fatty acids - β, α and ω oxidation. Role of Carnitine cycle in the regulation of β oxidation. Oxidation of odd chain fatty acids- fate of propionate. Metabolism of ketone bodies, formation, utilization, excretion, clinical significance and its control.
Biosynthesis of fatty acids. A brief account of the metabolism of triglycerides, phospholipids and cholesterol. Metabolism of lipoproteins - Exogenous and Endogenous pathways. Biosynthesis of Prostaglandins, Thromboxanes and Leukotrienes.

Unit 4 15 Hrs

Metabolism of aminoacids, purines and pyrimidines

Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen-transamination, deamination, ammonia formation, the urea cycle. Key role - Glutamate dehydrogenase, Regulation of Glutamate dehydrogenase and urea cycle. Catabolism of carbon skeletons of amino acids- overview only.
Metabolism of purines- de novo and salvage pathways for purine biosynthesis, purine catabolic pathway. Metabolism of pyrimidines. Regulation of biosynthesis and catabolism of purine and pyrimidine, Xanthine oxidase inhibitors. Mechanism of feedback regulation.

Unit 5 15 Hrs

Metabolic integration and hormonal regulation

Key Junctions in Metabolism; Glucose-6-Phosphate, Pyruvate and Acetyl CoA, metabolic profile of the liver, adipose tissue and brain. Hormonal regulation of metabolism-role of epinephrine, glucagon, cortisol and insulin. Brief account of leptin.

References

1. Nelson and Cox. Lehninger’s Principles of Biochemistry. Freeman, 7th ed., 2017.
2. Voet and Voet. Fundamentals of Biochemistry. 5th. Wiley, 2016.
3. Murray et al. Harper’s Illustrated Biochemistry 31st ed. McGraw Hill, 2018.
4. Berg, Tymoczko, Stryer, Biochemistry, 8th ed. Freeman, 2015.
5. Kuchel et al. Schaum’s Outline of Biochemistry. McGraw Hill. 3 rd ed., 2011.
6. Garrett, Reginald H - Grisham, Charles MBiochemistry.6th edition, Broks/Cole, Cengage Learning, 2016.
7. Christopher K. Mathews, K.E. Van Hole, Kevin G. Ahern Biochemistry 3rd edition. Pearson Education, Singapore, 2003.
8. https://www.slideshare.net/syed_ismail/metabolism-43769484.

9. https://www.slideshare.net/senchiy/nucleic-acids-and-nucleotide.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 8: Metabolism and Regulation	Cognitive Level
CO1	explain the concept of energy production in the living cell and identify the importance of thermodynamic principles is coupling anabolic and catabolic processes is metabolism	K2, K3
CO2	analyse the critical role of hormones in the control system with regard to the integration of metabolism	K4
CO3	demonstrate a conceptual theoretical knowledge of the diversity of metabolic regulation	K2
CO4	elaborate the concept of metabolism and significance of various metabolic pathways	K6
CO5	compare the different metabolic connectivity and its control system	K5
CO6	judge the various metabolism and regulation strategies in enzyme level	K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 8: Metabolism and Regulation														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	2	2	3	3	3	3	3	2	2
2	3	3	3	3	3	3	2	3	3	3	3	3	3	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	2	1	3	3	3	3	3	2	1
5	3	3	3	3	3	2	1	3	3	3	3	3	2	1
6	3	3	3	3	3	2	1	3	3	3	3	3	2	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-II/Ppr.9/Core - 9

PHYSIOLOGY AND NUTRITION

L	T	P	C
4	0	0	4

Objective

To acquire a comprehensive knowledge about the structure and function of vital internal organ systems in the human body and to understand the biological basis of nutrition in health

Total Hours: 60

Unit 1 12 Hrs

Circulatory system

Blood-Composition and functions of blood. Plasma proteins- types function and variation in disease. Erythrocytes, Leucocytes and Thrombocytes- Morphology, functions and variations. Mechanism of clotting and disorders of clotting factors. Blood groups-ABO and Rh system. Transport of oxygen and carbon dioxide in blood, lungs and tissues. Factors regulating blood pH- Buffers. Acid base imbalance- causes and biochemical findings.

Unit 2 12 Hrs

Digestive and Excretory system

Composition, functions and regulation of Saliva, gastric, Pancreatic, Intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and Nucleic acids. Structure of Nephron, Mechanism of urine formation, Renal threshold, GFR, Renal regulation of acid-base balance.

Unit 3 12 Hrs

Nervous system and Cardio vascular system

Structure of Neuron- divisions of Nervous system- CNS and PNS. Receptors; Conduction of Nerve impulse, Neurotransmitters. Heart- Physiological anatomy, Cardiac cycle- Systole and Diastole. ECG- Normal Electrocardiogram and changes during Myocardial infarction. Heart rate: Normal range, Variations and regulation.

Unit 4 12 Hrs

Food and Health

Basic food groups-Energy yielding, Body building, protective foods. (Functions of food rich relation to Nutrition and clinical health). Food production, Food storage, Functional foods, New protein and Fat foods,
Changing food habits, Food adulteration and hygiene. Improvement of protein quality by supplementation and fortification. Nitrogen balance - positive and negative.

Unit 5 12Hrs

Nutrition and Energy

Measurement of food stuffs by Bomb Calorimeter. Calorific value of Proteins, CHO and fats. Energy-Basal Metabolism-Measurement of BMR, factors affecting BMR, regulation of body temperature, Energy requirement. Requirements of Carbohydrates and Lipids. Special aspects of Nutrition during pregnancy and lactation.

References

1. Guyton and Hall Text book of Medical Physiology, Elsevier; 4thedition, 2020.
2. Smith et al. Principles of Biochemistry. Mammalian Biochemistry. McGraw Hill 7th ed.,1982.
3. Barrett et al. Ganong's Review of Medical Physiology. 25th ed. Lange, 2015.
4. Robin R Preston, Thad E Wilson, Physiology, Lippincotts Illustrated Reviews, 2nd edition, 2019.
5. Swaminathan, M., Essentials of Food and Nutrition, Vol I & II, Bappco Publishers, Madras 2000.
6. Mahtab, S, Bamji, Kamala Krishnasamy, G.N.V. Brahmam., Text book of Human Nutrition, 3rd edition, Oxford and IBH Publishing Co. P. Ltd., New Delhi, 2015.
7. Swaminathan, M.S. Handbook of Food and Nutrition, 5th Edition. The Bangalore Printing and Publishing Company, 2007.
8. Weighley, E.S. Robinson's Basic Nutrition and Diet Therapy, 8th Edition, Macmillan Publishers, 1997.
9. Insel, P. et al., Discovering Nutrition, 4th Edition, Jones and Bartlett Publishers, 2013.
10. Kaveri Chakrabarty, A. S. Chakrabarty, Textbook of Nutrition in Health and Disease, Springer, 2019.
11. http:/youtu.be/r-16hB76Ark/ (Oxygen Dissociation curve)
12. https://youtu.be/cKnEdvrmHK4 (Blood Groups)
13. https://youtu.be/xEHGIRpGyh4 (Oxygen transport in blood)

14. 10.https://youtu.be/hnWk0dVb8fQ (Digestion and absorption)

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 9: Physiology and Nutrition	Cognitive Level
CO1	recall the different systems of human body and explain their functions in biological system	K1, K2
CO2	summarize the composition and functions of blood, apply the blood grouping system and explain the mechanism of gaseous transport in different parts of the body and evaluate the causes and biochemical findings in acid base imbalance	K2, K5
CO3	explain the digestion and absorption of biomolecules in the human system by the action of various secretions and examine the mechanism of excretory function	K2, K4
CO4	distinguish the divisions of nervous system, nerve impulse transmission and examine the cardiac cycle, its changes during myocardial infarction by analyzing ECG	K4
CO5	make use of basic food groups, changing food habits and analyse food adulterants and interpret the se of bomb calorimeter for measuring the calorific value of food stuffs and asses the BMR	K3, K4, K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 9: Physiology and Nutrition														
CO	PO							PSO						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	3	3	3	3	2	3	2	3	3	3	3	2	3	2
2	3	3	3	3	2	2	3	3	3	3	3	2	2	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	2	2	3	3	3	3	3	2	2	3
5	3	3	3	3	3	2	3	3	3	3	3	3	2	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-II/Ppr.10/Core - 10

PLANT BIOCHEMISTRY

L	T	P	C
4	0	0	4

Objective

To acquire knowledge about the biochemical principles underlying plant metabolism, growth regulators, secondary metabolites and plant physiology

Total Hours: 60

Unit 1 12 Hrs

Photosynthesis

Photosynthesis – Photosynthetic apparatus, Organization of thylakoid, Photosynthetic pigments, Light absorption and energy conservation, properties of light, Light harvesting complex, the reaction center complex. The photosystem I and II.
Electron transport pathways in chloroplast membranes, Cyclic and noncyclic Photophosphorylation. Factors affecting photosynthesis.

