PERIYAR UNIVERSITY

SALEM– 636 011

DEGREE OF MASTER OF SCIENCE IN BIOCHEMISTRY

CHOICE BASED CREDIT SYSTEM

OBE REGULATIONS AND SYLLABUS

(SEMESTER PATTERN)

(For Candidates admitted in the Colleges affiliated to Periyar University

from 2023-2024 onwards)

REGULATIONS

"Biochemistry reveals what living things are made of and how they work, beginning at the level of atoms and working up through the genes and proteins to the cells, tissues and organs of multi cellular life"

Programme:	**M.Sc., BIOCHEMISTRY**
Programme Code:	**LIFC**
Duration:	**2 years**
Programme Outcomes:	**PO1.**To make students understand the importance of biochemistry a subject that deals with life processes, as well as the concepts, ories and experimental approaches followed in biochemistry, in order ursue a research career, either in an industry or academic setting. **PO2.**To develop analytical and problem-solving skills **PO3**.To create an awareness among the students on the rconnection between the interdisciplinary areas of biochemistry. **PO4**.To give the necessary practical skills required for biochemical niques and analysis. **PO5**.To develop ~~a~~ communication and writing skills in students. **PO6**.To develop leadership and teamwork skills **PO7**.To emphasiz**e** the importance of good academic and work cs and their social implications. **PO8**.To emphasize the importance of continuous learning and to mote lifelong learning and career development. **PO9**.To teach students how to retrieve information from a variety of rces, including libraries, databases and the internet. **PO10.** To teach students to identify, design and execute a research blem, analyze and interpret data and learn time and resource nagement.

Programme ecific Outcomes:	On successful completion of this course, students should be able
	PSO1. Understand the principles and methods of various nniques in Biochemistry, Immunology, Microbiology, Enzyme etics and Molecular Cell Biology. Based on their understanding, the dents may would be able to design and execute experiments during r final semester project, and further research programs **PSO2.** Insight on the structure-function relationship of molecules, their synthesis and breakdown, the regulation of these nways, and their importance in terms of clinical correlation. Students l also acquire knowledge of the principles of nutritional biochemistry also understand diseases and their prevention. **PSO3**. To understand the concepts of cellular signal transduction nways and the association of aberrant signal processes with various eases. Acquire insight into the immune system and its responses, and this knowledge in the processes of immunization, vaccine elopment, transplantation and organ rejection. **PSO4.** To visualize and appreciate the central dogma of molecular logy, regulation of gene expression, molecular techniques used in NA technology, gene knock-out and knock-in techniques. **PSO5.** To create awareness in students about the importance of d laboratory practices and the importance of ethical and social onsibilities of a researcher. Teach them how to review literature and art of designing and executing experiments independently and also k as a part of a team.

CONDITIONS FOR ADMISSION

A candidate who has passed B.Sc., degree in Biochemistry, Chemistry, Microbiology, Biotechnology, Botany, Zoology, Nutrition, Nutrition and Dietetics, Genetics or an Equivalent B, Sc. Examination in Bachelor in Medical/Clinical Laboratory Technology Course or some other B.Sc., board equivalence submitted by the respective University may be accepted by the syndicate as equivalent there to with Biochemistry shall be eligible for admission into M.Sc., course in Biochemistry.

1. DURATION OF THE COURSE:

The course for the degree of Master of Science shall consist of two academic years divided into four semesters.

2. COURSE OF STUDY:

The course of study for the M.Sc. Degree in the Branch Biochemistry shall comprise the following subjects according to the syllabus,

a. Core: Biochemistry

b. Elective courses (Discipline– Centric/Generic– Centric)

c. Soft Skill courses

d. NME

e. Human Rights

f. Summer Internship Training/Online courses (SWAYAM/NPTEL)

g. Industrial visit

h. Major Project

Non-Major Course (NME) subjects may be chosen by the respective colleges in the Second and third semester and the same must be communicated to the University.

3. EXAMINATIOS

There shall be four examinations-two in the first year, two in the second year. Candidates failing in any subject / subjects will be permitted to appear for such failed subject/subjects at subsequent examinations. The Syllabus has been divided into four semesters. Examinations for I and III semesters will be held in November/December and or II and IV semesters will be held in April/May.

The practical examination I & II will be held in semester-II. Practical III will be held at the semester-III and individual Research Project should be performed and dissertation should be submitted and their report shall be evaluated in Viva –Voce

examination conducted before the examiners at the end of IV-semester.

4. PASSING MINIMUM

A candidate shall be declared to have passed the examination if he /she secure not less than 50% of the marks in each paper / practical. Candidates who do not secure the required minimum marks for a pass in a paper / practical shall be required to appear for and pass the same at a subsequent appearance. For practical, the minimum for a pass includes the record notebook marks also. There is no passing minimum for the record notebook. However, submission of a record notebook is a must.

5. GRADING SYSTEM

Evaluation of performance of students is based on ten-point scale grading system as given below

Ten Point scale			
Grade of Marks	**Grade Points**	**Letter Grade**	**Description**
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
00-49	0.0	U	Re-appear
ABSENT	0.0	AAA	Absent

6. RANKING

Candidates who pass all the examinations prescribed forth course in the first instance and within a period of two academic years from the year of admission to the course only are eligible for University Ranking.

7. MAXIMUM DURATION FOR THE COMPLETION OF THE PG PROGRAMME

The maximum duration for completion of the PG Programme shall not exceed EIGHT semesters.

8. COMMENCEMENT OF THIS REGULATION

These regulations shall take effect from the academic year 2023-2024, i.e. for students who are to be admitted to the first year of the course during the academic year2023-2024 and thereafter.

9. TRANSITORY PROVISION

Candidates who were admitted to the PG course of study before 2021-2022 shall be permitted to appear for the examinations under those regulations for a period of three years i.e., up to and inclusive of the Examination of April/May 2025. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

10. PAPERS GIVEN BY THE BOARD AS NON - MAJOR COURSE

Semester II– Clinical Nutrition

Semester III- Human Physiology and Nutrition

11. SWAYAM/MOOC COURSES

The students are recommended to carryout Add -on courses from SWAYAM/MOOC platform to get extra credits.

12. PATTERN OF QUESTION PAPER (FOR CORE, ELECTIVE AND NME)

Maximum–75marks **Duration–3hours**

Section–A (1x15=15marks)

Answer all the questions

(Multiple Choice Questions-Three questions from each unit)

Section –B (2x5 = 10 Marks)

Answer any two questions (One question from each unit)

Section–C (5x10=50marks)

Answer all the questions (Either or Choice-Two questions from each unit)

13. PATTERN OF QUESTION PAPER (FOR PRACTICAL)

Internal – 40 marks (includes Attendance, Observation and Performance in the laboratory)

External – 60 marks

Biochemistry Programme structure, course work, contact hours, credits and maximum internal and external marks for the students admitted in 2023- 24 onwards

Semester	Course code	Title of the Course	Core/ Elective/ Soft Skill	Credits	Contact Hr/ week	Int Mark	Ext Mark	Total Mark
I	23PBCCT01	Basics of Biochemistry	Core	4	6	25	75	100
	23PBCCT02	Biochemical and Molecular Biology Techniques	Core	4	6	25	75	100
	23PBCCT03	Physiology and Cell Biology	Core	4	6	25	75	100
	23PBCCP01	Practical-I Lab course on Biomolecules and Biochemical Techniques	Core	4	6	40	60	100
	23PBCME01 23PBCME02	Microbiology and Immunology / Immunology and Immunotechnology (Note: Choose any one paper)	Elective - I	3	3	25	75	100
	23PBCSO01 23PBCSO02	Soft Skill – Tissue culture techniques / Soft Skill - Scientific writing skills and Presentation (Note: Choose any one paper)	Elective - II	3	3	25	75	100
				22	**30**			**600**
II	23PBCCT04	Enzymology	Core	4	5	25	75	100
	23PBCCT05	Cellular Metabolism	Core	4	5	25	75	100
	23PBCCT06	Clinical Biochemistry	Core	4	5	25	75	100
	23PBCCP02	Practical-II Lab course on Enzymology, Microbiology and Cell Biology	Core	4	5	40	60	100
			Elective -	3	3	25	75	100

	23PBCME03 23PBCME04	Energy and drug metabolism/ Biomedical Instrumentation (Note: Choose any one paper)	III					
	23PBCME05 23PBCME06	Nutritional Biochemistry/ Biochemistry in Human Health (Note: Choose any one paper)	Elective - IV	3	3	25	75	100
		NME - I		2	2	25	75	100
		***Internship** [Clinical Laboratory]						
		Human Rights		1	2	25	75	100
				25	**30**			**800**
III	23PBCCT07	Industrial Microbiology	Core	4	5	25	75	100
	23PBCCT08	Molecular Biology	Core	4	5	25	75	100
	23PBCCT09	Gene Editing, Cell and Gene therapy	Core	4	6	25	75	100
	23PBCCP03	Practical III Lab course on Clinical Biochemistry	Core	4	6	40	60	100
	23PBCME07 23PBCME08	Biostatistics and Data Science/ Research Methodology (Note: Choose any one paper)	Elective - V	3	3	25	75	100
	23PBCME09 23PBCME10	Molecular basis of diseases and therapeutic strategies/ Clinical Laboratory Techniques (Note: Choose any one paper)	Elective-VI	3	3	25	75	100
		NME - II		2	2	25	75	100
	23PBCIT1	***Internship**		2				
				26	**30**			**700**
IV	23PBCCT10	Pharmaceutical Biochemistry	Core	4	6	25	75	100
	23PBCCT11	Biochemical Toxicology	Core	4	6	25	75	100

	23PBCCP04	Project and viva	Core	4	12	40	60	100
	23PBCME11 23PBCME12	Bio safety, lab safety and IPR / Cancer Biology (Note: Choose any one paper)	Elective-VII	3	3	25	75	100
	23PBCME13 23PBCME14	Developmental Biology/ Plant Biochemistry (Note: Choose any one paper)	Elective-VII	3	3	25	75	100
	23PBCEX1	Industrial Visit – Pharma or Food Processing	Extension Activity	1				
				19	**30**			**500**
				92	**120**			**2600**

*** Internship will be carried out during the summer vacation of the first year and credits should be sent to the University by the College and the same will be included in the Third Semester Marks Statement.**

Component wise Credit Distribution

Credits	**Sem I**	**Sem II**	**Sem III**	**Sem IV**	**Total**
Part A Core	**16**	**16**	**16**	**12**	**60**
Part B Elective **(i)Discipline– Centric/Generic Skill**	**6**	**6**	**6**	**6**	**24**
(ii)Summer Internship /Industrial Training			**2**		**2**
iii) NME		**2**	**2**		**4**
Part C Human Rights		1			**2**
Extension Activity				**1**	**1**
Total	**22**	**25**	**26**	**19**	**92**

Course	**CORE THEORY- I**
Title of the rse:	**BASICS OF BIOCHEMISTRY**
Credits:	**4**
Pre-requisites, if any:	Basic Knowledge of Biochemistry and Biomolecules
Course Objectives	The main objectives of this course are to: 1. Students will be introduced to the structure of biomolecules. 2. The significance of carbohydrate sin biological processes will be understood. 3. The structure, properties and biological significance of lipids in the biological system will be studied 4. Students will learn about the concepts of protein structure and their significance in biological processes and creatively comprehend the role of membrane components with their biological significance. 5. Students will gain knowledge about the structures and functional roles of nucleic acids in the biological system
Course Outcomes	On successful completion of the course ,the students should be able to: **CO1:**Explain the chemical structure and functions of carbohydrates.(K1,K2) **CO2:**Using the knowledge of lipid structure and function, explain how it plays a role in Signaling pathways (K3,K4) **CO3:** Describe the various levels of structural organization of proteins and the role of proteins in biological system (K4,K5) **CO4:**Apply the knowledge of proteins in cell-cell interactions.(K3,K4) **CO5.**Applying the knowledge of nucleic acid sequencing in research and diagnosis (K2,K3,K4)
Units	
I	Carbohydrates- Classification, structure (configurations and conformations, anomeric forms), function and properties of monosaccharides, mutarotation, Disaccharides and oligosaccharides with suitable examples. Polysaccharides – Homopolysaccharides (starch, glycogen, cellulose, inulin, dextrin, agar, pectin, dextran). Heteropolysaccharides – Glycosaminoglycans– source, structure, functions of hyaluronic acid, chondroitin sulphates, heparin, Keratan sulphate, Glycoproteins – proteoglycans. O- Linked and N-linked glycoproteins. Biological significance of glycan. Bacterial cell wall (peptidoglycans, teichoic acid) and plant cell wall carbohydrates.
II	Lipids – Classification of lipids, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, sphingolipids and steroids – Biological importance. Eicosanoids- classification, structure and functions of prostaglandins, thromboxanes, leukotrienes. Lipoproteins – Classification, structure, transport (endogenous and exogenous Pathway) and their biological significance.

III	Overview of Amino acids – classification, structure and properties of amino acids, biological role. Non Protein aminoacids and their biological significance .Proteins – classification based on composition, structure and functions. Primary, secondary, super secondary (motifs) (Helix-turn –helix, helix-loop-helix, Beta-alpha-beta motif, Rosemann Rossmann fold, Greek key), tertiary and quaternary structure of proteins. Structural characteristics of collagen and hemoglobin. Determination of amino acid sequence, Forces involved in stabilization of protein structure. Ramachandran plot.
IV	Membrane Proteins – Types and their significance. Cytoskeleton proteins – actin, tubulin , intermediate filaments . Biological role of cytoskeletal proteins. Membrane structure-fluid mosaic model
V	Nucleic acids – types and forms (A, B, C and Z) of DNA. Watson-Crick model-Primary, secondary and tertiary structures of DNA. Triple helix and quadruplex DNA. Mitochondrial and chloroplast DNA. DNA supercoiling (calculation of Writhe, linking and twist number). Determination of nucleic acid sequences by Maxam Gilbert and Sanger's methods. Forces stabilizing nucleic acid structure. Properties of DNA and RNA. C-value, C-value paradox, Cot curve. Structure and role of nucleotides in cellular communications. Major and minor classes of RNA, their structure and biological functions.
Reading List (Print and Online)	https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Online_(Jakubowski) https://www.thermofisher.com/in/en/home/life-science/protein- biology/protein-biology-learning-center/protein-biology-resource- library/pierce-protein-methods/protein-glycosylation.html https://ocw.mit.edu/courses/biology/7-88j-protein-folding-and- human-disease-spring-2015/study-materials/ https://www.open.edu/openlearn/science-maths-technology/science/biology/nucleic-acids-and-chromatin/content-section- 3.4.2 https://www.genome.gov/genetics-glossary/Cell-Membrane https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod3.pdf
Self-Study	Classification of Sugars Nutritional classification of fatty acids
Recommended Texts	David L. Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed) W.H.Freeman. Voet.D &Voet.J.G(2010)Biochemistry,(4thed),JohnWiley&Sons,Inc. Metzler D.E(2003).The chemical reactions oflivingcells(2nded),Academic Press. Zubay G.L(1999)Biochemistry,(4thed),McGrew-Hill. LubertStryer(2010)Biochemistry,(7thed),W.H.Freeman Satyanarayan,U(2014)Biochemistry(4thed), ArunabhaSenBooks &Allied(P)Ltd,Kolkata.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total
10	10	5	75	100

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/ False, Short essays, Concept explanations, short summary or over view.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or offbeat situations, Discussion.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	**S**	**L**	**M**	**S**	**M**	**M**	**M**	**S**	**M**	**M**
CO2	**S**	**M**	**L**	**S**	**M**	**M**	**M**	**S**	**M**	**M**
CO3	**S**	**M**	**M**	**S**	**S**	**M**	**L**	**S**	**M**	**M**
CO4	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**S**	**M**	**M**
CO5	**S**	**S**	**M**	**S**	**S**	**M**	**M**	**S**	**M**	**M**

S- Strong M-Medium L-Low

Course	**CORE THEORY - II**
Title of the Course:	**BIOCHEMICAL AND MOLECULAR BIOLOGY TECHNIQUES**
Credits:	**4**
Pre-requisites, if any:	Comprehensive Knowledge of Tools of Biochemistry/Molecular Biology
Course Objectives	Biochemical techniques combine various inter-disciplinary methods in logical research and the course aims to provide students with the following ectives: 1. To understand the various techniques used in biochemical investigation and microscopy. 2. To explain chromatographic techniques.\ and their applications 3. To explain electrophoretic techniques. 4. To comprehend the spectroscopic techniques and demonstrate their applications in biochemical investigations. 5. To acquire knowledge of radio labeling techniques and centrifugation.
Course Outcomes	After completion of the course, the students should be able to: **CO1.** Attain good knowledge in modern used in biochemical investigation and microscopy and apply the experimental protocols to plan and carry out simple investigations in biological research. (K1, K5) **CO2.**Demonstrate knowledge to implement the theoretical basis of chromatography in upcoming practical course work.(K3, K5) **CO3.** Demonstrate knowledge to implement the theoretical basis of electrophoretic techniques in research work.(K3, K5) **CO4.**Tackle more advanced and specialized spectroscopic techniques that are pertinent to research. (K1, K2 & K5) **CO5.**Tackle more advanced and specialized radioisotope and centrifugation techniques that are pertinent to research work. (K1, K2 & K5)
Units	
I	General approaches to biochemical investigation, cell culture techniques and microscopic techniques. Organ and tissue slice technique, tissue homogenization techniques, cell sorting, and cell counting. Cryopreservation, Biosensors- principle and applications. Principle, working and applications of light microscope, dark field, phase contrast and fluorescent microscope. Electron microscope- Principle, instrumentation of TEM and SEM, Specimen preparation and applications-shadow casting, negative staining and freeze fracturing.
II	Chromatographic Techniques: Basic principles of chromatography- adsorption and partition techniques. Chiral Chromatography and counter current Chromatography. Adsorption Chromatography – Hydroxy apatite chromatography and hydrophobic interaction Chromatography. Affinity chromatography. Gas liquid chromatography- principle, instrumentation, column development, detectors and applications. Low pressure column chromatography – principle, instrumentation, column packing, detection, quantification and column efficiency, High pressure liquid chromatography- principle, instrumentation, delivery pump, sample injection unit, column packing, development, detection and application. Reverse HPLC, capillary electro chromatography and perfusion chromatography.
III	Electrophoretic Techniques: General principles of electrophoresis, supporting medium, factors affecting electrophoresis, Isoelectric focusing-principle, ampholyte, development of pH gradient and application. PAGE-gel casting-horizontal, vertical, slab gels, sample application, detection-staining using CBB, silver, fluorescent stains. SDS PAGE-principle and application in molecular weight determination principle of disc gel electrophoresis, 2D

	PAGE. Electrophoresis of nucleic acids-agarose gel electrophoresis of DNA, pulsed field gel electrophoresis- principle, apparatus, application. Electrophoresis of RNA, curve. Microchip electrophoresis and 2D electrophoresis, Capillary electrophoresis.
IV	Spectroscopic techniques: Basic laws of light absorption- principle, instrumentation and applications of UV-Visible, IR, ESR, NMR, Mass spectroscopy, Turbidimetry and Nephelometry. Luminometry (Luciferase system, chemiluminescence). X - ray diffraction. Atomic absorption spectroscopy - principle and applications - Determination of trace elements
V	Radiolabeling Techniques and Centrifugation: Nature of radioactivity-detection and measurement of radioactivity, methods based upon ionization (GM counter) and excitation (scintillation counter), autoradiography and applications of radioactive isotopes, biological hazards of radiation and safety measures in handling radioactive isotopes. Basic principles of Centrifugation. Preparative ultracentrifugation - Differential centrifugation, Density gradient centrifugation. Analytical ultracentrifugation - Molecular weight determination.
Reading List (Print and Online)	Principles and techniques of biochemistry and molecular biology: https://www.kau.edu.sa/Files/0017514/Subjects/principals%20and%20techiniques%20of%20biochemistry%20and%20molecular%20biology%207th%20ed%
Self-Study	1. Types of rotors 2. Colorimetry – principle and applications
Recommended Texts	1.Keith Wilson , John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th ed) Cambridge University Press 2.David Sheehan (2009), Physical Biochemistry: Principles and Applications (2nd ed), Wiley-Blackwell 3.David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology,W.H.Freeman 4.Rodney F.Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques,(2nd ed),Prentice Hall 5.Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer 6. Segel I.H (1976) Biochemical Calculations (2nd ed),John Wiley and Sons 7. Robyt JF (2015) Biochemical techniques: Theory and Practice (1st ed), CBS Publishers & Distributors

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**L**	**M**	**S**	**S**	**L**	**L**	**S**	**S**	**M**
CO 2	**S**	**M**	**M**	**S**	**M**	**L**	**M**	**S**	**S**	**L**
CO 3	**S**	**M**	**L**	**S**	**M**	**M**	**M**	**S**	**M**	**L**
CO 4	**S**	**S**	**L**	**S**	**S**	**M**	**M**	**S**	**M**	**M**
CO 5	**S**	**S**	**M**	**S**	**M**	**M**	**M**	**S**	**M**	**M**

S-Strong MS-Strong M-Medium L-Low

Course	**CORE THEORY –III**
Title of the Course:	**PHYSIOLOGY AND CELL BIOLOGY**
Credits:	**4**
Pre-requisites, if any:	Anatomy, Cell and Biological Compounds
Course Objectives	To understand the functions and activities of organs, tissues or cells and of physical and chemical phenomena involved in the human body
Course Outcomes	After completion of the course, the students should be able to: **CO1.** Specifically understand the biological and chemical processes within a human cell (K1, K2, K5, K6) **CO2.** Identify and prevent diseases(K2, K3, K4, k5, K6) **CO3.** Understand defects in digestion, nutritional deficiencies and intolerances, and gastrointestinal pathologies(K1, K2, K3,K4, K5, K6) **CO4.** Identify general characteristics in individuals with imbalances of acid-base, fluid and electrolytes.(K1 , K2 , K3, K4, K5, K6) **CO5.** Process the mechanism: the transmission of biochemical information between cell membrane and nucleus. (K1, K2, K5)
Units	
I	Major classes of cell junctions- anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs)- cadherins, integrins. Types of tissues. Epithelium- organization and types. The basement membrane. Cell cycle- mitosis and meiosis, Cell cycle-phases and regulation. Cell death mechanisms- an overview-apoptosis, necrosis.
II	Reproductive system- sexual differentiation and development; sperm transport, sperm capacitation, and Acrosome reaction. Clinical relevance of female reproductive physiology- menstrual cycle, pregnancy and menopause. Fertilization and infertility issues.
III	Digestive system- structure and functions of different components of digestive system, digestion and absorption of carbohydrates, lipids and proteins, role of bile salts in digestion and absorption, mechanism of HCl formation in stomach, role of various enzymes and hormones involved in digestive system. Respiratory system-Gaseous transport and acid-base homeostasis. Mechanism of the movement of O_2 and CO_2 through lungs, arterial and venous circulation. Bohr effect, oxygen and carbon dioxide binding hemoglobin.
IV	Sensory transduction, Nerve impulse transmission- nerve cells, synapses, reflex arc structure, resting membrane potential, Nernst equation, action potential, voltage gated ion-channels, impulse transmission, neurotransmission, neurotransmitter receptors, synaptosomes. Rod and cone cells in the retina, changes in the visual cycle, photochemical reaction and regulation of rhodopsin. Chemistry of muscle contraction – actin and myosin filaments, theories involved in muscle contraction, mechanism of muscle contraction, energy sources for muscle contraction.
V	Hormones – Classification, Biosynthesis, circulation in blood, modification and degradation. Mechanism of hormone action, Hormones of Hypothalamus, pituitary, Pancreatic, thyroid & parathyroid, adrenal and gonadal hormones. Synthesis, secretion, physiological actions and feedback regulation of synthesis.
Reading List (Print l online)	https://www.genome.gov/genetics-glossary/Cell-Cycle https://my.clevelandclinic.org/health/diseases/16083-infertility-causes https://www.webmd.com/heartburn-gerd/reflux-disease https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5760509/

	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3249628/
Self-Study	Variation in cell differentiation and progression LeschNyhansyndrome ,orotic aciduria and GERD
Recommended xts	1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6^{th} ed). John Wiley & Sons. Inc. 2. Bruce Alberts and Dennis Bray (2013),Essential Cell Biology,(4^{th} ed),Garland Science. 3. De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Cell and Molecular Biology.(8^{th} ed). Lippincott Williams and Wilkins, Philadelphia. 4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. (5^{th} ed). Sunderland, Mass. Sinauer Associates, Inc. 5. Wayne M. Baker (2008) the World of the Cell. (7^{th} ed). Pearson Benjamin Cummings Publishing, San Francisco. Cell Biology 6. John E. Hall (2010). Guyton and Hall Textbook of Medical Physiology (12^{th} ed), Saunders 7. Harrison's Endocrinology by J. Larry Jameson Series: Harrison's Specialty, 19^{th} Edition Publisher: McGraw-Hill, Year: 2016.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) –Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations and Discussion

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**M**
CO 2	**S**	**S**	**S**	**S**	**S**	**L**	**S**	**S**	**S**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**M**
CO 4	**S**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**M**
CO 5	**M**	**S**	**L**	**S**	**S**	**L**	**M**	**M**	**L**	**L**

S-Strong M-Medium L-Low

Course	**CORE PRACTICAL I**
Title of the Course:	**LAB COURSE ON BIOMOLECULES AND BIOCHEMICAL TECHNIQUES**
Credits:	**4**
Pre-requisites	Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions
Course Objectives	1. To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the biomolecules under investigation. 2.To inculcate the knowledge of various isolation and purification techniques of macromolecules like DNA, RNA, Glycogen and Starch, 3. To perform colorimetric estimations to quantify important metabolites like lactate and tryptophan and minerals like calcium and iron from various sources. 4. To achieve training in subcellular fractionation and to identify them by markers. 5 To achieve training in various chromatographic techniques. 6. To perform the isolation and identification of the organelles of a cell using differential centrifugation. 7. To perform phytochemical screening and quantification enabling them to give an insight on phytochemicals this will be useful for future research.
Course Outcomes	**On successful completion of this course, students should be able to:** After completion of the course, the students should be able to: **CO1.**The student will be able to acquire knowledge and skill in the techniques used in the isolation, purification and estimation of different biomolecules that are widely employed in research (K1, K2, K4) **CO2.**The students will get acquainted with Principle, Instrumentation and method of Performing UV absorption studies of DNA, Protein and interpreting the alteration occurred during the process of denaturation (K1,K2, K 3, K4).
	CO3. The student will be fine-tune in handling the instruments like colorimeter, spectrophotometer and will be able to estimate the biomolecules and minerals from the given samples (K1,K2,K4,) **CO4.** The student, in addition to acquiring skill in performing various biochemical techniques can also learn to detect presence of phytochemicals and quantify them in the plant sample.(K1,K2,K3,K4 & K6) **CO5.**The students will develop skill in analytical techniques like subcellular fractionation, Paper, Column and Thin layer Chromatography and the group experiments will enable them to build learning skills like team work, Problem solving, Communication ability. (K1, K2,K3,K4 & K6)
Units	
I	Biochemical studies and estimation of macromolecules 1. Isolation and estimation of glycogen from liver. 2. Isolation and estimation of DNA from animal tissue. 3. Isolation and estimation of RNA from yeast. 4. Purification of Polysaccharides –Starch and assessment of its purity

II	UV absorption 1. Denaturation of DNA and absorption studies at 260nm. 2. Denaturation of Protein and absorption studies at 280nm.
III	Colorimetric estimations 1. Estimation of Pyruvate 2. Estimation of tryptophan.
IV	Estimation of minerals 1. Estimation of calcium 2. Estimation of iron
V	Plant Biochemistry 1.Estimation of Alkaloids – Quantitative analysis 2.Estimation of Flavonoids –Quantitative analysis
VI	Group Experiments 1.Fractionation of sub-cellular organelles by differential centrifugation-Mitochondria and nucleus 2. Identification of the separated sub-cellular fractions using marker enzymes (any one) 3. Separation of identification of lipids by thin layer chromatography.. 4.Separation of plant pigments from leaves by columnchromatography 5.Identification of Sugars by Paper Chromatography 6.Identification of Amino acids by Paper Chromatography
Reading List (Print and Online)	1.https://www.researchgate.net/publication/313745155_Practical_Biochemistry_A_Student_Companion 2.https://doi.org/10.1186/s13020-018-0177-x 3.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5368116/ 4.https://www.life.illinois.edu/biochem/455/Lab%20exercises/2Photometry/spectrophotometry.pdf 5.https://ijpsr.com/bft-article/determination-of-total-flavonoid-and-phenol-content-in-mimusops-elengi-linn/?view=fulltext 6.https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf
Self-Study	1. Laboratory Safety Rules, Requirements and Regulations. 2.Preparation of standard solutions and reagent
Books Recommended	1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd 2. Jayaraman, J (2011),laboratory Manual in Biochemistry, New age publishers 3. Varley H (2006) Practical Clinical Biochemistry (6th ed) , CBS Publishers 4. O. Debiyi and F. A. Sofowora, (1978)"Phytochemical screening of medical plants," Iloyidia, vol. 3, pp. 234–246, 5. Prof. Sarin A. Chavhan, Prof. Sushilkumar A. Shinde (2019) A Guide to Chromatography Techniques Edition:1 6. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer(2011)

Method of Evaluation:

Test I	Test II	End Semester Examination	Total	Grade
20	20	40	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	S	S	S	S	M	S	L	S	M	S
CO 2	S	S	S	S	M	S	L	S	M	S
CO 3	S	S	S	S	M	S	M	S	M	S
CO 4	S	S	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	S	S	S	S

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**MICROBIOLOGY AND IMMUNOLOGY**
Credits:	**3**
Pre-requisites, if any:	The student should possess basic knowledge about microorganisms, types andtheirgeneralcharacteristics.Thestudentsarealsoexpectedtopossess basic understanding about the process of infection, immunological defence and pathological outcomes, if any.
Course Objectives	To appreciate the classification of microorganisms based on their structure, size and shape with an insight into the ancient scriptures about microbes. To understand the role of microorganisms in environment and also to learn the culture conditions. To recognize the possible contamination of foods by microorganisms, to learn about counteracting preservative measures and to know about probiotic nature of microorganisms. To gain knowledge on pathogenic mediation by microorganisms and preventive measures as well. To comprehend the features of antimicrobial agents, their mechanism of action along with the side effects and also toexplore natural remedial measures againstmicrobes. To be able to exploit the various features of microorganisms for the beneficial industrial production.
Course Outcomes	After completion of the course, the students should be able to: **CO1.** To classify (by both ancient and modern modes) different types of microorganisms and explain life cycle of the microbes(K1,K2&K5) **CO2.** To recognize the microorganisms involved in decay of foods and will be able to apply various counter acting measures. The students also will be able to relate the role of certain beneficial microbes in day-to- day's food consumption. (K1, K2 &K4) **CO3.** To understand the common pathogenic bacterial and fungi that cause toxic effects and also will be able to employ curative measures. (K1 & K2) **CO4.**To analyse various features of wide variety of anti microbial agents along with their mode of action, in addition, being able to apprehend the valuable potentials of traditional and easily available herbs. (K2,K5& K6) **CO5.**To apply knowledge gained in production of industrially important products as both pharmaceutical and nutraceutical. (K2, K4 &K5)
Units	
I	Taxonomical classification – bacteria, viruses, algae, fungi and protozoa. Distribution and role of microorganisms in soil, water and air. Life cycle of viruses - lytic cycle and lysogenic cycle. Types of culture media, isolation of pure culture, growth curve.

II	Contamination and spoilage of foods – cereals, fruits, vegetables, meat, fish, poultry, eggs, milk. General principles of traditional and modern methods of food preservation – Removal or inactivation of microorganisms, boiling, steaming, curing, pasteurization, cold processing, freeze drying, irradiation, vacuum packing. Microbes involved in preparation of fermented foods – cheese, yoghurt, curd, pickles, rice pan cake, appam, ragi porridge and bread.
III	Food poisoning- bacterial food poisoning, *Salmonella*, *Clostridium blotulinum* (botulism), *Staphylococcus aureus*, fungal food poisoning – aflatoxin. Pathogenic microorganisms, *E. coli, Pseudomonas, Klebsilla, Streptococcus, Haemophilus, & Mycobacterium*, causes, control, prevention, cure and safety. Food microbiological screening-Real time PCR, ELISA, Aerobic and anaerobic Plate Count, dye reduction method, anaerobic lactic acid bacteria, anaerobic spore formers, Hazard analysis critical control point (HACCP)
IV	Antimicrobial chemotherapy, General characteristics of antimicrobial agents. Mechanism of action – sulfonamides, sulphones and PAS. Penicillin, streptomycin- spectra of activity, mode of administration, mode of action, adverse effects and sensitivity test., Antiviral and antiretroviral agents, Antiviral RNA interference, Natural immune modulators routinely used in Indian medical philosophy.
V	Immune system- Types of immunity, Cells of the immune system – neutrophils, eosinophils, basophils, mast cells, monocytes, macrophages, dendritic cells, natural killer cells, and lymphocytes (B cells and T cells). Lymphoid organs- Primary and Secondary organs; structure and functions. Antigens: definition, properties- antigenicity and immunogenicity, antigenic determinants and haptens. Immunoglobulins: Structure, classes, properties and functions of antibodies. Antigen – antibody interactions – molecular mechanism of binding. Affinity, avidity, valency, cross reactivity and multivalent binding. Complement Activation: Classical and Alternative pathway. Transplantation immunology- graft rejection and HLA antigens.
Reading List (Print and Online)	https://www.ijam.co.in/index.php/ijam/article/view/1326 (Krumi (Microorganisms) in Ayurveda- a critical review) Virtual Lectures in Microbiology and Immunology, University of Rochester https://www.frontiersin.org/articles/10.3389/fphar.2020.578970/full#h9 https://www.frontiersin.org/articles/10.3389/fmicb.2018.02151/full https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7559905/
Self-Study	Microbial infections and gut microbiome with relevance to *tridoshas* Microbial population and pH variations in different dairy products.
Recommended Texts	Michael J.Pelczar Jr.(2001) Microbiology (5th ed), McGraw Hill Education (India) Private Limited Frazier WC ,Westhoff DC, Vanitha NM (2010) Food Microbiology (5th ed), McGraw Hill Education (India) Private Limited Willey J and Sherwood L (2011) ,Prescott's Microbiology (8th ed) McGraw Hill Education (India) Ananthanarayanan ,Paniker and Arti Kapil (2013) Textbook of Microbiology (9th ed) OrientBlackSwan Judy Owen , Jenni Punt Kuby (2013) ,Immunology (Kindt, Kuby Immunology) (7th ed) W. H. Freeman & Co Brooks GF and Carroll KC (2013) JawetzMelnick&Adelbergs Medical Microbiology,(26th ed) McGraw HillEducation Greenwood D (2012) ,Medical Microbiology, ElsevierHealth

Method of Evaluation:

	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Observe, Explain.