Unit 2 12 Hrs

Carbon Metabolism

Carbon reactions in C3, C4 and CAM plants – Dark reactions – Photosynthetic carbon reduction in Calvin cycle, Hatch – Slack pathway, CAM plants (Crassulacean acid metabolism). Biochemistry and genetics of RUBISCO, Starch biosynthesis and degradation. Metabolic transport between organelles.

Unit 3 12 Hrs

Nitrogen and Sulphur metabolism

Nitrogen cycle, Nitrogen fixation – Symbiotic and Non – symbiotic. Symbiotic Nitrogen fixation – biochemistry and physiology of nodule formation, enzymology of nitrogen fixation, Genetics of nitrogen fixation and nodulation, Nitrogen assimilation.
Sulphur chemistry and functions, sulphate activation – reduction and Sulphite reduction.

Unit 4 12 Hrs

Plant growth regulators and secondary metabolites

Plant growth regulators – Chemistry, Biosynthesis, transport, distribution, mechanism of action and physiological role of auxin, gibberellin, abscisic acid and ethylene.
Secondary metabolites – Biosynthesis and functions of flavonoids, alkaloids, terpenoids, anthocyanin, phenols and steroids. Role of secondary metabolites in defence mechanism.

Unit 5 12 Hrs

Plant physiology and photo morphogenesis

Water reactions of plants, Mechanism of water absorption, Mineral nutrients – Macro and Micro nutrients, their role in plants.
Biochemistry of seed germination and dormancy, Factors affecting seed germination and dormancy, Phytochrome, Photoperiodism and Vernalization.

References

1. Dey P M, Plant Biochemistry, Elsevier India, 2013.
2. Goodwin and Mercer. Introduction to Plant Biochemistry, 2nd Edition, CBS, 2005.
3. Devlin N Robert and Francis H Witham, Plant Physiology, 4th ed, PWS Publications, 1983.
4. Lincoln Taiz and Eduardo Zeiger, Plant Physiology, 3rd ed, Sinauer Associates, 2002.
5. Hans Watter Heldt, Plant Biochemistry and Molecular Biology, 4th ed, Oxford University, 2010.
6. Russel Jones, Helen Ougham, Howard Thomas, Susan Waaland, The Molecular life of Plants, Wiley Blackwell, 2012.
7. B. Thayumanavan, S Krishnaveni, K Parvathi, Biochemistry for Agricultural sciences, Galgotia Publications Pvt Ltd, 2004.
8. Salisbury & Ros, Plant Physiology, 3rd ed, CBS Publications, 2006.
9. https://byjus.com/biology/plant-cell/
10. https://www.topper.com/guides/biology/plant growth and development/ plant growth regulators/

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core - 10: Plant Biochemistry	Cognitive Level
CO1	outline the ETC and mechanism of photosynthesis	K2
CO2	list out the carbon reactions in C3, C4 and CAM plants	K1
CO3	discuss the Dark reaction and Hatch slack pathway	K3
CO4	analyse the cycles of elements and its fixation	K4
CO5	relate the mode of action of plant growth regulators and the biological functions of secondary metabolites	K2
CO6	assess water reaction of plants, mineral nutrients and the biochemical changes during seed germination and dormancy	K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core - 10: Plant Biochemistry														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	2	2	3	3	2	1	3	2	2	3	3	2	1
2	3	2	2	2	3	3	2	3	2	2	2	3	3	2
3	3	2	3	2	3	2	2	3	2	3	2	3	2	2
4	3	3	3	2	3	2	3	3	3	3	2	3	2	3
5	3	2	2	2	3	3	2	3	2	2	2	3	3	2
6	3	2	2	3	3	3	1	3	2	2	3	3	3	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

FIELD WORK

L	T	F	C
0	0	4	3

The students shall carryout a Field work study individually in an Industry or Agricultural land or Medical laboratory or Hospitals along with expert internal guidance from Faculties of the same Institution and shall submit a Field work report after successful completion.

External: Internal Assessment = 50:50 marks

b) Field Work report will be evaluated and Viva-Voce will be conducted by both the External examiner and the Internal Guide at the end of the second semester.

Components		Marks
External	Field Work Report	25
	Viva -Voce	25
Internal	Involvement & Interaction	25
	Knowledge & Skill	25
Total		**100**

Practical 3: ENZYME TECHNIQUES

L	T	P	C
0	0	4	2

1. Determination of total activity of Salivary amylase
2. Determination of specific activity of Salivary amylase
3. Assay of the activity of Arginase from liver tissue
4. Assay of the activity of Hexokinase from liver tissue
5. Assay of the activity of Glutathione peroxidase from animal tissue
6. Assay of the activity of Catalase from onion
7. Preparation and assay of Trypsin from soyabean
8. Preparation and purification of β amylase from sweet potato.
9. Enzyme immobilization technique (any one method)

References

1. Rodney F Boyer, Modern Experimental Biochemistry, 3rd edition, Pearson Education, 2002.
2. T. N. Pattabiraman, Laboratory Manual and Practical Biochemistry, All India Publishers & Distributors, 4th edition,2015.
3. J. Jayaraman, Laboratory Manual in Biochemistry - New Age International Publishers, 2nd edition, 2011.
4. S. Sadasivam, A. Manickam, Biochemical Methods - New Age International (P) Limited, 3rd edition, 2018.
5. David T. Plummer, An Introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, 3rd edition, 2017.
6. Aln Fersht, Enzymes Structure and Mechanism, NewYork: Freeman, 2nd edition, 1999.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 12; Practical 3: Enzyme Techniques	Cognitive Level
CO1	list out the activity of different enzymes in biological system and infer their mode of action	K1, K2
CO2	apply the activity of arginase and hexokinase from liver tissue and adapt the methods employed for its production	K3, K6
CO3	analyse the preparation and purification procedure involved in enzyme production from biological sources and interpret the results	K4, K5
CO4	evaluate the assay of catalase enzyme from onion and adapt the methodology for future research	K5, K6
CO5	outline the enzyme immobilization technique and apply the procedure industrially	K2, K3

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 12; Practical 3: Enzyme Techniques														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	2	3	3	3	3	2	3	2	3	3	3	3	2
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	2	3	3	3	3	1	3	2	3	3	3	3	1
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
5	3	2	3	3	3	3	2	3	2	3	3	3	3	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

Practical 4: ENZYME KINETICS

L	T	P	C
0	0	4	2

Enzyme Kinetic study of Trypsin/LDH

1. Time course of enzyme reaction
2. Effect of pH on enzyme activity
3. Effect of temperature on enzyme activity and determination of activation energy
4. Effect of substrate concentration on enzyme activity and determination of Km value
5. Effect of Enzyme concentration on enzyme activity
6. Effect of inhibitor(s) on activity of any one enzyme
7. Effect of activator(s) on activity of any one enzyme

References

1. Rodney F Boyer, Modern Experimental Biochemistry, 3rd edition, Pearson Education, 2002.
2. T. N. Pattabiraman, Laboratory Manual and Practical Biochemistry, All India Publishers & Distributors, 4th edition,2015.
3. J. Jayaraman, Laboratory Manual in Biochemistry - New Age International Publishers, 2nd edition, 2011.
4. S. Sadasivam, A. Manickam, Biochemical Methods - New Age International (P) Limited, 3rd edition, 2018.
5. David T. Plummer, An Introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, 3rd edition, 2017.
6. Aln Fersht, Enzymes Structure and Mechanism, New York: Freeman, 2nd edition, 1999.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 13; Practical 4: Enzyme Kinetics	Cognitive Level
CO1	list and explain the key characteristics which define an enzyme catalyzed reaction	K1,K2
CO2	analyse the impact of pH, temperature, activators and inhibitors on enzyme action and apply the same in development of novel and useful biological products	K3, K4
CO3	justify the Michaelis-Menten equation and make use of equation to predict Km and Vmax	K5
CO4	appraise and use Kcat and the ratio of Kcat/Km	K5
CO5	compile the major class of enzyme inhibitors and predict the mechanism of binding and impact on Km and Vmax	K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 13 Practical 4: Enzyme Kinetics														
CO	PO							PSO						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	3	3	3	3	3	3	2	3	3	3	3	3	3	2
2	3	3	3	3	3	3	2	3	3	3	3	3	3	2
3	3	3	3	3	3	3	2	3	3	3	3	3	3	2
4	3	3	3	3	3	3	2	3	3	3	3	3	3	2
5	3	3	3	3	3	3	1	3	3	3	3	3	3	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

IMMUNOLOGY AND IMMUNOTECHNIQUES

L	T	P	C
6	0	0	4

Objective

To learn about the structural features of the components of the immune system, their functions, immunization practices and immunological techniques

Total Hours: 90

Unit 1 18 Hrs

Elements of Immunology

Types of immunity-innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs-Thymus, bone marrow, spleen, lymph nodes and other peripheral lymphoid tissues-GALT. Cells of the immune system-lymphocytes, mononuclear phagocytes-dendritic cells, granulocyte, NK cells and mast cells, cytokines.
Antigens vs immunogens, Haptens. Factors influencing immunogenicity. Immunoglobulins structure, classification and functions. Isotypes, allotypes and idiotypes.