Analyse (K4)- Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6) – Check knowledge in specific or offbeat situations, Discussion, Debating, Presentation

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**L**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**S**	**M**	**L**	**M**	**S**	**S**
CO 3	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**M**	**L**	**M**
CO 4	**S**	**M**	**M**	**M**	**M**	**M**	**M**	**S**	**S**	**S**
CO 5	**S**	**L**	**S**	**S**	**M**	**L**	**L**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the rse:	**IMMUNOLOGY AND IMMUNOTECHNOLOGY**
Credits:	**3**
Pre-requisites, if	The student should possess basic knowledge about microorganisms, types and their general characteristics. The students are also expected to possess basic understanding about the process of infection, immunological defence and pathological outcomes, if any.
Course ectives	To study the immune responses of human body against antigen, immunological techniques and vaccine synthesis. .
Course comes	After completion of the course, the students should be able to: **CO1.** Understand basics of immune system and about the cells and organs of immunesystem. **CO2**.Describe the Antigen and Antibody structure and properties and obtain theknowledge about the hybridoma technology **CO3**. Familiarize with complement system, autoimmunity and immunodeficiencydisorders **CO4.**Get a clear idea about the immunization and hypersensitivity reactions. **CO5.**To Comprehend the antigen and antibody reactions and immunological techniques.
Units	
I	The Immune System: History of immunology- Cells and Organs of the immune system-primary and secondary lymphoid organs. Differentiation and Generation of T-cells and B-cells from bone marrow. Stem cells – sources, types, properties & applications. Antigens– types, properties that influence antigenicity & immunogenicity, epitopes, crossreactions. Haptens and mitogens. Adjuvants-types and properties. Antibodies–structure, types of immunoglobulins-structure, properties and functions, immunoglobulin superfamily. Complement cascades-components, mechanism of Classical, Alternative and other pathways, biological consequences of complement cascades and their fragments.
II	Types of immunities –Innate and Acquired. Immune response-Humoral and Cellular immune responses-their characteristics & effector mechanisms. Regulation of immune response. Immune response to infections-bacterial, viral, fungal and others. Immunodeficiency diseases-primary and secondary. Immuno genetics-antibody diversity-theories of antibody formation, organization of immunoglobulin gene and their expression, class switching. Major Histocompatibility Complex- organization, structure and functions of MHC and HLA genes and non-MHC molecules. Gene products. Role in antigen processing and presentation.
III	Hypersensitivity and Autoimmunity: Hypersensitivity–classification, causes, mechanism, clinical manifestations, diagnosis and treatment of TypesI–IV hypersensitivities. Autoimmunity- classification, role of MHC, TH cells and TCR in autoimmunity, spectrum of autoimmune diseases, overlap, pathogenesis, diagnosis and treatment of autoimmune diseases.
IV	Transplantation Immunology: Immunology of Allogeneic Transplantation, Types of Graft Rejection, Specific Immunosuppressive Agents, Immunology of Xenogeneic Transplantation, Transplantation- types of grafts, principles involved and mechanism of transplantation of various organs, immunosuppressive therapy, Graft Versus Host Disease. Role of MHC in transplantation, disease susceptibility and resistance and genet control of primary histocompatibility
V	Immunotechniques: Antigen-antibody interactions-Precipitation techniques. Agglutination techniques, ABO blood grouping & Rh typing. Tagged assays-RIA, ELISA, immunofluorescence, immunoblotting, immunoelectron microscopy. Isolation of pure

	antibodies, Assays for complement, FACS, Flow cytometry. Antibody engineering – Hybridoma technology- polyclonal and monoclonal antibody production and their applications. Recombinant antibody production. Vaccine production- types of vaccines, principles of vaccine production, production of conventional and modern vaccines, new vaccine strategies and vaccines under development. Vaccination strategies, immunization schedules.
Reading List (Print and Online)	https://www.ijam.co.in/index.php/ijam/article/view/1326 (Krumi (Microorganisms) in Ayurveda-a critical review) Virtual Lectures in Microbiology and Immunology, University of Rochester https://www.frontiersin.org/articles/10.3389/fphar.2020.578970/full#h9 https://www.frontiersin.org/articles/10.3389/fmicb.2018.02151/full https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7559905/
Recommended Texts	Kuby Immunology.W.H.Freeman & Co.Fourth edition, 2005. Cellular and molecular immunology, by Abul Abbas, Andrew Lichtman, and Jordan Pober. W.B.Saunders. Immunobiology – the immune system in health and disease, by Charles Janeway, Jr. and Paul Travers.Garland Publishing, Inc. Immunology by Ivan Roitt, Jonathan Brostoff,and David Male. Mosby, London.6th edition,2001. Clark WR, The experimental foundations of modern immunology. John Wiley and SonsInc.NewYork.1991. Noel R. Rose, Herman Friedman, John L. Fahey. Manual of Clinical Laboratory Immunology. ASM.3rd ed., 1986.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Observe, Explain.

Analyse (K4)- Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion, Debating, Presentation

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**L**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**S**	**M**	**L**	**M**	**S**	**S**
CO 3	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**M**	**L**	**M**
CO 4	**S**	**M**	**M**	**M**	**M**	**M**	**M**	**S**	**S**	**S**
CO 5	**S**	**L**	**S**	**S**	**M**	**L**	**L**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**SOFT SKILL**
Title of the Course:	**TISSUE CULTURE TECHNIQUES**
Credits:	**3**
Pre-requisites, if any:	The student should have a basic knowledge of Plant and Animal Biology
Course Objectives	Students will gain knowledge about plant and Animal tissue culture, transgenic plants, Nitrogen fixation, significance of viral vectors and the concepts of animal biotechnology. They will acquire the skill to set up tissue culture laboratory.
Course Outcomes	After completion of the course, the students should be able to: **CO1.**To understand the basics of cell culture medium **CO2.** To know the types of cell culture **CO3.**To understand the basics of genetic engineering **CO4.** To be aware of plant tissue techniques **CO5.** To understand the functions of viral vectors

Units	
I	Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of constituents of culture media, Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. Essential equipments required for animal cell culture
II	Types of cell culture- Primary, Secondary, Organ culture and cell lines. Role of feeder layers in cell culture, Cell separation techniques, cell synchronization, Cell counting methods, cryopreservation, Cell banking procedures.
III	Transfection of cells in culture- Animal viral vectors for transfection, Physical methods of transfection, HAT selection, selectable markers. Micro manipulation of cells, Gene targeting, gene silencing and Gene knockout and their applications. Cell culture as a source of valuable products –Transgenic Animals
IV	Media composition (MS media) – Micropropagation techniques – direct and indirect organogenesis – somoclonal variation – somatic embryogenesis – haploid and triploid – Protoplast isolation, fusion and culture – hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.
V	Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Ti and Ri Plasmid vectors and their utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia, nif gene. Transgenic plant.
Recommended Texts	Trivedi, P.C.2000. Applied Biotechnology: Recent Advances. PANIMA Publishing corporation. Ignacimuthu. 1996. Applied Plant Biotechnology. Tata McGraw – Hill. 3. Chawla, H.S., "Introduction to Plant Biotechnology", 3rd Edition, Science Publishers, 2009.. 4. R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications. 5. Glick, B.R. and Pasternark. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA. 6. Ramasamy.P. 2002.Trends in Biotechnology, University of Madras of Publications, Pearl Press

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend(K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application(K3)-Suggest idea/concept with examples,Solveproblems,Observe,Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate(K5)-Longer essay/ Evaluation, essay, Critique or justify with pros and cons

Create(K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**L**	**M**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 4	**S**	**M**	**M**	**L**	**S**	**L**	**S**	**S**	**S**	**M**
CO 5	**S**	**S**	**S**	**L**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**SOFT SKILL**
Title of the Course:	**SCIENTIFIC WRITING SKILLS AND PRESENTATION**
Credits:	**3**
Pre-requisites, if any:	Basic Knowledge on journals and articles
Course Objectives	1. Students will learn how to overcome writing barriers and develop a writing schedule. 2. Students will learn how to better organize the results of their experiments into effective tables and figures. 3. Students will improve their writing skills so that manuscript preparation becomes more efficient and productive. 4. Students will learn how to successfully navigate a manuscript through the entire manuscript preparation, revision, review and publishing process. 5. Students will successfully communicate their research findings to the scientific community through publication in peer-reviewed, scientific journals.
Course Outcomes	CO1. Write effective and well-organized research papers that are supported by information from several different, credible sources. CO2. Develop advanced scientific writing skills to write research articles, reviews, thesis, and proposals and to make oral, poster or power point presentations. CO3. Document sources correctly and incorporate information from sources while following the principles of academic honesty. CO4. Evaluate the credibility of research sources, especially the online resources. CO5. Understand the best practices of scientific writing by adhering to research ethics and by avoiding plagiarism
Units	
I	Introduction to scientific writing Elements of a scientific paper: Abstract, introduction, materials & methods, results, discussion, conclusion, and references. Preparing figures and figure legends, citations. Appropriate use of colour and font size.
II	Advanced Scientific Writing The art of writing: Basic principles, Creative writing skills. The organization of content: Structure and flow of ideas. Writing thesis and dissertation, Writing clinical study reports. Processing data & application of statistics Displaying data: Text, table, graph and defining terms and abbreviations.
III	Structures of writing Sentences, Paragraphs, Parts of a paragraph, Writing laboratory records, journal articles, textbooks, research reports, reviews, scientific papers, Types of journals, Journal impact factor. Other forms of professional writing: composing professional emails and letters for various purposes; preparing an effective resume.
IV	Oral communication: Presentation skills: Oral presentation, Poster Preparation and presentation, Preparation of power point slides and presentations. Simplicity of presentation material Animation Effects, Graphic Representation.
V	Plagiarism Referencing software: Mendeley, Endnote. Plagiarism: Definition, Common types of plagiarism, Intentional and Unintentional plagiarism, Detection of plagiarism by anti-plagiarism tools (Turnitin, Duplichecker, Viper, and plagiarism X checker), Penalties for plagiarism, Avoiding plagiarism.
Self-Study	Each student has to choose a scientific article and present it
Reading List (Print and Online)	https://plagiarismdetector.net https://www.duplichecker.com

Recommended Texts	Davis, Martha. 1997. Scientific Papers and Presentations. San Diego: Academic Press RA, Day, 1998. How To Write and Publish a Scientific Paper, 5th Edition, Oryx Press. ISBN-13: 978-1573561655 ISBN-10: 1573561657. A H,Hofman, 2010. Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford University Press, New York, NY. 682 pp. JR, Matthews, RW, Matthews. 2014. Successful Scientific Writing. A step-by-step guide for the Biological and Medical Sciences. Fourth Edition.
Recommended Texts	.Cambridge University Press, Cambridge, UK. ISBN 978-1-107-69193-3. Thomas, C George. 2019. Research Methodology and Scientific Writing 2nd edition.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or off beat situations, Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	S	S	M	S	S	S	M	M	S	S
CO 2	S	M	S	S	M	S	S	M	M	M
CO 3	S	M	L	S	M	M	S	S	M	S
CO 4	M	S	S	S	L	M	S	M	S	M
CO 5	S	S	M	S	S	M	M	S	S	S

S-Strong M-Medium L-Low

Course	**CORE THEORY IV**
Title of the rse:	**ENZYMOLOGY**
Credits:	**4**
Pre-requisites	Basic knowledge about catalysis, kinetics and chemical reaction mechanisms.
Course Objectives	1. Students will be introduced to the theory and practice of enzymology. 2. Mechanisms of catalysis and factors affecting catalysis will be understood 3. The kinetics of enzyme catalyzed reactions in the absence and presence of inhibitors will be studied and the options for applying enzymes and their inhibitors in medicine will be analyzed. 4. Students will learn about the applications of enzymes in research, medicine, and industry, which will prepare them for careers in industrial and biomedical research. 5. The control of metabolic pathways and cellular responses through enzyme regulation will be emphasized.
Course Outcomes	On successful completion of this course, students should be able to: CO1: Describe the catalytic mechanisms employed by enzymes (K1, K2 & K5) CO2: Choose and use the appropriate methods to isolate and purify enzymes and check the purity of the enzyme.(K1,K2 , K3,K4 & K5) CO3: Analyze enzyme kinetic data graphically, calculate kinetic parameters, determine the mechanism of inhibition by a drug/chemical and analyze options for applying enzymes and their inhibitors in medicine (K1, K2, K3 &K4) CO4: Explain allosterism and cooperativity and differentiate Michaelis-Menten kinetics from sigmoidal kinetics. The role played by enzymes in the regulation of vital cellular processes will be appreciated. (K1, K2 , K5, K6) CO5: Highlight the use of enzymes in industries and biomedicine (K1,K2& K3)

Units	
I	Introduction to enzymes and features of catalysis: A short history of the discovery of enzymes and how they became powerful biochemical tools. Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, Classification and Nomenclature, Specificity of enzyme action-group specificity, absolute specificity, substrate specificity, stereochemical specificity. Active site, Identification of amino acids at the active site-trapping of ES complex, identification using chemical modification of amino acid side chains and by site-directed mutagenesis.Mechanisms of enzyme catalysis: acid-base catalysis, covalent catalysis, electrostatic catalysis, metal ion catalysis, proximity and orientation effects, Low barrier H-bonds, Structural flexibility Mechanism of action of chymotrypsin
II	Enzyme techniques: Isolation and purification of enzymes – Importance of enzyme purification, methods of purification- choice of source , extraction, fractionation methods-based on size or mass (centrifugation, gel filtration); based on polarity (ion-exchange chromatography, electrophoresis, isoelectric focusing, hydrophobic interaction chromatography); based on solubility (change in pH, change in ionic strength); based on specific binding sites (affinity chromatography) ,choice of methods, Criteria of purity of enzymes. Enzyme units – Katal, IU. Measurement of enzyme activity – discontinuous, continuous, coupled assays; stopped flow method and its applications. Isoenzymes and their separation by electrophoresis with special

	reference to LDH
III	Enzyme kinetics I: Thermodynamics of enzyme action, Activation energy, transition-state theory, steady-state kinetics & pre-steady-state kinetics.Single substrate enzyme catalyzed reactions –assumptions, Michaelis-Menten and Briggs-Haldane kinetics, derivation of Michaelis-Menten equation . Double reciprocal (Lineweaver-Burk) and single reciprocal (Eadie –Hofstee) linear plots, their advantages and limitations. Analysis of kinetic data- determination of Km, Vmax, kcat, and their physiological significance, Importance of kcat/Km. Enzyme inhibition: Irreversible inhibition. Reversible inhibition-Competitive, uncompetitive, noncompetitive, mixed and substrate inhibition. Michaelis –Menten equation in the presence of competitive, uncompetitive and non-competitive inhibitors. Graphical analysis – Diagnostic plots for the determination of inhibition type. Therapeutic use of enzyme inhibitors-Aspirin, statins (irreversible inhibitors), Methotrexate (competitive inhibitor), Etoposide (non-competitive inhibitor), camptothecin (uncompetitive inhibitor). Demonstration :Using Microsoft Excel to Plot and Analyze Kinetic Data
IV	Enzyme kinetics II: Allosteric enzymes: Cooperativity, MWC and KNF models of allosteric enzymes, Sigmoidal kinetics taking ATCase as an example. Regulation of amount and catalytic activity by – extracellular signal, transcription, stability of mRNA, rate of translation and degradation, compartmentation, pH, temperature, substrate concentration, allosteric effectors, covalent modification. Regulation of glycogen synthase and glycogen phosphorylase. Feedback inhibition-sequential, concerted, cumulative, enzyme-multiplicity with examples. Bi – Substrate reactions: Single Displacement reactions (SDR) (Ordered and Random bi bi mechanisms), Double Displacement reactions (DDR) (Ping pong mechanism), Examples, Cleland's representation of bisubstrate reactions,
V	Enzyme technology: Immobilization of enzymes – methods – Reversible immobilization (Adsorption, Affinity binding), Irreversible immobilization (Covalent coupling, Entrapment and Microencapsulation, Crosslinking, Advantages and Disadvantages of each method, Properties of immobilized enzymes,. Designer enzymes- ribozymes and deoxyribozymes, abzymes, synzymes. Enzymes as therapeutic agents-therapeutic use of asparaginase and streptokinase. Application of enzymes in industry- Industrial application of rennin, lipases, lactases, invertase, pectinases, papain.
Reading List **(Print and Online)**	Enzymes | MIT OpenCourseWare | Free Online Course Materials https://ocw.mit.edu/high-school/biology/exam-prep/chemistry-of-life/enzymes/ Enzymology https://onlinecourses.swayam2.ac.in/cec20_bt20/preview https://mooc.es/course/enzymology/ The active site of enzymes https://dth.ac.in/medical/courses/biochemistry/block-1/1/index.php Enzymes and Enzyme Kinetics https://www.lecturio.com/medical-courses/enzymes-and-enzyme kinetics.course#/ Mechanistic enzymology in drug discovery: a fresh perspective https://www.nature.com/articles/nrd.2017.219 Enzyme Biosensors for Biomedical Applications: Strategies for Safeguarding Analytical Performances in Biological Fluids https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934206/
Self-Study	1.Mechanistic enzymology in drug discovery 2.Enzyme Biosensors for Biomedical Applications

Recommended Texts	1.Enzymes: Biochemistry, Biotechnology and Clinical chemistry, 2nd edition, 2007, Palmer T and Bonner P; Affiliated- East West press private Ltd, New Delhi 2.Fundamentals of Enzymology, 3rd edition, 2003, Price NC and Stevens L; Oxford University Press, New York 3.Voet's Biochemistry, Adapted ed, 2011,Voet,D and Voet JG; Wiley, India 4.Lehninger Principles of Biochemistry, 8th edition, 2021, .Nelson DL and Cox MM; WH Freeman & Co, New York 5. Biochemistry, Berg JM, Stryer L, Gatto,G, 8th ed, 2015;WH Freeman & Co., New York. 6.Enzyme Kinetics and Mechanism; Cook PF, Cleland W, ;2007; Garland Science, London

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**M**	**S**	**L**	**M**	**S**	**L**	**S**	**S**	**M**
CO 2	**S**	**S**	**S**	**S**	**M**	**M**	**L**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**M**	**L**	**M**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE THEORY –V**
Title of the Course:	**CELLULAR METABOLISM**
Credits:	**4**
Pre-requisites	Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds
Course Objectives	1. Familiarize on blood glucose homeostasis 2. Provide an insight into the metabolic path way of glycogen, glycoprotein, mucopolysaccharide and peptidoglycan with clinical correlation wherever required 3. Inculcate knowledge on nucleotide metabolism and disorders associated with it 4. Provide a platform to understand the versatile role of PLP in amino acid degradation, formation of specialized products and disorders associated with ammonia detoxification 5. Educate on heme and sulphur metabolism with associated clinical manifestation
Course Outcomes	On successful completion of this course, students should be able to: After completion of the course, the students should be able to: CO1. Appreciate the modes of synthesis and degradation of glucose and will be able to justify the pros and cons of maintain the blood sugar level (K1, K2, K5) CO2. Gain knowledge on polysaccharide metabolism and glycogen storage disease (K1, K2, K5) CO3. Acquaint with the making and braking of nucleotides (K1,K2,K4) CO4. Differentiate the diverse reaction a particular amino acid can experience (K1,K2,K3) CO5. Correlate the disturbance of metabolic reactions to clinical manifestations with reference to heme and sulphur metabolism (K1, K2, K4, K5)
Units	
I	Glycolysis – aerobic and anaerobic, inhibitors, and regulation. Feeder pathway- entry of hexoses into glycolysis, Galactosemia, fructosuria, Pyruvate dehydrogenase complex-mechanism and regulation. Glyoxalate cycle and its regulation. Gluconeogenesis – source, key enzymes, reaction sequence and its regulation. Blood glucose homeostasis and the role of hormones. Pentose phosphate pathway-significance and its regulation. Metabolism of glycogen and its regulation. Biosynthesis of N-linked and O-linked glycoproteins and mucopolysaccharides.

II	Oxidation of fatty acids-oxidation of saturated and unsaturated fatty acids (α, β & ω oxidation) Oxidation of fatty acids with odd and even numbered carbon atoms. Regulation of β oxidation. Ketogenesis and its regulation. Biosynthesis of fatty acid–saturated and unsaturated, chain elongation, regulation. Biosynthesis of prostaglandins, thromboxanes and leukotrienes and hydroxyl eicosanoic acids. Biosynthesis and degradation of triacylglycerol, phosphoglycero lipids-lecithin, cephalin, plasmalogens and phosphatidyl inositol, Sphingolipid-sphingomyelin, cerebrosides, sulfatides, and gangliosides. Cholesterol biosynthesis and its regulation. Lipoprotein metabolism-chylomicrons, VLDL, HDL and LDL.
III	Metabolism of nucleotides- *De novo* synthesis and salvage pathways of purine and pyrimidine nucleotides. Regulation and inhibitors of nucleotide biosynthesis. Role of ribonucleotide reductase and its regulation. Degradation of purine and pyrimidine nucleotides.
IV	Biosynthesis of non- essential amino acids.- Role and biological significance of glutamate dehydrogenase, glutamine and 35mphibian35s synthetase, lysine, proline and phenylalanine hydroxylase. Interconversion of amino acids – proline to glutamate, methionine to cysteine, serine to glycine. Biosynthesis of spermine and spermidine. Degradation of amino acids –glucogenic and ketogenic amino acids. Formation of acetate from leucine and aromatic amino acid, pyruvate from cysteine, threonine and hydroxy proline, α-keto glutarate from histidine and proline, succinate from methionine, threonine, valine and isoleucine, Oxaloacetate from aspartate, glycine and serine.
V	Biosynthesis and degradation of heme. Oxidation and reduction of inorganic sulphur compounds by microbes and plants. Sulpho transferases and their biological role-rhodanases, sulphatases, 3-mercapto pyruvate sulphur transferases. Oxidation of cysteine to sulphate and inter conversion of sulphur compounds.
Reading List (Print and Online)	1. https://www.embopress.org/doi/full/10.1038/msb.2013.19 2. https://people.wou.edu/~guralnl/450Glycogen%20metabolism.pdf 3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243375/ 4. https://www.researchgate.net/publication/334458898_Urea_Cycle 5.https://www.researchgate.net/publication/51233381_Heme_biosynthesis_and_its_regulation_Towards_understanding_and_improvement_of_heme_biosynthesis_in_filamentous_fungi 6.https://www.researchgate.net/publication/349746691_Microbial_Sulfur_Metabolism_and_Environmental_Implications
Self-study	1. Cori's Cycle and Glucose- Alanine Cycle 2. Coenzymes involved in Methanogenesis
Books Recommended	1.David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed), W.H.Freeman 2.Voet.D and Voet. J.G (2010) Biochemistry , (4th ed), John Wiley & Sons, Inc. 3.Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press. 4. Zubay G.L (1999) Biochemistry , (4th ed), Mc Grew-Hill. 5. Textbook of Biochemistry with Clinical Correlations, 7th Edition,Thomas M. Devlin (Editor), Wiley

	6. Human Biochemistry – James M.Orten&Otto.W.Neuhan- 10th edn-The C.V.Mosby Company

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 2	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**M**
CO 3	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**
CO 4	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 5	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course I	**CORE THEORY– VI**
Title of the Course:	**CLINICAL BIOCHEMISTRY**
Credits:	**4**
Pre-requisites, if any:	The student should have a basic knowledge of body fluids and their composition and metabolism; anatomy and physiology of vital organs.
Course objectives	1. To understand the need and methods of various biological sample collection. 2. To explicitly understand the etiopathogenesis, symptoms and complications of metabolic and hormonal disorders and the relevant diagnostic markers 3. To emphasize the diagnostic significance of serum enzymes in different pathologies and other Laboratory investigations of diagnostic importance so as to differentiate normal from disease 4. To conceive the role of inherited genes in inborn errors of metabolism and methodologies pertaining to *in utero* diagnosis and post-natal screening. 5. To get updated about electrolyte and hormonal imbalances and the biochemical tests to diagnose them.
Course Outcomes	CO1. To appreciate the biological significance of sample collection and awareness of the diagnostic/screening tests to detect common non-communicable diseases so as to understand role of laboratory investigations for biochemical parameters and understand the disorders associated with blood cells CO2. To understand the etiology of metabolic diseases like diabetes and atherosclerosis and avoid such lifestyle disorders by healthy eating and correlate the symptoms with underlying pathology based on diagnostic and prognostic markers. CO3. To understand the diagnostic application of serum/plasma enzymes to correlate their levels with the organ pathologies associated with specific diseases.
	CO4.To appreciate the role of pre and post-natal diagnosisleading to healthy progeny. CO5.To link the serum hormone levels and clinical symptoms with underlying hormonal disturbances. To review the onward transmission of signal via downstream signaling molecules from cell surface to the nucleus by different pathways by comparing and contrasting them and critically evaluate the network between them resulting in the biological outcome.
Units	
I	Biochemical investigations in diagnosis, prognosis, monitoring, screening: Specimen collection – blood, (primary /Secondary specimen)., urine and CSF. Preservation of biological specimens –blood, urine, CSF and amniotic fluid. ; . Biological reference ranges; Disorders of blood cells: Hemolytic, iron deficiency and aplasticanemia and diagnosis, sickle cell anaemia, thalassemia HBA1C variants. Porphyrias, Thrombocytopenia, Causes of leucopenia, leukemia and leucocytosis. Disorders of blood clotting mechanism – Von willebrand's disease, Hemophilia A, B and C, diagnostic test for clotting disorders, D-dimer and its clinical significance

II	Diabetes mellitus: pathology and complications: Acute changes; Chronic complications: Diabetic nephropathy, neuropathy, retinopathy and Diabetic foot ulcers, Random/Fasting/PP glucose testing, Impaired glucose tolerance (IGT), Impaired fasting glucose (IFT), Diagnosis-by GTT, Pre-diabetes, Gestational DM , Glycosylated Haemoglobin (HBA1c) ; Glycated albumin., Hypoglycaemia and critical alert value for glucose. Markers of complications of Diabetes mellitus: Metabolic syndrome, Lipid profile & lipoproteinemia, Atherosclerosis, Diabetic nephropathy, Microalbuminuira, eGFR. Point of care testing for glucose (Glucometers) and continuous glucose monitoring (CGM): principle and its use. Major groups of anti-diabetic drugs. Diet and life style modifications
III	Diagnostic Enzymology: Clinically Important Enzymes and Isoezyme as diagnostic markers: Clinical significance of AST, ALT, ALP, ACP, CK, γ-GT, amylase, pseudocholinesterase and their pattern in Myocardial infarction; Liver disease, Bone disease, Muscle disease, Cancer (tumor markers), GI tract (pancreatitis); Enzymes as therapeutic agents. Pre- and post-natal testing: Amniocentesis, prenatal detection of inborn errors of metabolism in developing fetus- Autosomal recessive mode of inheritance- cystic fibrosis, X linked recessive inheritance-Duchenne muscular dystrophy. New born screening (NBS) for In born errors of metabolism, Tandem mass spectrometry application in NBS.
IV	Liver function tests: Liver function test panel, Fatty liver. Plasma protein changes in liver diseases. Hepatitis A, Band C. Cirrhosis and fibrosis. Portal hypertension and hepatic coma. Acute phase proteins –CRP, Haptoglobins, α-fetoprotein, ferritin and their clinical significance, Interpreting serum protein electrophoresis. Inflammatory markers (cytokines such as TNF-alpha IL6 and others)
V	Renal function tests – tests for glomerular and tubular function-Acute and chronic renal failure-Glomerulonephritis, Nephrotic syndrome, uraemia-urinary calculi-Nephrocalcinosis and Nephrolithiasis-causes, pathology and symptoms. Chronic kidney disease. Dialysis-Hemodialysis and peritoneal dialysis. Electrolyte disorder : calcium: hypercalcemia and hypocalcemia; Calcium homoestasis in Blood;phosphate: hyperphosphatemia or hypophosphatemia; Clinical significance: Potassium: hyperkalaemia and hypokalaemia, Sodium: hypernatremia and hyponatremia; Chloride: hyperchloremia, hyporchloremia Hormonal disorders and diagnostics: T3,T4 and TSH in the diagnosis of thyroid disorders; Diagnostic methods for disorders associated with adrenal, pituitary and sex hormones – Addison's disease, Cushing's syndrome, pituitary tumour, Hypopituitarism, Hypogonadism
Reading List (Print and Online)	1.Utility of HIL in Clinical Chemistry: https://www.aacc.org/science-and-research/clinical-chemistry-trainee-council/trainee-council-in-english/pearls-of-laboratory-medicine/2018/utility-of-hil-in-clinical-chemistry 2. Pre, Post and Analytical Errors in Clinical Chemistry laboratory DOI: 10.7860/NJLM/2016/22587:2173 https://doi.org/10.2147/JMDH.S286679 3. Standards of Medical Care in Diabetes—2022 Abridged for Primary Care Providers https://diabetesjournals.org/clinical/article/40/1/10/139035/Standards-of-Medical-Care-in-Diabetes-2022 https://doi.org/10.2337/diaspect.16.1.32 http://www.ngsp.org/ 4. Quality control in clinical laboratory

	https://www.researchgate.net/publication/335830829_Quality_Control_in_a_Clinical_Laboratory https://labpedia.net/quality-control-of-the-clinical-laboratory/ https://journals.sagepub.com/doi/full/10.1016/j.jala.2008.12.001 https://doi.org/10.1016/B978-0-12-407821-5.00004-8 https://www.westgard.com/clia.htm https://www.labroots.com/webinar/bio-rad-unity-solution-molecular-quality-control-data-management
Self-Study	Potential sources of variability in the estimation of the analytes: Pre-analytical phase: acceptance rejection criteria in terms of haemolysis/icteric/lipemia (HIL) interferences Analytical phase: Linearity, detection limits precision, accuracy, specificity, sensitivity; Total Allowable Error. (Definitions and examples). Post-analytical phase : Units of reporting of clinical chemistry parameters- Interpretation of results in clinical chemistry based on laboratory investigations and quality control: critical / alert values American Diabetes Association (ADA) Standards of Medical Care in Diabetes (yearly update); HBA1C testing :NGSP Case studies to review Quality control for clinical chemistry in laboratory
Recommended Texts	ThomasM.Devlin (2014) Textbook of Biochemistry with Clinical Correlations (7th ed). John Wiley & Sons Montgomery R, Conway TW, Spector AA (1996),Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (2018) (8th ed),Saunders Dinesh Puri, (2020) Text book of Biochemistry: A clinically oriented approach – 4th Edition, Elsevier. 5. M.N.Chatterjee and RanaShinde (2012).Textbook of Medical Biochemistry (8th ed), Jaypee Brothers Medical Publishers. Clinical Case Discussion In Biochemistry A Book On Early Clinical Exposure (ECE), Poonam Agrawal , 2021, CBS Publishers & distributors pvt. Ltd

Method of Evaluation:

Test I	Test II	Assignment	End Semester amination	Total
10	10	5	75	100

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Observe, Explain.

Analyse (K4)- Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion, Debating,

Presentation

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**S**
CO 2	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**	**M**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**M**	**M**
CO 4	**S**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 5	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE PRACTICAL II**
Title of the Course:	**LAB COURSE IN ENZYMOLOGY, MICROBIOLOGY AND CELL BIOLOGY**
Credits:	**4**
Pre-requisites	Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions
Course Objectives	1. To inculcate skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the assay of enzymes under investigation. 2. To inculcate the knowledge of isolation and purification techniques of enzymes using alkaline phosphatase as an example 3. To perform experiments to study the factors affecting enzyme activity 4. To achieve training in assay of enzymes 5. To achieve training in basic microbiological techniques–preparation of culture, sterilization and staining methods. 6. To perform the blood grouping test and to prepare blood smear to study different types of blood cells 7. To learn molecular biology techniques like Gel electrophoresis and Blotting techniques 8. To introduce industrial visit so that students may be aware of actual need of the industry and various opportunities available
Course Outcomes	**On successful completion of this course, students should be able to:** After completion of the course, the students should be able to: **CO1.**Thestudentwillbeabletoemploytherelevanttechniquesforisolationand purification of enzymes and gain skill in kinetic studies which is essential fore search activity (K1,K2,K4) **CO2.**Student will acquire ability in performing enzyme assay, and explicate the methods that form the basis of enzyme characterization. (K1,K2,K4) **CO3.** Learn the Basic concepts in microbiology and cell biology which will be helpful for interdisciplinary research work. (K1,K3,K4) **CO4.** Students will be trained in separation techniques used in molecular Biology which will be supportive in their future research(K1,K3,K4 &K6) **CO5.** Industrial visits will provide the students with an opportunity to learn practically through interaction, working methods and employment practices. Students will have an exposure to Industrial standard and current work practices(K1,K2,K3,K4 &K6)
Units	
I	Enzymology Alkaline Phosphatase a. Isolation of Alkaline Phophatase. b. Purification of alkaline phosphatase c. Checking the purity using SDS-PAGE d. Determination of optimum pH and temperature of alkaline phosphatase. e. Determination of specific activity and Km of alkaline phosphatase. f. Effect of activators and inhibitors on the activity of alkaline phosphatase.

	Assay of enzymes a. Salivary Amylase b. Acid Phosphatase
II	Microbiology a. Safety measures and Good Laboratory Practices in microbiology laboratory b. Sterilization,Culture and media preparation c. Staining of bacteria – Gram Staining
III	Physiology & Cell Biology a. Test for blood grouping (Haemagglutination). b. Peripheral Blood smear –Staining and Interpretation
IV	Group Experiments a. Separation of proteins based on molecular weight by SDS PAGE b. Agarose gel electrophoresis of genomic DNA
V	Industrial visit can be organized to students through Academia –Industry collaborative Program
Reading List (Print and Online)	1.https://www.researchgate.net/publication/337146254_Kinetic_studies_with_alkaline_phosphatase 2.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4846332/ 3.https://www.ijsr.net/archive/v3i8/MDIwMTU0MDk=.pdf 4.https://www.researchgate.net/publication/349318898_ABC_of_ Periheral_smear 5.https://ncdc.gov.in/WriteReadData/l892s/File608.pdf 6.https://www.ncbi.nlm.nih.gov/books/NBK562156/
Self-Study	1. Preparation of Buffers and pH measurement 2. Michaelis-Menten equation and Lineweaver Burk plot
Books Recommended	1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd 2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers 3. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012). 4. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland , Wiley-VCH Publishers (2000). 5. Cappuccino JG & Sherman N (2005). Microbiology-A Laboratory Manual, Pearson Education Inc 6. Practical Enzymology, Second Revised Edtion: Hans Bisswanger, Wiley – Blackwell; 2 edition (2011)

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short

summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6) - Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**M**	**S**
CO 2	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**M**	**S**
CO 3	**S**	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**ENERGY AND DRUG METABOLISM**
Credits:	**3**
Pre-requisites	Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds
Course Objectives	1. Familiarize on concepts of enthalpy, entropy, free energy, redox system, biological oxidation and high energy compounds 2. Provide an insight into the relationship between electron flow and phosphorylation 3. Inculcate knowledge on processes involved in converting light energy to chemical energy and associated food production by autotrophs 4. Provide a platform to understand the versatile role of Krebs cycle, transport of NADH across mitochondrial membrane 5. Educate on the various phases xenobiotic metabolism
Course Outcomes	**On successful completion of this course, students should be able to:** After completion of the course, the students should be able to: **CO1.** Appreciate the relationship between free energy and redox potential and will be able to justify the role of biological oxidation and energy rich compounds in maintaining the energy level of the system (**K1,K2,K3,K4**) **CO2.** Gain knowledge on role of mitochondria in the production of energy currency of the cell **(K1, K2, K5, K6)** **CO3.** Acquaint with the process of photosynthesis **(K1,K2,K5)** **CO4.** Comprehend on the diverse role of TCA cycle and the energy obtained on complete oxidation of glucose and fatty acid **(K1,K2,K4,K5)** **CO5.** Correlate the avenues available to metabolize the xenobiotics (**K1, K2,K4,K5)**
Units	
I	Thermodynamic- principles in biology- Concept of entropy, enthalpy and free energy change. Redox systems. Redox potential and calculation of free energy. Biological oxidation – Oxidases, dehydrogenases, hydroperoxidases, oxygenases. Energy rich compounds – phosphorylated and non-phosphorylated. High energy linkages.
II	Electron transport chain-various complexes of ETC, Q-cycle. Inhibitors of ETC. Oxidative phosphorylation-P/O ratio, chemiosmotic theory. Mechanism of ATP synthesis – role of F0-F1 ATPase, ATP-ADP cycle. Inhibitors of oxidative phosphorylation ionophores, protonophores .Regulation of oxidative phosphorylation
III	Light reaction-Hills reaction, absorption of light, photochemical event. Photo ETC-cyclic and non-cyclic electron flow. Photophosphorylation-role of CF_0-CF_1 ATPase. Dark reaction- Calvin cycle, control of C3 pathway, and Hatch-Slack pathway (C4 pathway), Photorespiration.
IV	Interconversion of major food stuffs. Energy sources of brain, muscle, liver, kidney and adipose tissue. Amphibolic nature of Citric acid cycle. Anaplerotic reaction. Krebs cycle, Inhibitors and regulation of TCA cycle. Transport of extra mitochondrial NADH – Glycerophosphate shuttle, malate aspartate shuttle. Energetics of metabolic pathways – glycolysis, (aerobic and anaerobic) ,citric acid cycle, beta oxidation