Unit 2 18 Hrs

Complement activation and its biological consequences

Clonal selection theory. Organization and expression of immunoglobulin genes generation of antibody diversity. Class switching.
T- cell, B-cell receptors, Antigen recognition-processing and presentation toT-cells, Interaction of T and B cells. Immunological memory. Effector mechanisms- macrophage activation. Cell mediated cytotoxicity, immunotolerance, immunosuppression.

Unit 3 18 Hrs

MHC genes and products

Polymorphism of MHC genes, role of MHC antigens in immune response, MHC antigens in transplantation. Transplantation types- Graft Vs Host disease.
Immune responses to infectious diseases-viral bacterial and protozoal. Cancer and immune system. AIDS and other immunodeficiency disorder. Autoimmunity. Hypersensitivity-types.

Unit 4 18 Hrs

Immunization practices

Active and passive immunization. Vaccines-killed, attenuated-toxoids. Recombinant vector vaccines- DNA vaccines, synthetic peptide vaccines – antibiotype vaccines production of polyclonal and monoclonal antibodies. Principles, techniques and application. Genetically engineered antibodies.
Fractionation of leucocytes by density gradient centrifugation. Identification of lymphocytes and their subsets in blood. Leukocyte migration inhibition technique. Delayed type hypersensitivity technique.

Unit 5 18 Hrs

Agglutination and precipitation techniques

Immuno electrophoresis, RIA, immunoblotting, avidin-biotin mediated immuno assay. Immuno histochemistry-immunofluoresence, immunoferritin technique. Fluorescent immunoassay.
Cytokine assay -ELISA and ELISPOT. Production of cytokines *invitro*. Interferon production. Abzymes.

References

1. Goldsby et al. Kuby Immunology. WH Freeman & Co. 7th ed., 2013.
2. Abbas et al. Cellular and Molecular Immunology. 9th ed. Elsevier, 2018.
3. Janeway, C. (Ed), Travers. Immunobiology 9th ed. Garland Publ., 2016.
4. Richard Coico and Sunshine. Immunology: A short course. 7th ed. Wiley-Liss, 2015.
5. Roitt et al. Roitt's Essential Immunology. 13 th ed Wiley-Blackwell Sci., 2017.
6. Thao Doan and Rover Melvold et. al., Immunology, Lippincott's Illustrated Review, 2nd edition, Williams and Wilkins, 2012.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 14: Immunology and Immunotechniques	Cognitive Level
CO1	recall the history and development of immunology	K1
CO2	explain the importance of phagocytosis and natural killer cells in innate body defense	K2
CO3	list the roles of different types of T-cells, B cells and PACs	K4
CO4	evaluate the mechanism of hypersensitivity reactions	K5
CO5	justify the role of MHC in human immune system	K5
CO6	apply the principles of Ag-Ab reaction to develop various techniques to support biological research	K3

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 14: Immunology and Immunotechniques														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1		3	3	3	3	2	2	3	3	3	3	3	2	2
2	3	2	2	3	2	3	1	3	2	2	3	2	3	1
3	3	2	2	2	3	3	3	3	2	2	2	3	3	3
4	3	3	2	3	2	2	1	3	3	2	3	2	2	1
5	3	2	3	3	3	2	1	3	2	3	3	3	2	1
6	3	2	3	3	3	1	3	3	2	3	3	3	1	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

CLINICAL BIOCHEMISTRY

L	T	P	C
6	0	0	4

Objective

To learn various metabolic disorders their cause, their clinical manifestation, complications, diagnosis and management

Total Hours: 90

Unit 1 18 Hrs

Inherited Disorders of Metabolism

Patterns of inheritance-autosomal and sex-linked disorders, disorders of amino acid metabolism-amino aciduria, phenylketonuria, Hartnup's disease, alkaptonuria, albinism, cystinuria, cystinosis, homocystinuria and maple syrup urine disease. Disorders of carbohydrate metabolism-glycogen storage diseases, galactosemia, fructose intolerance and fructosuria. Disorders of Purine and pyrimidine metabolism: Hyperuricemia and gout. Hypouricemia. Orotic aciduria.

Unit 2 18 Hrs

Diabetes mellitus and Disorders of lipid metabolism

Blood sugar homeostasis - Role of tissues and hormones in the maintenance of blood sugar. Hypoglycemia, hyperglycemia, glycosuria. Diabetes mellitus-classification, metabolic abnormalities, diagnosis and management. Acute complications-diabetic ketoacidosis hyperosmolar non-ketotic coma. Long term complications - retinopathy, neuropathy and nephropathy, glycosylation.
Disorders of lipid metabolism - Lipoproteinemia, Atherosclerosis, Lipid storage diseases - Gaucher's, Taysach's Niemann Pick and Sandhoff's disease.

Unit 3 18 Hrs

Diseases of liver

Normal structure and functions of liver, Bilirubin metabolism, Jaundice, Dubin Johnson syndrome, Rotor syndrome, Crigglers and Najjar syndrome, Differential diagnosis of Jaundice, consequences and biochemical findings in hepatitis, Cirrhosis, Fatty liver disease, Liver function tests, Gall stones and steatorrhea.

Unit 4 18 Hrs

Plasma protein disorders and Renal dysfunction

Non-protein nitrogenous constituents in blood with reference to urea, uric acid, creatinine, abnormalities including uremia, plasma protein abnormalities - hemoglobinopathy, porphyria, acute phase proteins, proteinuria. Qualitative analysis of urine, renal function tests, Osmolality & free water clearance, acute & chronic renal failure, glomerulonephritis, Nephrotic syndrome, Renal hypertension, Urinary calculi, analysis of renal stones, Peritoneal & Hemodialysis.

Unit 5 18 Hrs

Clinical enzymology

Clinical enzymology in diagnosis, Clinical significance of Transaminases, Phosphatases, Creatine kinase, lactate dehydrogenase, aldolase, γ-glutamyl transpeptidase, amylase, lipase, choline esterase. Enzyme patterns in diagnosis of myocardial infarction, hepatobiliary disease, muscle dystrophy & bone disorders.