V	Activation of sulphate ions – PAPS, APS, SAM and their biological role. Metabolism of xenobiotics – Phase I reactions – hydroxylation, oxidation and reduction. Phase II reactions – glucuronidation, sulphation, glutathione conjugation, acetylation and methylation. Mode of action and factors affecting the activities of xenobiotic enzymes.
Reading List (Print and Online)	https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch21/gibbs.php 2.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7767752/#:~:text=The%20mitochondrial%20electron%20transport%20chain,cellular%20ATP%20through%20oxidative%20phosphorylation. 3. https://www.researchgate.net/figure/Oxidative-phosphorylation-in-mitochondrial-electron-transport-chain-ETC-and-proton_fig1_230798915 4.https://www.lyndhurstschools.net/userfiles/84/Classes/851/photosynthesis%20light%20&%20dark%20reactions%20ppt.pdf?id=560837 5.https://bajan.files.wordpress.com/2010/05/amphibolic-nature-of-krebs-cycle.pdf 6.https://www.sciencedirect.com/topics/medicine-and-dentistry/xenobiotic-metabolism#:~:text=Xenobiotic%20metabolism%20can%20be%20defined,more%20readily%20excreted%20hydrophilic%20metabolites
Self-Study	1. Calculation of Keq and ΔG 2. Interrelationship of carbohydrate, protein, and fat metabolism-role of acetyl CoA
Recommended Texts	1.David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed), W.H.Freeman 2. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012), Harper's Illustrated Biochemistry, (29th ed), McGraw-Hill Medical 3. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press. 4. Zubay G.L (1999) Biochemistry , (4th ed), Mc Grew-Hill. 5. Devlin RM (1983) Plant Physiology (4th ed), PWS publishers 6.Taiz L , Zeiger E (2010), Plant Physiology (5th ed), Sinauer Associates, Inc

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 2	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**L**
CO 5	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**BIOMEDICAL INSTRUMENTATION**
Credits:	**3**
Pre-requisites	Basic knowledge on biochemical techniques
Course Objectives	The Course focus on the instrumentations used in the medical field. By learning this course, the students can able to understand the basic concepts in Biomedical Instrumentation which will be very useful for operating the instruments in future.
Course Outcomes	**On successful completion of this course, students should be able to:** After completion of the course, the students should be able to: **CO1:** Explain the classification of biomedical instruments **CO2:** Analyze the working of Biosensors, electrodes and transducers **CO3**: Relate the principle & working of biopotential recorders **CO4:** Describe the principles and working physiological assist devices **CO5:** Summarize the recent advancements in biomedical instruments
Units	
I	**Biomedical Instrumentation**: Definition, Classification of Biomedical equipments – Diagnostic, therapeutic and clinical Laboratory equipments, sources of biomedical signals, components, design factors and characteristics.
II	**Biosensors** – Principle and mechanism of calorimetric, potentiometric, 47mphib and optical biosensors. Autoanalyser – types and application. **Electrodes**- theory, types-biopotential, microelectrodes, metal plate and needle electrodes. Transducers – types – magnetic induction, piezoelectric, photovoltaic, thermoelectric, strain guage.
III	**Biopotential Recorders**: Resting and action potential, propagation of action potential, wave forms- ECG, EMG, EEG, EOG, EGG & ERG. **Specialized Medical Equipments:** X- ray machine, Angiography.
IV	**Physiological assist devices**- pace makers, artificial heart valves, defibrillators, nerve and muscle stimulator (Galvanic and interrupted Galvanic current), heart-lung machine- mechanical functions, oxygenators- bubble, film. Kidney machine-hemo and peritoneal dialysis.
V	**Advances in biomedical instrumentation**- Lasers, endoscopes-types. Cryogenic surgery. Gamma ray camera, computerized tomography, infrared thermography, ultrasonic imaging, magnetic resonance imaging..
Self-Study	1. principles of Colorimetry, electro chemistry and spectroscopy
Recommended Texts	**1.** *Anandanatarajan*, R. 2013. Biomedical Instrumentation and measurements. PHI Learning Pvt., Ltd. New Delhi. 2. *Arumugam*, M. 2011. Biomedical Instrumentation. Anuradha publications, Chennai. 3. *Khandpur, R. S.* 1995. Hand book of Biomedical instrumentation. Tata Mc.Graw-Hill publishing company Ltd., New Delhi. 4.Biomedicalinstrumentation,LeslieCromwell,FredJ.Weibell,ErichA.Pfeiffer,19

	80.2nd Edn.Prentice-Hall, 5. Medical Instrumentation, JohnG.Webster, 2003, JohnWiley&Sons. 6. Principles of applied Biomedical instrumentation by L.A. Goddes andL.E. Baker, 1989. 3rdEdn. John Wiley India Pvt. Ltd.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 2	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**L**
CO 5	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**NUTRITIONAL BIOCHEMISTRY**
Credits:	**3**
Pre-requisites, if any:	Basic knowledge on food, nutrition & dietetics, and metabolism of nutrients.
Course Objectives	1. To understand basic concepts involved in growth , health, nutrition, physiology and metabolism 2. To discuss the concepts and applications of nutrition in correlation with biochemistry 3.To define nutritional needs in healthy individuals and modification of diet during illness.
Course Outcomes	After completion of the course, the students should be able to: CO1. Plan a balanced diet based on an individual's energy requirement, Assess nutritional status of an individual(K3, K4, K5) CO2. Describe the biochemical, physiological and nutritional functions of macronutrients and their integrated role. Understand the role played by antinutritional factors(k! to K6) CO3. Evaluate the functions of vitamins and minerals ,and fluids and electrolyte balance in different physiological states and in sports persons(K1 to K6) CO4. Identify nutritional deficiency conditions , its prevention and dietary management((K3,K4) CO5. Acquire knowledge about the importance of balanced diet and diet therapy (k5,K6)
Units	
I	Basic concepts - Nutrition - Food groups and balanced diet. Novel Foods. Calorific value of foods: Direct and indirect calorimetry. Empty calories. Basal metabolic rate: Factors affecting BMR. SDA and physical activity. Calculation of day's energy requirement. Assessment of nutritional status. Lactose intolerance. Nutritional requirement and biochemical changes in different physiological states -infancy, childhood, pregnancy, lactation, and ageing. Sports nutrition.
II	Elements of nutrition - Plant and animal sources of simple and complex carbohydrates, fats and proteins and their requirement. Biological significance, deficiency and toxicity of macronutrients and micronutrients. Role of dietary fibre. Protein sparing action of carbohydrates and fats. Essential amino acids. Essential fatty acids. Effects of naturally occurring food toxins, preservatives, additives, alcohol and tobacco on health.
III	Vitamins and Minerals- Dietary sources, classification, biochemical functions, requirements, absorption, metabolism and excretion. Vitamin B complex as coenzyme. Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.
IV	Malnutrition - Diseases arising due to Protein - Calorie Malnutrition and undernutrition (Kwashiorkor and Marasmus), Prevention of malnutrition. Deficiency diseases associated with vitamin B complex, vitamin C and A, D, E & K vitamins - Mineral deficiency diseases - aetiology, sign and symptoms and dietary supplementation. Enrichment and fortification (vitamins and minerals)
V	Nutrition in diseases – Aetiology, signs and symptoms , treatment and dietary management during fever(Typhoid and Malaria) and infectious diseases (COVID-19), Jaundice, hyper acidity (Ulcer), Atherosclerosis, Hypertension, kidney diseases and diabetes in adults. Starvation and Obesity. Inter-

	relationship of nutrition, infection, immunity and poverty
Reading List (Print and Online)	https://www.jmedscindmc.com/article.asp?issn=1011-4564;year=2014;volume=34;issue=5;spage=211;epage=213;aulast=Shrivastava https://www.researchgate.net/figure/Relationship-between-malnutrition-infection-and-immunity-Malnutrition-is-considered-the_fig1_280722727 https://en.wikipedia.org/wiki/Novel_food https://www.chemicalsafetyfacts.org/preservatives/ https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/food-enrichment
Self-Study	Antabuse drugs and food Selection of foods and market visit, reading and understanding the food labels
Recommended Texts	Srilakshmi. E .(2016) Nutrition Science, New Age International Publishers. Mahan, Kathleen L. (2004) Krause's Food, Nutrition and Diet Therapy, W.B.Saunder's 11th Edition Andreas M. Papas (1998). Antioxidant Status, Diet, Nutrition, and Health (1st ed) CRC Press. M. Swaminathan (1995) Principles of Nutrition and Dietetics. Bappco Margaret Mc Williams (2012). Food Fundamentals (10th ed) Prentice Hall Tom Brody (1998) Nutritional Biochemistry (2nd ed). Academic Press, USA

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend (K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 2	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**L**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**BIOCHEMISTRY IN HUMAN HEALTH**
Credits:	**3**
Pre-requisites, if any:	**Basic Knowledge On Nutrition And Pathophysiology Of Diseases**
Course Objectives	1. To provide students with up-to-date understanding of the biochemical basis of a wide range of human diseases and conditions. 2. To become knowledgeable in the mechanisms of disease, etiology, progression and pathogenesis in humans. 3. To understand the role of antioxidants in human health
Course Outcomes	After completion of the course, the students should be able to: CO1. Be aware of energy requirements for humans in maintaining health. CO2. Understanding of energy values and requirements CO3. Understanding basic concept of Communicable Diseases. CO4. Understanding basic concept of non Communicable Diseases CO5. Acquire knowledge about the importance of antioxidants
Units	
I	International Agencies-Introduction to biochemistry programme, Relationship of health and biochemistry, Role of various agencies to improve the nutritional status of the community (WHO, UNICEF, NIN, ICAR, FAO, CSIR). National Health Programs-Planning, Execution and Evaluation of various health programs.
II	Energy – Energy content of food, energy utilization in cells. Basal metabolic rate (BMR) and specific dynamic action (SDA) and factors affecting BMR. Energy balance and Energy requirements of man and woman and factors affecting energy requirements.
III	Community Health and Communicable Diseases Concepts of community Health, National Health Policy .Epidemiology of Communicable Diseases Factors responsible for the spread of communicable diseases, mode of transmission — typhoid fever, tuberculosis, leprosy, filariasis and AIDS.
IV	Non-communicable diseases Etiology and management of diseases like Obesity, Diabetes mellitus, and Cardiovascular disorders. Immune responses to SARS-CoV-2, Vaccines and Immunotherapy. Preventive health checkups (PHC) - important parameters/biomarkers; relevance of PHC in health and disease prevention/early diagnosis.
V	Antioxidants and human health Chemistry of free radicals and reactive oxygen species, Free radicals in health and disease. Antioxidant defence enzymes-Superoxide dismutase, catalases, glutathione peroxidase, Glutatione reductase, glutathione-S-transferases.
Self-Study	Concepts of Nutrition and Dietetics Prevention of Diseases

Recommended Texts	The Assessment of Nutritional Status of Community WHO/FAO. Jelliffe, D. B. Latest Ed. Monograph series No.53, WHO Geneva. Nutrition in the Community 2nd Ed. Maclaren, D. S. 1986. John Willey and Sons, NewYork. Manual on Community Nutrition. Mann, S. K, Sangha, J. K, Mehta, U and Jain, R. 1999. College of Home Science, PAU, Ludhiana. Text Book of Biochemistry for Medical Students. Vasudevan D.M and Sreekumari S. 2007 5th Edition. Jaypee Publishers. Textbook of Medical Biochemistry. Chatterjea M. N and Rana Shinde 2012 8th EditionJaypee Brothers Medical Publishers (P) Ltd New Delhi 110 002, India.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend(K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application(K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 2	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**L**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**

S-Strong M-Medium L-Low

Course	**CORE THEORY VII**
Title of the Course:	**INDUSTRIAL MICROBIOLOGY**
Credits:	**4**
Pre-requisites, if any:	Basic Knowledge of Microbiology and microbial techniques
Course Objectives	1. To gain knowledge of the structure, classification and use of microorganisms in various industries. 2. To know various fermenter designs, culture systems and the application of fermentation process in industry. 3. To understand the production and purification of fermented products and their industrial applications. 4. Understand the basic concepts of food and agricultural microbiology.
Course Outcomes	CO1.Students will be able to understand the structure and classification of microorganisms (K2 , K4) CO2.Gain knowledge of the uses of microorganisms in various industrial applications (K3 , K4) CO3.Understand the concepts of fermentation process, harvest and recovery. (K1 , K5) CO4.Students will know the types of microbial fermentation processes and their applications in pharmaceutical industry. (K2 , K3) CO5.Students will learn about the use of microorganisms in beverages,diary and food industries. (K3 , K6)
Units	
I	Structure of bacteria, fungi and viruses and their classification. Types and characteristics of microorganisms used in Industry (a) Food Industry (b) Chemical Industry (c) Pharmaceutical Industry
II	Fundamentals and principles of microbial fermentation techniques – application in industry and pharmaceutical Biochemistry. Fermentation – types, techniques, design and operation of fermenters including addition of medium. Types and characteristics of microorganisms, environmental conditions required for the growth and metabolism of industrially and pharmaceutically important microbes. Sterilization methods in fermentation techniques, air, gas, culture medium sterilization. Steam-filtration and chemicals. Types and constituents of fermentative culture medium and conditions of fermentations, Antifoaming devices.
III	Recovery and estimation of products of fermentation- Production of ethanol, acetic acid, glycerol, acetone, butanol and citric acid by fermentation. Production of Enzymes- amylase, protease, lipase, Production of pharmaceuticals by fermentation– penicillin, streptomycin, tetracycline, riboflavin, vitamin B12. Beverages-wine, beer and malt beverages.
IV	Food Microbiology: Production of dairy products-bread, cheese and yoghurt (preparation and their types). Food borne diseases- Bacterial and Non-Bacterial. Food preservation – Principles–Physical methods: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, Chemical methods – salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

V	Agricultural Microbiology: General Properties of soil, microorganisms in soil – decomposition of organic matter in soil. Biogeochemical cycles, nitrogen fixation, Production of bio fertilizers and its field applications – Rhizobium, azotobacter, blue green algae, mycorrhizae, azospirilium, Production of biofuels (biogas- methane), soil inoculants.
Self-Study	Micro-organisms in food processing and pharma industries Upstream and Downstream processes in Biopharma
Reading List (Print and Online)	Industrial biotechnology: https://nptel.ac.in/courses/102/105/102105058/ Bioreactors: https://nptel.ac.in/courses/102/106/102106053/ Food Microbiology: https://nptel.ac.in/courses/126/103/126103017/ Agriculture Microbiology: https://www.youtube.com/watch?v=f7UXyVImZ_c
Recommended Texts	Food Microbiology: An Introduction: 4th edition,Matthews KR, Kniel KE, Montville TJ; American Society for Microbiology Food, Fermentation and Micro-Organisms,2nd edition, Charles, BW; Blackwell Science Ltd Microbiology. 5th edition ,Pelczar MJ, Chan ECS and Krieg NR; McGraw Hill BookCompany. Text book of Microbiology:11th edition, Ananthanarayanan R and Paniker CKJ; Universities Press (India) Pvt.Ltd. FoodMicrobiology, 3rd edition, Frazier WC and WesthoffDC;TataMcGrawHill Publishing Company Ltd, NewDelhi New Methods of Food Preservation:1st edition, Gould GW;Springer Manual of Industrial Microbiology and Biotechnology: 3rd edition, Baltz

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	S	S	M	S	S	S	M	M	S	S
CO 2	S	M	S	S	M	S	S	M	M	M
CO 3	S	M	L	S	M	M	S	S	M	S
CO 4	M	S	S	S	L	M	S	M	S	M
CO 5	S	S	M	S	S	M	M	S	S	S

S-Strong M-Medium L-Low

Course	**CORE THEORY –VIII**
Title of the Course:	**MOLECULAR BIOLOGY**
Credits:	**4**
Pre-requisites, if any:	Knowledge of the basics of genetics, cell biology and molecular biology.
Course Objectives	1. To introduce the students to the process of inheritance, concepts of genes, genome, chromatin and chromosomes. 2. To impart a thorough understanding of the key events of molecular biology, including the mechanisms of DNA replication, transcription and translation along with DNA repair mechanisms. 3. To provide a detailed understanding of post transcriptional and posttranslational modifications and processing of eukaryotic RNA and proteins 4. To give a detailed explanation of transcriptional regulation with lac operon and tryptophan operon as examples 5. To impart adequate information of the types of regulatory RNAs along with key concepts of gene silencing
Course Outcomes	After completion of the course, the students should be able to: CO1: Comprehend the organization of genomes, the molecular basis of DNA replication, recombination and transposition, the significance of these processes, the various ways in which the DNA can be damaged leading to mutations and lesions and the different ways in which they are repaired.(K1,K2,K3,K5) CO2: Gain knowledge about how genes are transcribed and translated in prokaryotes and eukaryotes and how these processes are regulated, recognize the nature of the genetic code and the various experimental approaches used to crack the code (K1,K2,K3,K4,K5) CO3: Acquire knowledge of the molecular basis of RNA processing and RNA splicing and the various human pathologies that can result from defects of RNA modification. (K1,K2,K4,K5) CO4: Comprehend the techniques of gene silencing and its applications.(K1,K2,K3,K4,K5,K6) CO5: Apply the knowledge they have gained in understanding the above vital life processes to enhancing their analytical and problem-solving skills and develop an interest to pursue high quality research. (K2,K3,K4,K5,K6)
Units	
I	Mendel's laws of inheritance-dominance-complete, incomplete and co-dominance, multiple alleles-gene mapping in haploids and diploids, recombination mapping- restriction mapping- modes of gene information transfer in bacterial-conjugation, transformation and transduction. The bacterial chromosome, the eukaryotic genome- chromosome structure – Histones, Nucleosome, chromatin-heterochromatin, euchromatin, chromatin remodeling, DNAase hypersensitive sites, genome organization – the C-value paradox, reassociation kinetics, repetitive sequences, gene amplification, telomeres, pseudogenes, split genes, organelle genomes – mitochondrial and chloroplast genome.