References

1. Varley, H., Gowenlock, A.H. and Hill, M. William, Practical Clinical Biochemistry, CBS Publishers; 6th Edition, 2006.
2. Andrew Day, Philip Mayne, Clinical Chemistry in diagnosis and treatment, 6th edition, Hodder Arnold Publication, 1994.
3. W.J. Marshall, S. K. Bengert, M. Lapsley, Clinical Chemistry, 8th edition, Elsevier, 2016.
4. Robert K Murray et. al., Harper's Illustrated Biochemistry, 31st edition-McGraw Hill, 2018.
5. Tietz, Textbook of Clinical Chemistry and Molecular Diagnostics,7th edition Saunders, 2014.
6. Harrison's Principles of Internal Medicine. Vol 1 & 2, 19 th edition McGraw Hill, 2015.
7. M.N. Chatterjee, Rana Shinde, Medical Biochemistry, Jaypee Brothers, 8th edition, 2012.
8. Shivananda Nayak B, Essentials of Medical Biochemistry, 3rd ed, Jaypee Brothers Medical Publishers Pvt Ltd, New Delhi, 2016.
9. Thomas M Devlin, Text book of Biochemistry with clinical correlations, 7th ed, 2010.
10. Michael Bishop, Clinical chemistry – Principles, techniques and correlations, enhanced edition, 8th ed, Jones and Bartlett Publications, 2020.
11. Peter Rae, Mike Crane, Rebecca Pattenden, Clinical Biochemistry, 10th ed, Wiley Blackwell, 2017.
12. https://www.britannica.com/science/metabolic -disease/ Disorders of carbohydrate metabolism
13. https://www.Slideshare.net/Mohit Adhikary/Pancreatic function test

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 15: Clinical Biochemistry	Cognitive Level
CO1	outline the disorders of carbohydrate, purine and pyrimidine metabolism and discuss Hyperuricemia and Gout	K2, K6
CO2	recall the blood sugar homeostasis and justify the coordinate regulation and disorders leading to imbalance	K1, K5
CO3	explain the normal structure and functions of liver and diseases of liver	K2
CO4	list out plasma protein disorders and make use of renal function tests to diagnose and help treat acute and chronic renal failure	K1, K3
CO5	interpret the role of serum enzymes in clinical diagnosis	K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 15: Clinical Biochemistry														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	2	3	3	3	2	2	3	2	3	3	3	2	2
2	3	3	3	3	3	2	2	3	3	3	3	3	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	2	2	3	3	3	3	3	2	2
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

BIOTECHNOLOGY

L	T	P	C
5	0	0	4

Objective

To know the principles of rDNA technology and genetic engineering, Plant and Animal tissue culture techniques and their applications in crop development, medicinal and industrial applications

Total Hours: 75

Unit 1 15 Hrs

Recombinant DNA Technology

Brief history of DNA Technology, Use of restriction enzymes, DNA ligases, Alkaline phosphatase, cloning vectors-plasmids (PBR 322, PUC18), Bacteriophages (M13), Cosmids, Artificial chromosome vectors. Splicing of DNA-Cohesive and Blunt end ligation. Techniques in genetic engineering-FISH, PCR, RFLP, DNA finger printing. Gene libraries.

Unit 2 15 Hrs

Gene therapy and Fertilization techniques

Gene therapy-*Ex vivo and In vivo* with examples, Antisense therapy, DNA in diagnosis of infectious disease and genetic disease. Recombinant vaccines subunit vaccines. IVF and ET in humans, GIFT and ZIFT, Hazards and safety aspects of genetic engineering.

Unit 3 15 Hrs

Plant Biotechnology

Brief history of plant tissue culture. Types of culture- Callus culture, Cell culture and Suspension culture, Culture media, Basic technique of plant tissue culture, Micropropagation and soma clonal variation. Protoplast culture and Somatic hybridization. Gene transfer methods in plant- Vector mediated and vector less DNA Transfer. Transgenic plants- Insect resistance, Virus resistance and Herbicide resistance. Improvement of crop yield and quality- Delay of fruit ripening, Golden rice. Use of plants to produce commercially important carbohydrates, Lipids and Proteins (few examples).

Unit 4 15 Hrs

Animal Biotechnology

Basic requirement of animal cell culture, Culture media for animal tissue culture. Primary cell culture and cell lines. Transgenic animals- Transgenic mice and its applications. Production of Therapeutic proteins- Immunoglobulins, Vaccines. Enzymes- Amylase and Protease. Biosensors- Types and Applications.

Unit 5 15 Hrs

Industrial Biotechnology

Waste water treatment-Stages-Primary, Secondary and Tertiary treatment, sludge and solid wastes treatment and disposal, Bioremediation, Microbial degradation of xenobiotics, Single cell proteins. Fermentation – fermenters –types, Fermentation culture media, Downstream processing.

References

1. Gupta PK. Elements of Biotechnology, Rastogi Publication, 2nd ed., 2010.
2. R C Dubey, A text book of Biotechnology, S. Chand and company Ltd., 4th edition), 2006.
3. H. K. Das, Text book of Biotechnology, Wiley, 5th edition, 2017.
4. Dale and von Schantz. From Genes to Genomes: Concepts and applications of DNA technology. 3rd ed. Wiley-Interscience, 2011.
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6. Glick and Pasternak. Molecular Biotechnology. 4 th ed. ASM Press, 2009.
7. Winnacker EL. From Genes to clones. 4 thed VCH Publ., 2003.
8. Watson et al. Recombinant DNA 3rd ed. Freeman, 2006.
9. Primrose, Twyman and Old. Principles of gene manipulation. 8 th ed. Wiley-Blackwell, 2016.
10. Satyanarayana U, Biotechnology, Generic, 12th edition, 2018.
11. Smith. JE. Biotechnology. Cambridge Univ Press. 5 th ed., 2012.
12. https://youtu.be/fg3pvxej0ia (Gene splicing and rDNA)
13. https://youtu.be/xoqfjjobgmo (Gene therapy)
14. https://yotu.be/utlkkvqxbww (Protoplast fusion)
15. https://youtu.be/8HTjul7521y (Transgenic animals)

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 16: Biotechnology	Cognitive Level
CO1	define rDNA technology, outline the basic history, the enzymes and vectors used in gene transfer and make use of the important techniques in Genetic Engineering	K1, K2, K3
CO2	analyse the process of gene therapy & identify the use of DNA in diagnosis of infectious diseases and discuss the methods employed in IVF & ET	K3, K4, K6
CO3	recall about tissue culture, its types & the basic technique of tissue culture	K1
CO4	utilize the technique of developing transgenic plants and apply the technique to produce commercially important products using plants	K3
CO5	outline the techniques involved in animal tissue culture and utilizes the technique to produce transgenic animals and apply the same commercially to produce various therapeutic proteins	K2, K3
CO6	design the steps involved in waste water treatment and evaluates the fermentation process, its types and the recovery of products using Down Stream Processing	K5, K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 16: Biotechnology														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	2	3	2	3	2	3	3	2	3	2	3	2	3
2	3	3	3	2	2	2	2	3	3	3	2	2	2	2
3	3	3	3	3	3	2	2	3	3	3	3	3	2	2
4	3	1	3	2	3	1	3	3	1	3	2	3	1	3
5	3	1	3	3	2	2	3	3	1	3	3	2	2	3
6	3	3	3	2	1	2	2	3	3	3	2	3	2	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

RESEARCH METHODOLOGY

L	T	P	C
5	0	0	4

Objective

To learn the scientific basis of research methodology, scientific writing, data collection and analysis using statistics and Bioinformatics.

Total Hours: 75

Unit 1 15 Hrs

Research

Goals of research – Types of research – Importance and need for research ethics and scientific research. Research problem - components of research problem, formulation of research problem, Research Design - Classification of research designs, need for research design, features of good research design, experimental research design. Research Hypothesis – definition, types and characteristics. Experimental approaches - biological, physical and chemical methods

Unit 2 15 Hrs

Scientific Writing

Thesis writing - Characteristic logical format for writing thesis and papers. Essential features of abstract, Introduction, Review of literature, Materials and methods, results and discussion, Effective illustration, Tables and figures, reference style - Harvard and Vancouver system. Publication in a scientific journal, Preparation of abstract and manuscript. Selection of journals for publication- Impact factor - Citation index and H-index. Principle and method of patenting.

Unit 3 15 Hrs

Biostatistics

Introduction, Concept of sampling and sampling methods. Collection of data in experiments - primary and secondary data. Classification and tabulation of data. Diagrammatic and graphical representation of data. Frequency distribution, Measure of central tendencies- Mean, median, mode, geometric mean and harmonic mean. Measures of dispersion–Range, Quartile deviation, Standard Deviation and Coefficient of variation. Correlation and Regression analysis.

Unit 4 15 Hrs

Sample statistics

Sampling distribution and standard error. Testing of Hypothesis, Test of significance based on large samples. Test for mean, difference of means, proportions and equity of proportions. Small sample tests-Student's 't', test for mean, difference of two means, test for correlation and regression coefficients. Chi square test for goodness of a nonindependence of attributes. ANOVA – one way and two-way classifications.

Unit 5 15 Hrs

Bioinformatics

Bioinformatics and its applications, Information networks - EMB net and NCBI. Databases; primary nucleic acid databases - EMBL; GenBank and DDBJ. Protein sequences databases; primary databases - PIR, MIPS, SWISS - PROT, TrEMBL, NRL-3D. Secondary Databases - PROSITE, PROFILES, PRINTS, Pfam, BLOCKS and IDENTITY. Composite protein Databases.

References

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10. Supratim Choudhuri, Bioinformatics for Beginners, 1stedition, Elsevier, 2014.
11. Anna Tramontano, Introduction to Bioinformatics, 1st edition, Chapman and Hall/ CRC, 2006.
12. https://WWW.scribbr.com/methodology /sampling methods/
13. https://books.google.com/books/about/A Text book of Biostatistics.html?id=RzpFK
14. https://microbenotes.com/primary-data-and-secondary-data

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 17: Research Methodology	Cognitive Level
CO1	define research, importance and its link with theoretical knowledge in research studies	K1
CO2	develop skill in art of scientific writing, oral presentation and to construct an effective research proposal	K3, K6
CO3	formulate the basic concepts of bioinformatics and its significance in biological data analysis	K6
CO4	apply statistical tools like mean, median, mode, standard deviation, standard error, t-test and ANOVA in biological research	K3
CO5	create hypothesis testing and its importance in solving problems	K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 17: Research Methodology														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	2	2	3	3	3	3	3	2	2
2	3	3	3	3	3	2	2	3	3	3	3	3	2	2
3	3	3	3	3	3	3	2	3	3	3	3	3	3	2
4	3	3	3	3	3	2	1	3	3	3	3	3	2	1
5	3	3	3	3	3	3	1	3	3	3	3	3	3	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

Practical 5: PHYSIOLOGY, NUTRITION AND PLANT BIOCHEMISTRY

L	T	P	C
0	0	4	2

1. Enumeration of RBC
2. Enumeration of WBC
3. Differential counting of Leukocytes
4. Estimation of Hb levels by Drabkin's method
5. Estimation of Iron content from Plant source
6. Estimation of β-carotene from carrot
7. Estimation of total free amino acids in plant tissue
8. Estimation of reducing sugars in fruit
9. Estimation of calcium content in milk
10. Estimation of Chlorophyll content in leaves
11. Determination of total phenolic content in plant extract
12. Determination of total flavonoid content in plant extract

References

1. Estridge, Reynold and Walter, Basic Medical Laboratory Techniques - 4th edition, Delmar Publishers, 2000.
2. Kanai L Mukherjee, Vol I-III. Medical Lab Technology, Tata McGraw Hill Education India, 3rd edition, 2010.
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4. J. Jayaraman, Laboratory Manual in Biochemistry - New Age International Publishers, 2nd edition, 2011.
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6. David T. Plummer, An Introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, 3rd edition, 2017.
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Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 18; Practical 5: Physiology, Nutrition and Plant Biochemistry	Cognitive Level
CO1	list out the types of blood cells and examine the blood cells using microscopy technique and make use of the skill for clinical diagnosis	K1, K4, K6
CO2	estimate the chlorophyll, iron content, Beta carotene, aminoacids, reducing sugars from plant as sources and make use of the methods employed for further higher studies and research	K3, K6
CO3	evaluate the calcium content present in milk & assess the process skilfully for milk quality improvement	K5
CO4	elaborate the determination of total phenol and flavanoid content of plant extracts and develop the procedure for various investigations	K3, K6
CO5	develop wide practical skills and get trained in lab methods in Biochemistry research	K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 18; Practical 5: Physiology, Nutrition and Plant Biochemistry														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	2	3	3	3	3	3	3	2	3	3
2	3	3	3	3	2	3	3	3	3	3	3	2	3	3
3	3	3	3	3	2	3	3	3	3	3	3	2	3	3
4	3	3	3	3	3	3	2	3	3	3	3	3	3	2
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

Practical 6: CLINICAL BIOCHEMISTRY

L	T	P	C
0	0	4	2

Estimation of the following blood constituents

1. Blood Sugar by Folin and Wu method
2. Blood Glucose by GOD/POD method (kit method)
3. Blood Urea by DAM method
4. Serum Uric acid by Caraway method
5. Serum Iron by Ramsay method
6. Serum Phosphorus by Fiske and Subbarao method
7. Serum Total protein and A/G ratio by Biuret method
8. Serum Cholesterol by Zak's method
9. Serum Creatinine by Jaffey's Alkaline Picrate method
10. Serum Triglycerides by GPO/PAP method (kit method)
11. Serum Bilirubin by Diazo method

References

1. Practical Clinical Biochemistry, Varley, H., Gowenlock, A.H. and Hill, M. William, CBS Publishers; 6th Edition, 2006.
1. Estridge, Reynold and Walter, Basic Medical Laboratory Techniques - 4th edition, Delmar Publishers, 2000.
2. T. N. Pattabiraman, Laboratory Manual and Practical Biochemistry, All India Publishers & Distributors, 4th edition,2015.
3. J. Jayaraman, Laboratory Manual in Biochemistry - New Age International Publishers, 2nd edition, 2011.
4. Henry Bernard, J., Sanford, T and Davidson, W.B. Clinical diagnosis and Management by laboratory methods, Saunders, New York, 2002.
5. Gradwohls, (ed) Ales C. Sonnenwirth and Leonard Jarret, M.D. Clinical Laboratory Methods and Diagnosis, B.I. publications, New Delhi, 2000.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 19; Practical 6: Clinical Biochemistry	Cognitive Level
CO1	justify the principle and methods of estimation of various biochemical parameters in blood, plasma and serum	K5
CO2	determine each biochemical parameter using suitable colorimetric methods precisely and accurately and report the results	K5
CO3	analyse the estimated values of blood sugar, blood urea, uric acid, total protein, A/G ratio, cholesterol, creatinine, iron and phosphorus in serum to help diagnosis of metabolic disorders	K4
CO4	assess the significance of enzymatic method for the estimation of triglycerides for detection of coronary artery diseases	K5
CO5	apply the skills obtained in the clinical biochemistry labs, create their own clinical biochemistry labs and utilize in clinical research	K3, K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 19; Practical 6: Clinical Biochemistry														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	3	2	3	3	3	3	3	3	2
2	3	3	3	3	3	3	2	3	3	3	3	3	3	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	2	3	3	3	3	3	3	2
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MOLECULARENDOCRINOLOGY

L	T	P	C
5	0	0	4

Objective

To provide the basis for understanding the endocrine organs and its hormones, to study the roles of endocrine system in maintaining homeostasis, integrating growth and development etc. during health and diseases and their management.

Total Hours: 75

Unit 1 15 Hrs

Introduction to endocrine system

The endocrine glands, Hormones - Definition, classification, biosynthesis, circulation in blood, modification and degradation. Hormone receptors-external features and structure of plasma membrane receptors and intracellular receptors. Mechanisms of hormone action of Class I and Class II hormones. Signal transduction. Second messengers - adenylate cyclase system, role of G proteins, protein kinases, tyrosine kinase, inositol phosphates, calcium, calmodulin. Feedback regulation of hormones, Down regulation of hormone receptors.

Unit 2 15 Hrs

Hypothalamus and pituitary hormones

Hypothalamic releasing factors. Anterior pituitary hormones–Synthesis, feedback regulation and biological effects of Glycoprotein hormones, Growth hormone, ACTH and Prolactin. Hyper and Hypo activity of anterior pituitary –gigantism& acromegaly, dwarfism. Posterior pituitary hormones - Vasopressin and oxytocin. Diabetes insipidus, syndrome of inappropriate ADH secretion.

Unit 3 15 Hrs

Thyroid and Parathyroid hormones

Thyroid hormones - Synthesis, secretion, regulation, transport, metabolic fate and biological actions. Antithyroid agents. Hyperthyroidism, thyrotoxicosis, Graves's disease, Hypothyroidism, Goitre, Hashimoto's thyroiditis. Thyroid function tests.
Parathyroid hormones - Hormonal regulation of calcium and phosphorous metabolism. Biosynthesis, secretion, regulation and biological action of Parathyroid hormone, Calcitonin and Calcitriol. Hyper and Hypocalcemia, Rickets and Osteomalacia.

Unit 4 15 Hrs

Pancreatic and Gastrointestinal hormones

The Pancreas - Cell types of the islets of Langerhans. Insulin – Biosynthesis, regulation of secretion, Mechanism of action - Insulin receptor, Insulin signalling pathways, Biological actions. Synthesis, regulation, mechanism of action and biological effects of glucagon, somatostatin and pancreatic polypeptide. Insulin like growth factors.
Gastrointestinal hormones-location of peptide producing cells, synthesis, structure and functions of Secretin, GIP, VIP, Gastrin, CCK, Ghrelin, Leptin.