II	DNA replication and repair: Enzymes of replication, prokaryotic replication mechanisms, primosome & replisomes, eukaryotic DNA replication, the role of topoisomerases and telomerase, regulation of replication, difference between prokaryotic and eukaryotic replication. Mutations –Types of mutations, mechanisms of mutations, mutagenic agents. DNA repair mechanisms – Direct repair, excision repair, mismatch repair, recombination repair, SOS response, eukaryotic repair systems. Recombination and mobile genetic elements- the Holliday model, the general recombination in *E.coli*, site specific recombination, transposons and retroposons.
III	Transcription – Prokaryotic transcription-subunits of RNA polymerase, E. coli promoters, sigma factor and promoter recognition, alternative sigma factors, initiation, elongation, Rho-dependent and independent termination of transcription. Eukaryotic transcription- Initiation, promoter elements, RNA polymerases, transcription factors, regulatory sequences in eukaryotic protein – coding genes, CpG islands, enhancers. Translation – organization of the ribosome, the genetic code, evidence for a triplet code, deciphering the genetic code, wobble hypothesis, deviation in the genetic code, unusual codons. Activation, initiation, elongation and termination of translation in E. coli. The role of tRNA and rRNA, suppressor tRNAs and inhibitors of protein synthesis, Comparison of prokaryotic translation with eukaryotic translation.
IV	Regulation of gene expression in prokaryotes–Positive and negative control, the lac operon, identification of operator and regulator sequences by mutations, induction and repression, Foot-printing and gel-shift assays for identification of protein-DNA interactions. Catabolite repression. *Trp* operon – Attenuation, alternative secondary structures of *trp* mRNA. Regulation of gene expression in eukaryotes- Response elements, DNA-binding motifs, steroid receptors, association of methylation and histone acetylation with gene expression.
V	Post transcriptional modifications in eukaryotes- RNA processing- mRNA 5' capping and 3'poly-adenylation, introns and exons, RNA splicing,- spliceosome assembly, alternative splicing, processing of tRNA and rRNA, self-splicing, ribozymes,RNA editing- substitution and insertion/deletion editing, Genome editing-CRISPR- Cas technology Post translational modification of proteins- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation, Protein sorting – signal peptides, transport of secretory proteins, Golgi and post-golgi sorting, coated vesicles, targeting of mitochondrial, lysosomal and nuclear proteins, Protein degradation-Ubiquitination of proteins, Protein folding-chaperones
Reading List (Print and Online)	1. Molecular Biology Free Online Course by MIT Part 3: RNA Uploaded by edX 2. https://mooc.es/course/molecular-biology/ 3. https://onlinecourses.swayam2.ac.in/cec20_ma13/preview 4. https://learn.genetics.utah.edu/ 5. https://www.cellbio.com/education.html 6. https://lifescienceinteractive.com/category/molecular-biology/
Self-Study	. 1. Multiple roles of noncoding RNAs (long ncRNA ,siRNA, miRNA) in development and differentiation; implication of ncRNAs in pathologies. 2. mRNA degradation- nonsense-mediated decay.

Recommended Texts	Lewin's Genes XII : 12th edition, Krebs JE, Goldstein ES, Kilpatrick ST ;Prentice Hall, Delhi Molecular Biology of the Gene : 6th edition, Watson JD , Baker TA, Bell S, Gann A, Levine M, Losick R; Cold Spring Harbor Laboratory Press, New York Essential Cell Biology :3rd edition, Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P ; Garland Science, New York Molecular Cell Biology : 8th edition , Lodish H, Arnold Berk; W.H.Freeman & Co, New York Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edition; Wiley, India An Introduction to Genetic Analysis 12th edition,, Griffith A. F, Doebley J, Peichel C, David A, Wassarman DA; Albion Press.W.H.Freeman & Co ,New York

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4)- Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**L**	**M**	**L**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**M**	**M**	**L**	**M**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**L**	**M**	**L**	**M**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**M**	**M**	**L**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE THEORY – IX**
Title of the Course:	**GENE EDITING, CELL AND GENE THERAPY**
Credits:	**4**
Pre-requisites, if any:	To introduce students molecular basis of cell gene therapy; viral and nonviral gene transfer techniques and gene therapy applications in hereditary and acquired diseases.
Course Objectives	1. To train the student in techniques related to the molecular basis of genetic diseases and to incorporate skills essential for various types ofsequencing. 2. To inculcate practical knowledge on comparing the animal models used to model genetic diseases 3. To introduce and also elaborate knowledge about wide varieties of vectors and their features in addition to their applications and to identify the viral and nonviral gene transfer techniques 4. To educate about the characteristics of cell culture, therapeutic strategies in gene therapy with relevant safety/ethics involved and patents aswell.
Course Outcomes	After completion of the course, the students should be able to: CO1. Ability to read, and evaluate scientific articles within the subjects of immune therapy, gene therapy and cell therapy. (K1, & K2) CO2. To clone gene of their interest for several downstream purposes with a robust comprehension about wide variety of applicable gene delivery vectors. (K1, K2 &K5) CO3. Be able to provide examples of diseases that can be treated with immune therapy, gene therapy and cell therapy. (K2, K3 & K4) CO4. To identify knowledge gaps and need for further research within their chosen topic of immune therapy, gene therapy or cell therapy. (K2, K4 & K5) CO5.To critically discuss and reflect on ethical and social aspects of using immune, gene or cell therapy.The student will be persuaded to contemplate on upcoming technologies for futuristic benefits. (K2, K5 & K6)
Units	
I	Gene Editing: Basis of gene editing, DNA repair mechanisms, Double strand DNA breaks, Nonhomologous End-Joining (NHEJ), Homology directed repair, Programmable nucleases for gene editing, Meganucleases, Zinc-Finger nucleases, Transcription Activator-Like Effector Nucleases (TALEN), CRISPR-Cas systems, gene editing using CRISPR-Cas, drawbacks and major challenges to present gene editing techniques, gene editing for human disease therapy
II	Gene and cell therapy: Basics of Gene and cell therapy, types of gene therapy, gene therapy strategies, therapeutic targets for gene therapy, choice of the therapeutic target, administration routes, delivery systems, expression of transgene, persistence of the gene therapy, cell targeting, immunological response to the therapy, ethical and legal issues, concerns about gene and cell therapy
III	Vectors for Gene therapy: Non-viral and viral vectors for gene therapy, Physical methods of gene delivery, Polymer, Lipid and inorganic material based chemical systems for gene delivery, Viral vectors, Lentiviral, Adenoviral, Adeno-associated virus, Herpes Simplex virus, vaccinia, baculoviral vectors for gene delivery, choice of viral vector and oncolytic virus. Gene therapy applications, Gene therapy for cancer, suicide and oncolytic gene therapy.

IV	Stem cells and tissue regeneration: Adult and fetal stem cells, embryonic stem cells, cell reprogramming, induced pluripotent stem cells (iPSC), Chemically induced pluripotent stem cells (CiPSC), reprogramming factors, iPSC derived progenitors cells, Organoids, three dimensional (3D) bioprinting.
V	Regulatory and Ethical Considerations of stem cell and Gene Therapy, pluripotent stem cell-based cell replacement therapies. Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies. Technological challenges towards development of pluripotent stem cell-based cell replacement therapies.
Reading List (Print and Online)	Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler,
Self-Study	Applications of gene editing strategies CART therapy for Cancer
Recommended Texts	An Introduction to Human Molecular Genetics (2nd Edition), J.J. Pasternak, 2005 An Introduction to Molecular Medicine and Gene Therapy 1st Edition by Thomas F. Kresina Upadhyay, S. K. (Ed.). (2021). Human Molecular Genetics (4th Edition), Tom Strachan & Andrew Read, 2010. Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003,

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Observe, Explain.

Analyse (K4)- Finish procedure in stepwise manner, Differentiation between various ideas, Map knowledge

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons.

Create (K6)- Check knowledge in specific or offbeat situations, Discussion, Debating, Presentation

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**L**	**M**	**S**	**M**	**M**	**M**	**M**	**M**	**M**
CO 2	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**M**	**M**	**S**
CO 3	**S**	**M**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**L**	**M**	**M**	**M**	**M**	**S**	**M**	**M**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE PRACTICAL – III**
Title of the Course:	**LAB COURSE ON CLINICAL BIOCHEMISTRY**
Credits:	**4**
Pre-requisites, if any:	Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions
Course Objectives	1. To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the investigation of biological samples, clinical approach, normal values of biochemical constituents and clinical interpretations. 2. To inculcate the knowledge of collection, preservation of blood sample and learning various hematological parameters and their significance. 3. To perform experiments to assess liver functions. And also to study the marker enzymes of liver 4. To evaluate lipid profile and assess their relation to cardiac function. 5. To perform experiments to estimate blood glucose and glycosylated hemoglobin. 6. To perform urine analysis, estimate BUN and clearance test to assess renal function . 7. To learn basic immunotechnniques antigen –antibody reactions. 8. To perform data analysis in using MS Excel 9. To introduce visit to hospital so that students may be aware of Phleobotomy ,Collection and storage of specimen, Good laboratory practices, Automation and current methods adopted in the diagnostic labs
Course Outcomes	After completion of the course, the students should be able to: CO1.The student will be able to acquire knowledge and skill in hematology techniques. They will get familiar with methods and knowledge to interpret the electrolyte concentration in serum (K1,K2,K3,K4,K5) CO2. The student will be able to assess the Liver Function and interpret the biochemical investigation in a given clinical situation (K1,K2,K3,K4,K5) CO3.Skill to perform the Renal function test to assess the function of Kidney and report the abnormal parameters with reference range will be achieved by the student (K1,K2,K3,K4,K5) CO4. To estimate the blood glucose content and lipid profile , to evaluate the alterations and record the observation in accordance to reference range will be acquired by the student (K1,K2,K3,K4,K5,K6) CO5: The Group Experiments will support them to acquire practical skills to work in health care sector and assist them to understand the automation process in clinical labs (K1,K2,K3,K4,K5,K6)
Units	

I	Haematology: RBC count, WBC count – total and differential count, ESR, PCV, MCV. Bleeding Time, Clotting Time Estimation of hemoglobin. Determination of Electrolytes :Sodium, Potasium and Calcium
II	Liver function test: Estimation of bilirubin – direct and indirect. Estimation of plasma protein, A/G ratio, Thymol turbidity test, Prothrombin Time (PT), Assay of serum glutamate oxaloacetate transaminase, alkaline phosphatase, Gamma-glutamyltransferase (GGT), Isoenzyme separation of LDH by electrophoresis.
III	Renal function test: Collection and Preservation of Urine sample Qualitative tests for normal and pathological components of urine. BUN: Estimation of blood Urea, creatinine, and uric acid. Urea Clearance test
IV	Estimation of blood glucose by orthotoluidine and glucose oxidase method. Determination of glycosylated Hb. Glucose tolerance test. Lipid profile: Estimation of cholesterol by Zak's method, Lipoprotein profile, Estimation of ketone bodies, Estimation of triglycerides, free fatty acids and phospholipids.
V	Group Experiments a. Antigen – Antibody Reaction – HCG kit method , RA kit method b. Phlebotomy –Venipuncture , Different techniques of venipuncture c. Collection of blood ,Serum or Plasma separation and Storage d. Automation in Clinical Biochemistry –Autoanalyser ,Semiautoanalyser
Reading List (Print and Online)	1.https://www.researchgate.net/publication/260182512_Practical_Manual_in_Biochemistry_and_Clinical_Biochemistry 2.https://main.icmr.nic.in/sites/default/files/upload_documents/GCLP_Guidelines_2020_Final.pdfhttps://www.westgard.com/clia.html 3.https://www.researchgate.net/publication/263929434_Biochemistry 4. https://ucms.ac.in/Lectures-C-2020/Renal%20function%20Tests%20-%20PPT.pdf 5. https://youtu.be/i2PfjEks4GQ 6.https://www.euro.who.int/__data/assets/pdf_file/0005/268790/WHO-guidelines-on-drawing-blood-best-practices-in-phlebotomy-Eng.pdf
Self-Study	1. Laboratory handling of human biological specimen 2.Automation in Clinical Biochemistry
Recommended Texts	1Practical Clinical Biochemistry- Varley's by Alan H Gowenlock, published by CBS Publishers and distributors, India Sixth Edition ,1988. 2. Manipal Manual of Clinical Biochemistry (For Med.Lab. And MSc Stud.) 2013 (4 Edition) 3. Case Oriented Approach in Biochemistry – Dr. Rajesh Kawaduji Jambhulkar, Dr. Abhijit D. Ninghot: 2019 First Edition 4. Medical Lab Technology Vol I& II, Kanai L Mukerjee New Delhi: Tata Mcgraw Hill Publishing Company, 1996. 5. Practical Biochemistry – Plummer, New Delhi: Tata Mcgraw Hill Publishing Company, 2000.

	6. Introductory practical Biochemistry – S.K. Sawhney, Randhir Singh, 2nd ed, 2005.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create(K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**M**	**S**
CO 2	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**M**	**S**
CO 3	**S**	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**BIOSTATISTICS AND DATA SCIENCE**
Credits:	**3**
Pre-requisites, if any:	Basic knowledge of Statistics and Computer Applications
Course Objectives	1. To summarize the data and to obtain its salient features from the vast mass of original data. 2. To understand the concept of various measures of dispersion. 3. To understand the concepts of sampling and learning test of significance. 4. To understand the concept of various attributes and relate to Biological studies. 5. To gain knowledge in SPSS, a software package which gives a perfect graphical representation and appropriate result for the data that has been entered
Course Outcomes	After completion of the course, the students should be able to: CO1: Concepts of statistical population and sample, variables and attributes. Tabular and graphical representation of data based on variables.(K1,K2,K3) CO2:Conditions for the consistency' and criteria for the independence of data based on attributes. Measures of central tendency, Dispersion, Skewness and Kurtosis.(K1,K2,K3) CO3:Learning different sampling methods and 64mphibian statistical significance.(K1,K2,K3,K4) CO4: Understanding students t-test , ANOVA , Chi square test to analyse the significance of various research. (K1,K2,K3,K4) CO5: Learning on data science, algorithm for machine learning, artificial intelligence and big data, their applications in clinical and pharma domain. (K1,K2,K3,K4.K6)
Units	
I	Nature of biological and clinical experiments – Collection of data in experiment- Primary and secondary data. Methods of data collection. Classification and tabulation. Different forms of diagrams and graphs related to biological studies. Measures of Averages- Mean, Median, and mode. Use of these measures in biological studies.