Unit 5 15 Hrs

Adrenal and Gonadal hormones

Adrenal cortical hormones - Biosynthesis, secretion, transport, metabolism and biological effects of Glucocorticoids and Mineralocorticoids. Adrenal medullary hormones - Biosynthesis, storage, metabolism, regulation and biological effects of Catecholamines. Abnormal secretion of adrenal hormones-Addison's disease, Cushing's syndrome, Congenital adrenal hyperplasia, Pheochromocytoma.
Gonadal hormones - Biosynthesis, regulation, transport, metabolism and biological effects of Androgens, Estrogens and Progesterone. Biological actions. Ovarian cycle.

References

1. Shlomo Melmed et al., Williams Text Book of Endocrinology, 13th edition, Saunders, 2015.
2. Robert K Murray et. al., Harper's Illustrated Biochemistry, 31st edition, McGraw Hill, 2018.
3. Emil L Smith, Principles of Biochemistry: Mammalian Biochemistry, 7th ed., Mc Graw Hill, 1983.
4. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 7th ed., 2017.
5. Andrew Day, Philip Mayne, Clinical Chemistry in diagnosis and treatment, 6th edition, Hodder Arnold Publication, 1994.
6. W.J. Marshall, S. K. Bengert, M. Lapsley, Clinical Chemistry, 8th edition, Elsevier, 2016.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core –20: Molecular Endocrinology	Cognitive Level
CO1	classify and analyse the general features of hormones and elucidate the mechanism of action of Class I and Class II hormones	K2, K4
CO2	illustrate feedback regulation mechanism and analyse the coordinate regulation of hormones by hypothalamus and pituitary	K2, K4
CO3	recall the biosynthesis, discuss the physiological and metabolic roles of various hormones	K1, K6
CO4	elaborate the anatomical characteristics of islets of thyroid, parathyroid, pancreas, adrenals and gonads	K6
CO5	outline and distinguish the nature circulation, modification and degradation of each hormone	K2, K4
CO6	evaluate the disorders associated with endocrine gland dysfunction	K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core –20: Molecular Endocrinology														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	2	2	3	3	3	3	3	2	3
2	3	3	3	3	3	3	2	3	3	3	3	3	3	2
3	3	3	3	3	3	2	2	3	3	3	3	3	2	2
4	3	3	3	3	3	2	2	3	3	3	3	3	2	2
5	3	3	2	2	3	3	3	3	3	3	3	3	3	3
6	3	3	2	2	2	3	3	3	3	3	2	2	2	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MOLECULAR BIOLOGY

L	T	P	C
5	0	0	4

Objective

To provide in depth knowledge of the prokaryotic and eukaryotic replication, transcription and translation process and their regulatory mechanisms

Total Hours: 75

Unit 1 15 Hrs

DNA Replication, Repair and Recombination

Genetic Material - DNA and RNA, Viroid, Prions - Concept and definition of Gene, Organization of cellular DNA into Chromosomes, Unit of Replication, DNA replication - Modes of DNA Replication (Semi-conservative, Semi-discontinuous, Bidirectional replication, Rolling circle, Mitochondrial D loop). DNA Polymerase of Prokaryotes, Mechanism of replication in Prokaryotes. Eukaryotic DNA polymerases, Mechanism of Replication in Eukaryotes - Nuclear and Mitochondrial, Cellular control of replication. Role of Telomerases. DNA damage and repair mechanism. Homologous, Transposition and Site-specific recombination. DNA repetitive sequences.

Unit 2 15 Hrs

Prokaryotic transcription and regulation

Basic principles of transcription – E.Coli RNA polymerase, submit structure. Promoter sequence in E coli; Steps in transcription-initiation, elongation and termination. Rho dependent and Rho independent termination. Inhibitors of transcription, Post transcriptional processing of rRNA and tRNA. Regulation of transcription in prokaryotes – the lac operon and trp operon.

Unit 3 15 Hrs

Eukaryotic transcription and regulation

Eukaryotic RNA polymerases-structure and functions. RNA pol I, II and III, promoters, transcription factors, transcription complex assembly and mechanism of transcription, Transcriptional regulation in eukaryotes-hormonal (steroid hormone receptors), phosphorylation (STAT proteins). Post transcriptional processing of mRNA, rRNA and tRNA. Alternative splicing. Catalytic RNA (ribozymes), RNA editing, Antisense RNA. The genetic code-general features. Mutations-point mutations and frameshift mutations. Suppressor mutations-nonsense and missense suppression.

Unit 4 15 Hrs

Translation

Components of protein synthesis-m RNA, ribosomes and tRNA. Mechanism of protein synthesis in bacteria and eukaryotes-amino acid activation, initiation, elongation and termination translation control in bacteria and eukaryotes. Regulation of protein synthesis-constitutive, and narrow domain regulation, Inhibition of protein synthesis. Co and post translation modification. Protein degradation: Ubiquitin pathway. Protein folding models, molecular chaperones.

Unit 5 15 Hrs

Gene expression and regulation

Levels of gene expression. Principles of gene regulation, cis acting elements and trans acting factors. Upregulation, down regulation, induction, repression, global and narrow domain mechanisms. Genetic and epigenetic gene regulation by DNA methylation. DNA methylation in prokaryotes-modification systems, Dam methylation. Dcm methylation. DNA methylation in eukaryotes-cytosine methylation, CpG islands. Methylation and gene regulation in mammals and plants. Epigenetic gene regulation by DNA methylation in mammals-role of imprinting and X-chromosome inactivation.

References

1. Karp. Cell & Molecular Biology 8 th ed. Wiley, 2016.
2. Lodish et al Molecular Cell Biology 8th ed. Freeman, 2016.
3. Murray et al. Harper's Illustrated Biochemistry 30th ed. McGraw Hill, 2015.
4. Nelson and Cox. Lehninger's Principles of Biochemistry. Freeman, 7th ed., 2017.
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7. Krebs JE et al. Lewin's. Genes XII. Jones & Bartlett Publ., 2017.
8. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu., 2013.
9. Watson et al. Recombinant DNA: Genes and genomes - A short course. 3 rd ed. Freeman, 2006.
10. Twyman. Advanced Molecular Biology. BIOS Sci Publ., 2000.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core - 21: Molecular Biology	Cognitive Level
CO1	define DNA replication and explain the mechanism of replication in prokaryotes and eukaryotes	K1, K2
CO2	recall the steps involved in transcription and explain the regulation of transcription in prokaryotes	K1, K2
CO3	explain the types of mutations and analyse the general features of genetic code and its significance	K4, K5
CO4	illustrate the mechanism of protein synthesis and make use of various inhibitors in antibiotic therapy	K2, K3
CO5	elaborate the levels of gene expression and explain the importance of DNA methylation in prokaryotes	K6
CO6	analyse the various models of DNA replication and examine the types of DNA repair mechanisms	K4

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core - 21: Molecular Biology														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	2	3	3	3	2	3	3	2	3	3	3	2	3
2	3	3	2	2	2	3	2	3	3	2	2	2	3	2
3	3	3	2	2	1	3	1	3	3	2	2	1	2	1
4	3	2	3	3	1	2	2	3	2	3	3	1	2	2
5	3	3	2	2	3	1	2	3	3	2	2	3	1	2
6	3	3	2	2	2	3	3	3	3	2	2	2	3	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

PHARMACOLOGY AND TOXICOLOGY

L	T	P	C
4	0	0	4

Objective

To gain knowledge about the pharmacokinetics and pharmacodynamics of drugs, adverse effects and to study the general principles of toxic compounds and poisons and their effects

Total Hours: 60

Unit 1 12 Hrs

General Pharmacology

Introduction of Pharmacology, Drug categories, Source of drugs, Dosage forms, Drug nomenclature, Routes of drug administration, Combined effect of drugs, Factors modifying drug action, Drug interactions, Dose response curve - ED50&LD50. Pharmacokinetics - ADME Process - Complex of events between drug administration and drug action. Pharmacodynamics – Receptors – Classification of receptors, Drug receptor interaction, Forces in drug – receptor interaction.

Unit 2 12 Hrs

Pharmacology of Central Nervous System

Sedatives, Hypnotics – benzodiazipines, barbiturates. General anaesthetics, local anaesthetics, Analgesics and anti-inflammatory agents, Anti-Anxiety, Antidepressant drugs – different classes of drugs used as antidepressants – anti manic mood stabilizing agents, hallucinogens. Drug used in Epilepsies Anti-seizure drugs, Skeletal Muscle Relaxants.