II	Measures of Dispersion for biological characters – Quartile deviation, Mean deviation, Standard deviation and coefficient of variation. Measures of skewness and kurtosis. Correlation and regression – Rank correlation – Regression equation. Simple problems based on biochemical data.
III	Basic concepts of sampling- Simple random sample stratified sample and systemic sampling. Sampling distribution and standard error. Test of significance based on large samples. Test for mean, difference of means, proportions and equality of proportions.
IV	Small sample tests – Students 't' test for mean, difference of two way means, tests for correlation and regression coefficients. Chi-square test for goodness of a non independence of attributes. F test for equality of variances. ANOVA- one way and two way. Basic concept related to biological studies
V	Introduction to Data Science, Definition of data science, importance, and basic applications, Machine Learning Algorithms, Deep Learning, Artificial Neural Networks and their Application, Reinforcement Learning, Natural Language Processing Artificial Intelligence (AI), Data Visualization, Data Analysis, Optimization Techniques, Big Data, Predictive Analysis. Application of AI in medical, health and pharma industries.
Reading List (Print and Online)	https://www.ibm.com/docs/en/SSLVMB_28.0.0/pdf/Accessibility.pdf https://pure.tue.nl/ws/portalfiles/portal/19478370/20160419_CO_Mzolo.pdf https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5453888/ https://home.ubalt.edu/ntsbarsh/excel/excel.htm https://students.shu.ac.uk/lits/it/documents/pdf/analysing_data_using_spss.pdf https://www.ibm.com/support/pages/ibm-spss-statistics-28-documentation
Self-Study	1.Simple problems on probability, theoretical distributions, hypothesis testing 2. Relationship between mean, median and mode pros and cons of the measures of central tendency and deviation
Recommended Texts	1. Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition 2. Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to Biostatistics", 2nd edition,.Prestographik, Vellore, India,. 3. Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1st edition,Springer 4. Milton,J.S.(1992),. "Statistical methods in the Biological and Health Sciences", 2nd edition ,Mc Graw Hill, 5. Rosner,B (2005), "Fundamentals of Biostatistics", Duxbury Press 6. Introducing Data Science, Davy Cielen, Anro DB Meysman, Mohamed Ali.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain

Analyse (K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6) – Check knowledge in specific or off beat situations, Discussion, Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**RESEARCH METHODOLOGY**
Credits:	**3**
Pre-requisites, if any:	Basic knowledge of Statistics
Course Objectives	1. To summarize the data and to obtain its salient features from the vastmass of original data. 2. To understand the concept of various measures of dispersion. 3. To understand the concepts of sampling and learning test of significance. 4. To understand the concept of various attributes and relate to biological studies.
Course Outcomes	After completion of the course, the students should be able to: CO1: Concepts of statistical population and sample, variables and attributes. Tabular and graphical representation of data based on variables.(K1,K2,K3) CO2: Conditions for the consistency' and criteria for the independence of data based on attributes. Measures of central tendency, Dispersion, Skewness and Kurtosis.(K1,K2,K3) CO3:Learning different sampling methods and 67mphibian statistical significance.(K1,K2,K3,K4) CO4: Understanding students t test , ANOVA , Chi square test to analyse the significance of various research. (K1,K2,K3,K4) CO5: Gain knowledge about concept, philosophical consideration and epistemology of science, ethical terms, principles and theories of bioethics
Units	
I	Nature of biological and clinical experiments – Collection of data in experiment- Primary and secondary data. Methods of data collection. Classification and tabulation. Different forms of diagrams and graphs related to biological studies. Measures of Averages- Mean, Median, and mode. Use of these measures in biological studies. Measures of Dispersion for biological characters – Quartile deviation, Mean deviation, Standard deviation and coefficient of variation. Measures of skewness and kurtosis.
II	Correlation and regression – Rank correlation – Regression equation. Simple problems based on biochemical data. Basic concepts of sampling- Simple random sample stratified sample and systemic sampling. Sampling distribution and standard error. Test of significance based on large samples. Test for mean, difference of means, proportions and equality of proportions.
III	Small sample tests – Students't' test for mean, difference of two way means, tests for correlation and regression coefficients. Chi-square test for goodness of a non independence of attributes. F test for equality of variances. ANOVA- one way and two way. Basic concept related to biological studies
IV	Meaning and significance of research, characteristics and types of research, the research process, features of good research study. Research applications. Research report – Structure and components of scientific reports, types of report, writing and documentation of research report, developing successful research proposals,
V	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

Reading List (Print and Online)	https://www.ibm.com/docs/en/SSLVMB_28.0.0/pdf/Accessibility.pdf https://pure.tue.nl/ws/portalfiles/portal/19478370/20160419_CO_Mzolo.pdf https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5453888/ https://home.ubalt.edu/ntsbarsh/excel/excel.htm https://students.shu.ac.uk/lits/it/documents/pdf/analysing_data_using_spss.pdf https://www.ibm.com/support/pages/ibm-spss-statistics-28-documentation
Self-Study	1.Simple problems on probability, theoretical distributions, hypothesis testing 2. Relationship between mean, median and mode pros and cons of the measures of central tendency and deviation
Recommended Texts	1. Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition 2. Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to Biostatistics", 2nd edition,.Prestographik, Vellore, India,. 3. Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1st edition,Springer 4. Milton,J.S.(1992),. "Statistical methods in the Biological and Health Sciences", 2nd edition ,Mc Graw Hill, 5. Research methods for biological science. Gurumani.N, 2007.MJP pub. Research methods in biological science. Dr.S.Palanichamy, & M. Shanmugavelu, .

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3) – Suggest idea/concept with examples, Solve problems, Observe, Explain

Analyse (K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or off beat situations, Discussion, Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**MOLECULAR BASIS OF DISEASES AND THERAPEUTIC STRATEGIES**
Credits:	**3**
Pre-requisites, if any:	Knowledge of Human Physiology, Metabolism and Clinical Biochemistry
Course Objectives	1.To understand the concepts of the mechanisms involved in regulation of blood sugar and management of diabetes mellitus 2.To gain in-depth knowledge of the mechanisms of cancer and of tumor metastasis 3.The student will review the basic organization of the central and peripheral nervous system that coordinate the sensory and motor functions of the body. In addition, the student will explore impaired features underlying the major neuropathological complications. 4.To gain knowledge in renal diseases 5.To understand the mechanisms involved in cardiac disorders
Course Outcomes	On completion of this course the student will be able to understand CO1.Overall view about the complications of diabetes mellitus and its management. CO2.Comprehensive understanding of the concepts of cancer biology and implicating the theoretical concepts for further research CO3.Understand and appreciate the pathophysiology of conditions affecting the nervous system. CO4.A thorough knowledge of renal and cardiac diseases with emphasis related to mechanistic aspects and therapeutic interventions. CO5.A thorough knowledge on the experimental models of non-communicable diseases that will be applied for future research or project dissertation. An in-depth knowledge on development of drugs against non-communicable diseases.
Units	
I	Mechanism of blood sugar regulation in human body. Pathophysiology of Type I and II diabetes, Diabetes – investigation methods for the diagnosis of diabetes. Nutritional care. Complications related to diabetes – Diabetic cardiovascular disease, retinopathy, neuropathy and nephropathy. Cellular and molecular mechanism of development of diabetes- Management of Type I and Type II diabetes, drugs for the treatment of diabetes.
II	Biology of cancer: Overview of hallmarks of cancer. Tumorigenesis, Tumor progression and mechanism of Metastasis. Proto-oncogene to oncogene. Oncogene- myc and src family. Tumor suppressor gene-Rb and p53 pathway in cancer. Diagnosis- Non-invasive imaging techniques, Tumor diagnosis, Interventional radiology, New imaging technique, Molecular techniques in cancer diagnosis.- treatment of cancer- surgery, radiotherapy, chemotherapy, hormonal treatment, and biological therapy. Introduction to personalized medicine.
III	Brain- neuronal network- memory- Neurogenerative diseases- Parkinson and Alzheimer Disease- molecular understanding of the neurodegenerative diseases- treatment modalities.
IV	Acute and chronic renal failure, glomerular diseases–glomerulonephritis, nephritic syndrome, diabetes insipidus, diagnosis of kidney disease.
V	Introduction to cardiovascular diseases, Lipids and lipoproteins in coronary heart disease-cardiac enzymes, Molecular changes during cardiac remodeling –

	hypertrophy of hearts – heart failure- treatment modalities.
Reading List (Print and Online)	The Biochemical basis of disease:2018,Barr AJ; Portland Press Biochemical Basis of Diseases https://www.biologydiscussion.com/diseases-2/biochemical-basis-of-diseases/44276
Recommended Texts	Wills' Biochemical Basis of Medicine: 2nd edition,Thomas H, Gillham B;Elsevier Molecular Biochemistry of Human Diseases,2021,Feuer G ,de la Iglesia F; CRC Press

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total
10	10	5	75	100

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview

Application (K3) – Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain

Analyse (K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**S**	**S**	**S**
CO 2	**S**	**M**	**S**	**L**	**M**	**M**	**M**	**M**	**M**	**S**
CO 3	**S**	**S**	**M**	**L**	**S**	**S**	**M**	**M**	**S**	**M**
CO 4	**S**	**M**	**M**	**M**	**M**	**M**	**S**	**S**	**M**	**S**
CO 5	**S**	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELACCTIVE**
Title of the Course:	**CLINICAL LABORATORY TECHNIQUES**
Credits:	**3**
Pre-requisites, if any:	Knowledge on sample collection and handling
Course Objectives	1. The Course focuses the students to gain knowledge about the routine clinical techniques in medical laboratories 2. To gain knowledge on analysis of biological samples for the diagnosis of diseases
Course Outcomes	On completion of this course the student will be able to understand CO1. Explain about the laboratory safety, hazards in clinical laboratories CO2. Describe the methods of analysis of blood. CO3. Illustrate the various blood grouping systems, complications in blood transfusion, methods in collection and storage of blood in blood banks CO4. Handle and examine biological samples like urine and stools CO5. Describe the analysis of Sputum and Semen
Units	
I	Clinical laboratory standards and Basic laboratory safety, hazards in the clinical laboratory. Specimen processing: blood – Phlebotomy, Methods of collection, Anticoagulants – EDTA, Double oxalate, Sodium citrate, Sodium fluoride, Potassium oxalate, Heparin. Preparation of serum and protein free filtrate
II	Blood: Difference between serum and plasma. Blood cell count: TC – Haemocytometry, DC, Platelet count. Estimation of Hemoglobin – Sahli's Method, Cyan met Haemoglobin method, PCV – Microhaematocrit method. ESR – Westergren's method, bleeding time – Duke's method. Clotting time – Capillary tube method. Clinical interpretation of haematological tests – Anemia, polycythemia and leukemia,
III	Human blood group system: ABO, sub groups of ABO, variants of ABO and Rh blood group system. Blood transfusion: Definition and clinical significance. Complications, Blood banking: Blood collection – Screening of donor. Criteria for rejecting donor. Blood collection procedure. Transportation of blood. Storage of blood and changes in the stored blood
IV	Urine analysis: Urine – Methods of collection. Storage – Preservatives. Gross examination of urine, chemical examination of urine. Reducing sugar , Protein, ketone bodies, bile salts and bile pigments Stool examination – Specimen collection, Physical & chemical examination, Test for Occult, Microscopic examination of stool..
V	Sputum Analysis: Specimen collection, macroscopic examination – Color, Volume, Odour. Microscopic examination. Semen Analysis: Collection, Gross examination, Microscopic examination, Chemical examination of semen.
Recommended Texts	1. *Kanai.L. Mukherjee.* 2005. Medical Laboratory Technology, Volume III. Tata McGraw- Hill Publishing Co. New Delhi. 2. *Ramnik Sood*. 2006. Medical Laboratory Technology. Jaypee Brothers Medical Publishers Ltd., New Delhi.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total
10	10	5	75	100

Methods of assessment:

Recall (K1) – Simple definitions, MCQ, Recall steps, Concept definitions

Understand/ Comprehend (K2) – MCQ, True/False, Short essays, Concept explanations, Short summary or overview

Application (K3) – Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain

Analyse (K4) – Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge

Evaluate (K5) – Longer essay/ Evaluation essay, Critique or justify with pros and cons

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**S**	**S**	**S**
CO 2	**S**	**M**	**S**	**L**	**M**	**M**	**M**	**M**	**M**	**S**
CO 3	**S**	**S**	**M**	**L**	**S**	**S**	**M**	**M**	**S**	**M**
CO 4	**S**	**M**	**M**	**M**	**M**	**M**	**S**	**S**	**M**	**S**
CO 5	**S**	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**S**	**S**

S-Strong M-Medium L-Low

Course I	**CORE THEORY – X**
Title of the Course:	**PHARMACEUTICAL BIOCHEMISTRY**
Credits:	**4**
Pre-requisites, if	The student should have a basic knowledge of drug discovery and development. Student should possess basic knowledge of bioinformatics to understand and correlate the drug development process.
Course ectives	1. To understand the different types of bioinformatic tools for drug discovery. 2. To get an overview of how different bioinformatic tools aid in the process of target identification, drug screening and quantitative structure activity relationship. 3. To assimilate the involvement of different metabolic pathways involved in drug metabolism and correlate their involvement in elimination process 4. To understand the biochemical basis of drug action at the target tissue. 5. To understand different phases in drug clinical trials and its assessment.
Course Outcomes	After completion of the course, the students should be able to: **CO1.**To understand and explain the basic concepts of drug discovery and drug development process. **CO2.**To review the different software and computational tools which aid in the design of drugs and its rationalization. **CO3.**To analyze the different stages of the drug discovery process with the target & hit identification, assays for drug screening and preclinical studies. **CO4.**To understand the various phases of the clinical trails and the method of conduct of clinical trails.
Units	
I	Drug discovery and development, drug target identification and validation, Hit identification, General principles of screening, correlations between various animal models and human situations, Correlation between in-vitro and in-vivo screens; Special emphasis on cell-based assay, biochemical assay, radiological binding assay, Pharmacological assay, In vitro, In vivo & Ex-vivo experiments, lead optimization, preclinical studies.
II	Bioinformatics approaches for drug development: Identification of potential molecules, chemical compound library preparation, Identification of target in pathogen, Ligand & protein preparation, Molecular docking, Binding free energy estimation, High throughput virtual screening, Docking protocol validation and enrichment analysis, Single point energy calculation, Pharmacokinetics and Pharmacodynamics, ADME & toxicity prediction, Molecular dynamic simulation, Rule of three and five, Lipinsky rule, Pharmacophore development, Quantitative structure activity relationship, 3D-QSAR, Techniques of developing a pharmacophore map covering both ligand based and receptor based approaches.
III	Drug metabolism & interactions: Drug-receptor interactions, receptor theories and drug action, Xenobiotics, xenobiotics phases (Phase-I, Phase-II and Phase-III), role of cytochrome P450 oxidases and glutathione S-transferases in drug metabolism, factors affecting drug metabolism, Enzymes as a drug target, Kinase inhibitors, ATPase inhibitors, drug protein interaction, DrugDNA interaction. Basic ligand concepts-agonist,

	antagonist, partial agonist, inverse agonist, efficiency and potency. Forces involved in drug-receptor complexes. Receptor classification – the four super families. Receptor binding assays- measurement of Kd, Bmax and IC_{50}.
IV	Biochemical mode of action of antibiotics- penicillin and chloramphenicol, actions of alkaloids, antiviral and antimalarial substances. Biochemical mechanism of drug resistance- sulphonamides. Drug potency and drug efficacy. General principles of chemotherapy: chemotherapy of parasitic infections, fungal infections, viral diseases. Introduction to immunomodulators and chemotherapy of cancer.
V	Clinical trials (Phase-I, Phase-II, Phase-III and Phase-IV clinical trial). Main features of clinical trials, including methodological and organizational considerations and the principles of trial conduct and reporting. Key designs surrounding design, sample size, delivery and assessment of clinical trials.
Self-Study	Examples of pharmaceutical development of a drug Basic pharmacology of drug action and kinetics
Reading List (Print and Online)	Textbook of Drug Design. Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002. Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA, 2005
Recommended ts	Practical Application of Computer-Aided Drug Design, Ed. Charifson P., Marcel Dekker Inc. 3D QSAR in Drug Design: Theory, Methods and Applications, Ed. Kubinyi H., Ledien Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns, EH, Lipinski CA, Thakker DR and Wang B, AAPS Press, 2004 Drug Discovery and Development; Technology in Transition. HP Rang. Elsevier Ltd 1st edition 2006. Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1st Edition 2012.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simpledefinitions,MCQ,Recallsteps,Conceptdefinitions.

Understand/Comprehend(K2)-MCQ,True/False,Shortessays,Concept explanations,Shortsummaryoroverview.

Application(K3)-Suggestidea/conceptwithexamples,Solveproblems,Observe,Explain.

Analyse(K4) – Problem-saving questions,Finish a procedure in many steps,Differentiate between various ideas.

Evaluate(K5)-Longer essay/ Evaluationessay,Critiqueorjustifywithprosandcons

Create(K6) – Check knowledge in specific or offbeat situations.Discussion.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**M**	**S**	**M**	**S**	**M**	**M**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**L**	**S**	**M**	**M**	**S**	**S**	**M**
CO 4	**S**	**M**	**S**	**L**	**S**	**L**	**M**	**S**	**S**	**M**
CO 5	**S**	**S**	**S**	**L**	**S**	**M**	**M**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE THEORY – XI**
Title of the Course:	**BIOCHEMICAL TOXICOLOGY**
Credits:	**4**
Pre-requisites, if any:	The student should have a basic knowledge of pharmacology of drug action and understanding on their biochemical pathways.
Course Objectives	1. To understand the detailed study of biochemical basis of drugs and its toxicity, particularly their actions on living systems. 2. To understand the relevance and methods to identify the chemotherapeutic value of drug. 3. To understand the fundamentals of toxicology and dose- response relationships. 4. To understand the toxicological drug testing procedures based on in vitro and animal studies 5. To understand biochemical pathways of drug toxicity and its manifestation on vital organs.
Course Outcomes	On completion of this course, the student will be able **CO1:** To appreciate and understand the role of toxicological biomarkers to assess drug toxicities. **CO2:** To conceive the role of disposition of drug in human system and their metabolism and methodologies pertaining to toxicological studies. **CO3:** To understand and evaluate the functions of different organs on drug disposition and associated drug toxicities. **CO4 :** To understand the toxicological response to foreign compounds and their pharmacological, physiological and biochemical effects. **CO5:** To link the mechanism of toxicity and clinical symptoms with underlying physiological disturbances.
Units	
I	Fundamentals of Toxicology and dose-Response Relationships: Introduction, Biomarkers Criteria of Toxicity, Evaluation of Toxicity Interactions; Dose Response; Measurement of Dose-Response; Relationships Linear Dose Response, Hormesis; Hazard and Risk Assessment, Duration and Frequency of Exposure and Effect.
II	Factors Affecting Toxic Responses: Disposition: Absorption ,Sites of absorption, distribution, Excretion; Metabolism: types of Metabolic change phase I reactions; Phase 2 reactions; control of Metabolism, Toxication Vs. Detoxication
III	Toxicity testing; Test protocol, Genetic toxicity testing & Mutagenesis assay: In vitro test systems: bacterial mutation tests-Reversion test, Ames test, Fluctuation test, and Eukaryotic mutation test. In vivo test system Mammalian mutation test-Host mediated assay and Dominant Lethal test. Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Covalent binding to cellular macromolecules & genotoxicity, Tissue specific toxicity
IV	Toxic Responses to Foreign Compounds: Direct Toxic Action: Tissue Lesions; Mechanism and response in cellular toxicity, pharmacological, physiological and Biochemical effects; Developmental Toxicology- Teratogenesis; Immunotoxicity Genetic Toxicity; Chemical Carcinogenesis

V	Biochemical Mechanisms of Toxicity: Tissue Lesions: Liver Necrosis; kidney Damage; Lung Damage, Liver damage, Cardiac damage; Neurotoxicity; Exaggerated and Unwanted pharmacological effects; Physiological effects; Biochemical Effects: Lethal Synthesis and Incorporation, Interaction with specific Protein Receptors; Teratogenesis; Immunotoxicity; multi-Organ Toxicity
Self-Study	Case studies to review
Reading List Print and Online)	1. Preclinical Safety Evaluation of Biopharmaceuticals: A Science-Based Approach to Facilitating Clinical Trialsby Joy A. Cavagnaro 2. A Comprehensive Guide to Toxicology in Nonclinical Drug Development 2nd Editionby Ali S. Faqi
Recommended Texts	1.Principles Of Toxicology by: Karen E Stine, Thomas M Brown 2006 Publisher. Crc Press 2. Principles of Biochemical Toxicology by John A. Timbrell Publisher: Informa Healthcare 3. Environmental Toxicology by Sigmund F. Zakrzewski, (2002) Publisher: Oxford University Press, USA

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simpledefinitions,MCQ,Recallsteps,Conceptdefinitions.