Unit 3 12 Hrs

Pharmacology of Respiratory and Cardiovascular system

Drugs used in treatment of asthma – Drugs used for cough. Pharmacological aspects of non-steroidal anti-inflammatory drugs – Mechanism of action of NSAID'S – Therapeutic and side effects of NSAIDs – Pharmacology of Cardiovascular system: Drugs used in the myocardial ischemia – Treatment of heart failure, Antihypertensive drugs.

Unit 4 12 Hrs

Pharmacology of gastrointestinal tract system, Antibiotics and Chemotherapy

GIT drugs - Antacids, Antiulcer drugs, Laxatives, antiulcer and antidiarrheal drugs.
Antibiotics - Antibacterial, Antifungal & Antiviral drugs.
Chemotherapy - General Principles of Chemotherapy, Chemotherapy of Cancer.

Unit 5 12 Hrs

Toxicology

Classification of toxicity, Principles of toxicology, Definition of acute, subacute & chronic toxicity, Types of toxins & their mechanism of action. Definition of poison, General principles of treating of poisoning. Heavy metals poisoning. Toxicity of anticancer drugs.
Factors affecting toxicity – Drug tolerance, Intolerance, Addiction, Habituation, Allergy, Hypersensitivity, Idiosyncrasy, antagonism, synergism, Potentiation, Tachyphylaxis.

References

1. Mohammed Ali, Text book of pharmaceutical chemistry, CBS Publishers and Distributors, New Delhi, 2018.
2. William O. Foye, Thomas L. Lenke, David A. Williams, Principles of Medicinal Chemistry, 4 th Edition, B.I. Waverely Pvt., Ltd., New Delhi, 2012.
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5. Manfred E Wolf, Burger's medicinal chemistry and drug discovery. Principles and practice, John Wiley, 2012.
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7. Gareth Thomas, Fundamentals of Medicinal Chemistry, Wiley Blackwell Publishers, 2003.
8. K.D. Tripathi, Essentials of Medical Pharmacology 6 th edition, Jaypee Brothers Medical publishers(P) Ltd., New Delhi, 2013, ISBN No: 81-8448-085-7.
9. Bertram G. Katzung, Susan B. Masters, Anthony J. Trevor Basic and Clinical Pharmacology, 12 th edition, McGraw Hill medical publishers Ohio, 2012, ISBN: 978-0-07-176402-5
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11. Ernest Hodgson, A textbook of Modern Toxicology. 3 rd edition. John Wiley & Sons, Inc., New York, 2004. ISBN 0-471-26508-X.
12. https://www.slideshare.net/swaroophassan/drug-metabolism-40740005.
13. https://www.slideshare.net/MalayPandya1/drug-metabolism-111690745.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core – 22: Pharmacology and Toxicology	Cognitive Level
CO1	recall the principles of pharmacology and its development history	K1
CO2	illustrate the principle of action of drugs and mechanism of action towards various diseases	K2
CO3	justify knowledge in the chemotherapy for cancer, microbial diseases and different antiviral agents	K5
CO4	formulate the principles of toxicology and treatment of various poisonings	K6
CO5	analyse the concept of ADME of drug in human body	K4
CO6	identify and recognize adverse drug reaction and drug interaction	K3

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core – 22: Pharmacology and Toxicology														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	2	2	1	3	3	3	3	2	2	1
2	3	3	3	3	3	3	2	3	3	3	3	3	3	2
3	3	3	3	3	3	2	3	3	3	3	3	3	2	3
4	3	3	3	3	2	2	2	3	3	3	3	2	2	2
5	3	3	3	3	2	2	1	3	3	3	3	2	2	1
6	3	3	3	3	3	3	1	3	3	3	3	3	3	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

Practical 7: IMMUNOLOGY AND MOLECULAR BIOLOGY TECHNIQUES

L	T	P	C
0	0	4	2

1. Single Radial Immunodiffusion
2. Outcherlony Double Immunodiffusion
3. Rocket Immunoelectrophoresis
4. Coombs Test/ Widal Test/VDRL Test
5. Dot ELISA
6. Separation of proteins by SDS-PAGE
7. Western Blotting of protein
8. Isolation of yeast RNA
9. Isolation of plasmid or genomic DNA
10. Isolation of chloroplast DNA from leaves

References

1. J. Jayaraman, Laboratory Manual in Biochemistry - New Age International Publishers, 2nd edition, 2011.
2. S. Sadasivam, A. Manickam, Biochemical Methods - New Age International (P) Limited, 3rd edition, 2018.
3. David T. Plummer, An Introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company, 3rd edition, 2017.
4. T. S. Work and E. Work., (Ed) 1969. Vol I & II, Elsevier. Laboratory techniques in Biochemistry and Molecular biology, Copyrright 2017.
5. Olivier Cochet, Jean-Luc Teillaud and Catherine SautÃ¨s, Immunological Techniques Made Easy, Wiley, 1st edition, 1998.
6. Manash Pratim Sarma and Minakshi Bhattacharjee, Laboratory Techniques in Biological Sciences, 24by7 Publishing, 2020.
7. Sue Carson et. al., Molecular Biology Techniques: A Classroom Laboratory Manual, Academic Press; 4th Edition, 2019.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core - 23; Practical 7: Immunology and Molecular Biology Techniques	Cognitive Level
CO1	rephrase the principle and methods of identification of antigens and antibodies	K2
CO2	develop hands on skill in the isolation and quantification of specific serum immunoglobulins	K3
CO3	analyse the collected clinical data using wide range of immunological methods for the identification of bacterial or viral infection	K4
CO4	develop skills in the technique of separation of proteins by SDS-PAGE and Western Blotting	K3
CO5	apply and evaluate the methods of isolation and separation of RNA from sources such as Yeast, plasmid and genomic DNA	K3, K5
CO6	formulate novel methods of isolation and purification of antibodies, proteins and nucleic acids from various biological samples and make use of the same in biological research and medical diagnosis	K6

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core –23; Practical 7: Immunology and Molecular Biology Techniques														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	1	3	3	3	3	3	3	1
3	3	3	3	2	2	3	3	3	3	3	2	2	3	3
4	3	3	3	3	3	3	2	3	3	3	3	3	3	2
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	1	3	3	3	3	3	3	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

Practical 8: CLINICAL ENZYMOLOGY

L	T	P	C
0	0	4	4

Assay of the activity of serum enzymes

1. Alkaline phosphatase
2. Acid phosphatase
3. Aspartate transaminase
4. Alanine transaminase
5. Amylase
6. Lipase
7. Lactate dehydrogenase
8. Creatine phosphokinase - Colorimetric assay kit
9. Gamma glutamyl transferase - Colorimetric assay kit

References

1. Varley, H., Gowenlock, A.H. and Hill, Practical Clinical Biochemistry, M. William, CBS Publishers; 6th Edition, 2006.
2. Estridge, Reynold and Walter, Basic Medical Laboratory Techniques - 4th edition, Delmar Publishers, 2000.
3. T. N. Pattabiraman, Laboratory Manual and Practical Biochemistry, All India Publishers & Distributors, 4th edition,2015.
4. J. Jayaraman, Laboratory Manual in Biochemistry - New Age International Publishers, 2nd edition, 2011.
5. Henry Bernard, J., Sanford,T and Davidson, W.B. Clinical diagnosis and Management by laboratory methods, Saunders, New York, 2002.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Core –24; Practical 8: Clinical Enzymology	Cognitive Level
CO1	find and interpret the importance of the clinical enzymes in practice	K1, K2
CO2	perceive the different assay procedure in serum enzymes and its kinetics	K6
CO3	apply practical knowledge in quantitative assay of serum enzymes	K3
CO4	analyse and identify appropriate diagnostic tools for interpreting the results in both normal and disease conditions	K2, K4
CO5	develop the hands-on training experience to use colorimeter and spectrophotometer to analyse the activity of enzymes in biological samples	K4, K6
CO6	assess the role of enzymes in clinical diagnosis of diseases	K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Core –24; Practical 8: Clinical Enzymology														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	3	3	3	2	3	3	3	3	3	3	2	3	3
2	3	3	3	3	3	3	2	3	3	3	3	3	3	2
3	3	3	3	3	3	3	2	3	3	3	3	3	3	2
4	3	3	3	3	2	3	3	3	3	3	3	2	3	3
5	3	3	3	3	3	3	2	3	3	3	3	3	3	2
6	3	3	3	3	3	3	2	3	3	3	3	3	3	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

(Select any one from the four courses below)

L	T	P	C
0	0	3	3

Open Online Course in Biochemistry

Elective course – Evaluation – IV Semester

a) External: Internal Assessment = 75:25 marks

b) The external evaluation will be done at the end of the 4th semester.

c) Evaluation of Study tour report and verification of Open online course certificate will be done by both the External examiner and the Internal Guide.

Electives (Any one)	External (75 Marks)	Internal (25 Marks)
a) Open online course (fromUGC approved MOOC platform)	Subject relevance - 25 marks Skill development – 25 marks Oral presentation - 25 marks	Attendance – 10 marks Participation and Interaction in discussions – 15 marks
Total	**100**	

Study Tour

L	T	P	C
3	0	0	3

Elective course – Evaluation – IV Semester

a) External: Internal Assessment = 75:25 marks

b) The external evaluation will be done at the end of the 4th semester.

c) Evaluation of Study tour report and verification of Open online course certificate will be done by both the External examiner and the Internal Guide

Electives (Any one)	External (75 Marks)	Internal (25 Marks)
b) Study tour	Study Tour Visit - 50 marks Study Tour Report- 25marks	Attendance – 10 marks Involvement, Interaction and Exposure – 15 marks

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-IV/Ppr.25/Elective - 1(c)

MUSCLE BIOCHEMISTRY AND BIOMEMBRANES

L	T	P	C
3	0	0	3

Objective

To gain in-depth knowledge on the biochemical basis of muscle action and bio membranes

Total Hours: 45

Unit 1 9Hrs

Skeletal muscle structure

Biochemical characterization of the extracellular matrix, plasmalemma, transverse tubular system, Sarcoplasmic reticulum and myofibrils.
Actin, myosin, tropomyosin, troponin, Z disc and H line components. The sliding filament mechanism and subcellular ion movements during the contraction cycle in skeletal muscle, length tensions relationship.

Unit 2 9Hrs

Muscle Metabolism

Metabolic and functional classification of skeletal muscle fibers (types 1, 2A, 2B). Twitch speeds and myosin ATPase activities. Enzyme, histochemical and immunofluorescence characterization of muscle fibers. The motor unit and differentiation.
Skeletal muscles diseases - Specialized metabolism in cardiac and smooth muscle. All or none versus graded responses.

Unit 3 9 Hrs

Signal transduction

Cyclic AMP and hormonal sensitivity. Role of calmodulin, phospholamban, cardiac troponin I, slow Ca^{++} channel phosphorylation. Depolarization induced and calcium induced release from S.R.I, calcium export from muscle cells. Role of sodium, effects of ouabain, stimulation frequency and verapamil.

Unit 4 9 Hrs

Membrane potential and action potential

Basic physics of membrane potential- membrane potential caused by diffusion, measuring the membrane potential, Resting membrane potential of nerves, Nerve action potential.

Unit 5 9Hrs

Molecular membrane transport

Mobile carrier and pores mechanisms, Membrane biogenesis and regulation of cell membrane components; cell-cell interaction. Artificial membranes - transport studies.

References

1. Geoffrey L. Zubay, Biochemistry 4th edition, William C K. Brown Publication, 1998.
2. Robert K Murray et. al., Harper's Illustrated Biochemistry, 31st edition-McGraw Hill, 2018.
3. Nelson and Cox. Lehninger's Principles of Biochemistry. Freeman, 7th ed. 2017.
4. Tymoczko, John L., Jeremy M. Berg, and Lubert Stryer. Biochemistry, 8th ed. Freeman 2015.
5. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. Fundamentals of biochemistry. New York: John Wiley & Sons,5th Edition, 2016.
6. Lippincott Williams and Wilkins; Illustrated Reviews: Biochemistry, Seventh, North American edition, 2016.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Elective– 1(c): Muscle Biochemistry and Biomembranes	Cognitive Level
CO1	name the different types of muscles and rephrase the characterization of muscle components, muscle proteins and its functions in muscle contraction and relaxation	K1, K2
CO2	assess the types of muscle fibers, its characterization and rephrase muscle metabolism and muscle diseases	K2, K5
CO3	explain the process of signal transduction and summarize the functions of it in human system	K2, K4
CO4	evaluate the basic physics of membrane potential and distinguishes the types	K4, K5
CO5	assess the mechanism of membrane transport and apply the principles for drug, enzyme and hormone studies	K5

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Elective – 1(c): Muscle Biochemistry and Biomembranes														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	2	2	2	3	2	2	3	2	2	2	3	2	2
2	3	3	3	3	3	3	1	3	3	3	3	3	2	1
3	3	3	2	3	3	3	3	3	3	2	3	3	3	3
4	3	2	2	2	3	2	1	3	2	2	2	3	2	1
5	3	3	3	3	3	3	2	3	3	3	3	3	3	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)

MSU/2021-22/PG - Colleges/M.Sc. (Biochemistry)/Semester-IV/Ppr.25/Elective - 1(d)

MICROBIAL BIOCHEMISTRY

L	T	P	C
3	0	0	3

Objective

To understand the microbial classification, morphology, growth &metabolism and methods in microbiology

Total Hours: 45

Unit 1 9Hrs

Ultrastructure and classification of microbes

Ultrastructure of bacteria, fungi, algae and protozoa. Classification of microbes, molecular taxonomy. Purple and green bacteria, cyanobacteria, homoacetogenic bacteria, Acetic acid bacteria, Budding and appendaged bacteria, spirilla, spirochaetes, Gliding and sheathed bacteria, Pseudomonas, Lactic acid and propionic acid bacteria. Endospore forming rods and cocci, Mycobacteria, Rickettsia and Mycoplasma. Archaebacteria.

Unit 2 9Hrs

Microbial growth

Microbial growth-definition. Mathematical expression of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, factors affecting growth.

Unit 3 9 Hrs

Microbial Metabolism

Microbial metabolism - overview. Photosynthesis in microbes. Role of chlorophylls, carotenoids and phycobilins, Calvin cycle. Chemolithotrophy; Hydrogen –iron-nitrite oxidizing bacteria; nitrate and sulfate reduction; methanogenesis and acetogenesis, fermentations-diversity, syntrophy-role of anoxic decompositions. Nitrogen metabolism, nitrogen fixation, hydrocarbon transformation.

Unit 4 9 Hrs

Viruses

Bacterial, plant, animal and tumor viruses. Classification and structure of viruses. Lytic cycle and lysogeny. DNA viruses; positive and negative strand, Double stranded RNA viruses. Replication; example of Herpes, pox, adenoviruses, Retroviruses. Viroids and prions.

Unit 5 9 Hrs

Methods in microbiology

Current methods in microbial identification. Pure culture techniques. Theory and practice of sterilization. Principles of microbial nutrition, construction of culture media, Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microbes.

References

1. Atlas, Principles of Microbiology, McGraw Hill Education; 2nd edition, 2014.
2. Daniel Caldwell R., Microbial Physiology and Metabolism, Star Pub Co; 2nd edition, 1999.
3. Prescott's Microbiology, Joanne Willey, McGraw-Hill Education; 10th edition, 2016.
4. Michael Pelczar, Microbiology, McGraw Hill Education; 5th edition, 2001.
5. R Ananthaarayan and CK Jayaram Paniker ,Text book of Microbiology, Universities Press (India) Pvt. Ltd.; Eleventh edition, 2020.
6. John. L. Ingraham, Catherine A. Ingraham. Introduction to Microbiology –A case history approach. Houghton Mifflin; 3rd Revised edition, 2003.

Course Outcomes

On completion of the course, the students will be able to

CO. No.	Elective - 1(d): Microbial Biochemistry	Cognitive Level
CO1	outline the ultrastructure and classification of microbes	K2
CO2	explain microbial growth and list out the factors affecting growth	K1, K2
CO3	illustrate microbial metabolism and analyse photosynthesis in microbes	K2, K4
CO4	summarize the bacterial, plant and tumour viruses and its replication	K2
CO5	apply current methods in microbial identification and sterilization	K3

Remember (K1); Understand (K2); Apply (K3); Analyse (K4); Evaluate (K5); Create (K6)

Mapping

Elective - 1(d): Microbial Biochemistry														
CO	**PO**							**PSO**						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	3	2	3	2	2	2	2	3	2	3	2	2	2	2
2	3	3	2	2	3	2	1	3	3	2	2	3	2	1
3	3	3	2	1	2	1	2	3	3	2	1	2	1	2
4	3	2	3	2	2	2	2	3	2	3	2	2	2	2
5	3	3	3	1	3	2	1	3	3	3	1	3	2	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1); No Correlation (0)