Understand/Comprehend(K2)-MCQ,True/False,Shortessays,Concept explanations,Shortsummaryoroverview.

Application(K3)-Suggestidea/conceptwithexamples,Solveproblems,Observe,Explain.

Analyse(K4) – Problem-saving questions,Finish a procedure in many steps,Differentiate between various ideas.

Evaluate(K5)-Longer essay/ Evaluationessay,Critiqueorjustifywithprosandcons

Create(K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**L**	**S**	**L**	**M**	**M**	**M**	**M**
CO 2	**M**	**M**	**S**	**M**	**M**	**L**	**M**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**M**	**M**	**L**	**S**	**S**	**M**	**M**
CO 4	**S**	**M**	**S**	**M**	**M**	**M**	**S**	**S**	**M**	**M**
CO 5	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE**
Title of the Course:	**BIOSAFETY, LAB SAFETY AND IPR**
Credits:	**3**
Pre-requisites, if any:	The student should have a basic knowledge of hazards associated with the handling of biological agents and importance of intellectual property from scientific research.
Course Objectives	1. To assimilate the hazards associated with the handling of biological and chemical agents. 2. To understand how to protect from the hazards by the implementation of various safety measures in biochemical laboratories. 3. To implicate the importance of protecting the scientific intellect by filing patent and understand the various offices for filing and maintaining patents 4. To understand the scope of patenting in biological research. 5. To create an awareness of ethics associated with used of genetically modified organisms/cells and its rationale for use in living organisms.
Course Outcomes	After completion of the course, the students should be able to: **CO1.**To understand and implement various aspects of biosafety and carry out risk assessment of products in biological research **CO2. U**nderstand the basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights. **CO3.**To appreciate the intellectual property rights and its implementation of on the invention related to biological research. **CO4.** To understand the statutory bodies that regulate the property rights and its validity in various countries. **CO5.** Critique the ethical concerns associated with modern biotechnology processes and plan accordingly.

Units	
I	Biosafety: Introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; recommended biosafety levels for infectious agents and infected animals; biosafety guidelines – government of India, roles of IBSC, RCGM, GEAC etc. for GMO applications in food and agriculture; environmental release of GMOs; risk assessment.
II	Laboratory safety – Chemical, electrical and fire hazards; handling and manipulating human or animal cells and tissues, toxic, corrosive or mutagenic solvents and reagents; mouth pipetting, and inhalation exposures to infectious aerosols, Safe handling of syringe needles or other contaminated sharps, spills and splashes onto skin and mucous membranes. Health aspects; toxicology, allergenicity, antibiotic resistance. Personal protective equipment, Laboratory facilities and safety equipment, Disinfection, decontamination, and sterilization, Regulatory compliance, Laboratory security and emergency response and administrative controls.

III	Intellectual Property Rights (IPR): Introduction to patents, types of patents, process involved in patenting in India, trademarks, copyright, industrial design, trade secrets, traditional knowledge, geographical indications, history of national and international treaties and conventions on patents, WTO, GATT, WIPO, Budapest Treaty, Patent Cooperation Treaty (PCT) and TRIPS. Patent databases: Searching international databases; analysis and report formation. Indian Patent Act 1970; recent amendments; filing of a patent application; precautions before patenting disclosure/non-disclosure; procedure for filing a PCT application.
IV	Patent filing and infringement: Patent application- forms and guidelines, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and convention patent applications, international patenting-requirement, financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India. Research Patenting: Patenting by researchers and scientists-University/organizational rules in India and abroad. Detailed information on patenting biological products, Case studies on patents (basmati rice, turmeric, neem etc.), and patent infringement.
V	Bioethics: Introduction to bioethics, human genome project and its ethical issues, genetic manipulations and their ethical issues, ethical issues in GMOs, foods and crops in developed and developing countries, environmental release of GMOs, ethical issues involved in stem cell research and use, use of animals in research experiments, animal cloning, human cloning and their ethical aspects, testing of drugs on human volunteers.
Self-Study	Review of drug patent documents Safety in biological research laboratories
Reading List (Print and Online)	V. Shree Krishna, (2007). Bioethics and Biosafety in Biotechnology, New Age International Pvt. Ltd. Publishers. (Unit III, Unit IV and Unit V) Deepa Goel, Shomini Parashar, (2013). IPR, Biosafety and Bioethics, Pearson. (Unit II) R. Ian Freshney, 2016. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Ed, John Wiley & Blackwell. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007. (Unit I)
Recommended Texts	Biosafety in Microbiological and Biomedical Laboratories, (2020) 6th Ed. (https://www.cdc.gov/labs/pdf/SF__19_308133-A_BMBL6_00-BOOK-WEB-final3.pdf) Kankanala C., (2007), Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd.,

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend(K2)- MCQ, True/False, Short essays, Concept explanations, Short summary oroverview.

Application(K3)-Suggestidea/conceptwithexamples,Solveproblems,Observe,Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate(K5)-Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create(K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**L**	**M**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 4	**S**	**M**	**M**	**L**	**S**	**L**	**S**	**S**	**S**	**M**
CO 5	**S**	**S**	**S**	**L**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE ELECTIVE IV**
Title of the Course:	**CANCER BIOLOGY**
Credits:	**3**
Pre-requisites, if any:	The student should have a basic knowledge of cell Biology
Course Objectives	1. To understand the genetic basis of cancer. 2. To understand the disease processes involved in malignancy.
Course Outcomes	After completion of the course, the students should be able to: **CO1.**To understand cell signal transduction pathways **CO2.** To comprehend the concepts of apoptosis **CO3.**To know the process of carcinogenesis **CO4.** To aware of carcinogens. **CO5.** To understand the functions of tumor suppressor genes

Units	
I	Cell signaling; Extra cellular signal molecules, Cell surface receptor proteins- Ion channel linked receptors, G-Protein coupled receptors, and Enzyme linked receptors. Signal transduction; RTK-Ras dependent pathway, RTK-Ras independent pathway, MAP kinase pathways.
II	Overview of cell cycle, check points in cell cycle, Regulation of cell cycle. Programmed cell death or Apoptosis: mechanism, regulation, pro-apoptotic regulators.
III	Introduction to cancer, Differences between normal cell and cancer cell, Cytological changes, Molecular changes and genetic changes in cancer cell. Onset of cancer: Carcinogenesis- initiation, promotion and progression, Tumor micro environment influence cancer development, Angiogenesis
IV	Causes of cancer- physical and chemical carcinogens. Oncogenes, viral oncogenes, activation of proto oncogenes.
V	Tumor suppressor genes- Rb, p53, BCL2 and BRCA2. Loss of heterozygosity, Tumor markers.
Recommended ts	1. The Cell – A Molecular Approach, Geoffrey M. Cooper and Robert ıusman, sixth edition,2013 2. Cell Biology, Veer Bala Rastogi, MedTech Science Press.

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend(K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application(K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate(K5)-Longer essay/ Evaluation, essay, Critique or justify with pros and cons

Create(K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**
CO 2	**S**	**S**	**S**	**L**	**M**	**M**	**S**	**S**	**S**	**S**
CO 3	**S**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 4	**S**	**M**	**M**	**L**	**S**	**L**	**S**	**S**	**S**	**M**
CO 5	**S**	**S**	**S**	**L**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course I	**CORE ELECTIVE**
Title of the Course:	**DEVELOPMENTAL BIOLOGY**
Credits:	**3**
Pre-requisites, if	Comprehensive Knowledge of Cell Biology
Course Objectives	The candidates undertaking this course will understand the concepts of developmental biology. To understand the background of developmental biology To gain in-depth knowledge of various model organisms To gain insight into aspects of stem cell technology To gain insights into morphogenesis and 83mphibian83sis To acquire in-depth understanding of cell death mechanisms and cell fate decision
Course Outcomes	CO1.Grasp knowledge about the background of developmental biology CO2.Gain abundant knowledge about model oraganisms and gametogenesis CO3.Gain knowledge about stem cells and their applications in regenerative therapy CO4.Good knowledge about organogenesis CO5.Learn the basics of cell death mechanisms and cell fate decision.
Units	
I	Overview of Developmental biology: Background of Developmental biology – Principles of developmental biology –Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenicsin analysis of development.
II	Model organisms Gametogenesis – production of gametes, Formation of zygote, fertilization and early development: molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants;cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. Drosophila Developmental biology- Axis formation, Genes & mutation. *C.elegans*– Vulva formation, Axisformation.
III	Regeneration Developmental Biology Stem cells – Definition, Classification, Embryonic and adult stem cells, properties, identification, Culture of stem cells, Differentiation and dedifferentiation, Stem cell markers, techniques and their applications in modern clinical sciences. Three- dimensional culture and transplantation of engineered cells. Tissue engineering – skin, bone and neuronal tissues.
IV	Morphogenesis & Organogenesis: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibian and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens formation, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

V	Cellular senescence and Cell fate decision Cellular senescence – concepts & Frizzled receptor in Development and disease. Diabetes and developmental biology, Cell death pathways in developments. Markers of important diseases.
Reading List (Print and Online)	Developmental Biology – Gilbert Scott http://bgc.org.in/pdf/study-material/developmental-biology-7th-ed-sf-gilbert.pdf
Recommended Texts	Developmental biology: VIII edition, Gilbert, SF; Sinauer Associates, Inc

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simpledefinitions,MCQ,Recallsteps,Conceptdefinitions.

Understand/Comprehend(K2)-MCQ,True/False,Shortessays,Concept explanations,Shortsummaryoroverview.

Application(K3)-Suggestidea/conceptwithexamples,Solveproblems,Observe,Explain.

Analyse(K4) – Problem-saving questions,Finish a procedure in many steps,Differentiate between various ideas.

Evaluate(K5)-Longer essay/ Evaluationessay,Critiqueorjustifywithprosandcons

Create(K6) – Check knowledge in specific or offbeat situations.Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**M**	**M**	**S**	**S**	**M**	**L**	**S**	**S**	**M**
CO 2	**M**	**M**	**M**	**M**	**M**	**S**	**M**	**S**	**M**	**M**
CO 3	**M**	**M**	**L**	**M**	**M**	**S**	**L**	**S**	**L**	**L**
CO 4	**S**	**M**	**L**	**S**	**S**	**M**	**S**	**S**	**M**	**M**
CO 5	**S**	**S**	**M**	**S**	**L**	**M**	**M**	**S**	**M**	**M**

S-Strong M-Medium L-Low

Course I	**CORE ELECTIVE**
Title of the Course:	**PLANT BIOCHEMISTRY**
Credits:	**3**
Pre-requisites, if any:	Comprehensive Knowledge of Plant cell structure and functions
Course Objectives	This paper aims to provide a basic understanding of plant physiology, photosynthesis, nitrogen fixation, and pytohormones. This paper also provides the knowledge about secondary metabolites and plant tissue culture
Course Outcomes	CO1. Understand the basic knowledge of mechanism of water transport and Photosynthesis CO2. Describe the nitrogen fixation mechanisms in plants and interrelationship betweenphotosynthesis and nitrogen metabolism. CO3. Get the Knowledge about the Biosynthesis, transport, distribution, mechanism of action and physiological effects of plant hormones CO4. Understand the role of secondary metabolites in drug development CO5 Know about the isolation, fusion and culture of protoplast and also understand geneticmanipulation of plants.
Units	
I	Water absorption – Mechanism of water absorption, symplast and apoplast concepts. Transpiration – types, mechanism and factors affecting transpiration. Photosynthesis – Photosynthetic apparatus, role of photosynthetic pigments, Biochemistry of light reactions of Photosynthesis – photo systems, factors affecting photosynthesis, cyclic and non-cyclic photo phosphorylation. Biochemistry of dark reactions of Photosynthesis – Carbon reactions in C3, C4 and CAM plants – Calvin cycle, Hatch – Slack pathway.
II	Nutrients – Role of macro and micronutrients in plants and hydroponics, Nitrogen fixation and its types. Biochemistry of symbiotic and nonsymbiotic nitrogen fixation. Physiology of nodule formation. Gene manipulation of nitrogen fixation genes. Nitrogen assimilation, Interrelationship between photosynthesis and nitrogen metabolism.
III	Biosynthesis, transport, distribution, mechanism of action and physiological effects of Phytohormones – Auxin, Gibberellins, Cytokines, Abscisic acid and Ethylene. Phytochrome, biological clock, physiology and biochemistry of seed germination. Dormancy – types and methods to overcome dormancy. Senescence.
IV	Secondary metabolites – Basic biosynthetic pathways. Functions of secondary metabolites – Flavonoids, alkaloids, terpenoids, anthocyanins, Tannins, steroids and lignin. Applications of secondary metabolites – Drug development, Biopesticides and Biofertilizers.
V	Plant tissue culture- Micropropagation, Callus induction, cell and protoplast culture, organogenesis and somatic embryogenesis. Applications of tissue culture for crop improvement in agriculture, horticulture and forestry.

Recommended Texts	Plant Biochemistry, Dey J.B. Harborne, 2000. Academic Press. Plant Biochemistry and Molecular Biology Peter J. Lea Richard. C. Lee good,1999 2nd edition. John Wiley & Sons, NY. Introduction to Plant Biochemistry Goodwin T.W. and Mercer E.I 1998. 2nd edition. CBSpublication. Plant pathology by Pandey B.P, S. 2009 Chand & Co. An introduction to Plant Tissue culture. Razdan M.K. 2003. Oxford & IBH Publishing Co,New Delhi. Plant Tissue culture, A Practical approach Dixon R.A and Gonzales R.A., 2nd edition. Natural Products: A Laboratory Guide. Raphael Ikan. 1991. Academic Press

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simpledefinitions,MCQ,Recallsteps,Conceptdefinitions.

Understand/Comprehend(K2)-MCQ,True/False,Shortessays,Concept explanations,Shortsummaryoroverview.

Application(K3)-Suggestidea/conceptwithexamples,Solveproblems,Observe,Explain.

Analyse(K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate(K5)-Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create(K6) – Check knowledge in specific or offbeat situations and Discussion.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**M**	**M**	**S**	**S**	**M**	**L**	**S**	**S**	**M**
CO 2	**M**	**M**	**M**	**M**	**M**	**S**	**M**	**S**	**M**	**M**
CO 3	**M**	**M**	**L**	**M**	**M**	**S**	**L**	**S**	**L**	**L**
CO 4	**S**	**M**	**L**	**S**	**S**	**M**	**S**	**S**	**M**	**M**
CO 5	**S**	**S**	**M**	**S**	**L**	**M**	**M**	**S**	**M**	**M**

S-Strong M-Medium L-Low

NME Courses offered to other Departments

Course	**NME-I**
Title of the Course:	**CLINICAL NUTRITION**
Course Code:	**23PBCNE01**
Credits:	**2**
Pre-requisites, if any:	**Basic Knowledge On Food, Nutrition & Dietetics, And Metabolism of Nutrients.**
Course Objectives	1. To understand basic concepts involved in growth , health, nutrition, physiology and metabolism 2. To discuss the concepts and applications of nutrition in correlation with biochemistry 3.To define nutritional needs in healthy individuals and modification of diet during illness.
Course Outcomes	After completion of the course, the students should be able to: CO1. Plan a balanced diet based on an individual's energy requirement, Assess nutritional status of an individual(K3, K4, K5) CO2. Describe the biochemical , physiological and nutritional functions of macronutrients and their integrated role. Understand the role played by antinutritional factors(k! to K6) CO3. Evaluate the functions of vitamins and minerals ,and fluids and electrolyte balance in different physiological states and in sports persons(K1 to K6) CO4. Identify nutritional deficiency conditions , its prevention and dietary management((K3,K4) CO5. Acquire knowledge about the importance of balanced diet and diet therapy (k5,K6)
Units	
I	Carbohydrate - Source of carbohydrates, significance of carbohydrates in cellular activities and organism life system. Mucopolysaccharidosis, Lactose and Fructose intolerance. Normal level of sugar, alterations; Diabetes mellitus, types and its complications. Control and Management of diabetes mellitus.
II	Protein -Sources of proteins and amino acids. Importance of proteins in living organisms. Normal level of protein in human. Protein deficiency disease-Kwashiorkor and Marasmus Protein quality 'Inborn error of amino acid metabolism.
III	Fatty acids - source of fats and importance of fats and lipids in living organism and. Role of LDL, VLDL, HDL and chylomicrons in human body. Normal levels of cholesterol hypercholesterolemia and role of cholesterol in Blood pressure. Atherosclerosis and Heart attack' Prevention and control of heart related diseases
IV	Water structure, physical and chemical properties. Vitamins- water soluble and fat soluble vitamins; Sources, chemical composition, Biological function and property, Deficiency diseases in human.
V	Minerals Source and deficiency disorders of Macro-minerals; Sodium, Potassium, Calcium, Magnesium, Micro-minerals: Copper,

	phosphorus, Iron, Iodine, Zinc and Selenium in human Prevention and control of Anemia.
Reading List (Print and Online)	https://www.jmedscindmc.com/article.asp?issn=1011-4564;year=2014;volume=34;issue=5;spage=211;epage=213;aulast=Shrivastava https://www.researchgate.net/figure/Relationship-between-malnutrition-infection-and-immunity-Malnutrition-is-considered-the_fig1_280722727 https://en.wikipedia.org/wiki/Novel_food https://www.chemicalsafetyfacts.org/preservatives/ https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/food-enrichment
Self-Study	Antabuse drugs and food Selection of foods and market visit, reading and understanding the food labels
Recommended Texts	Srilakshmi. E .(2016) Nutrition Science, New Age International Publishers. Mahan, Kathleen L. (2004) Krause's Food, Nutrition and Diet Therapy, W.B.Saunder's 11th Edition Andreas M. Papas (1998). Antioxidant Status, Diet, Nutrition, and Health (1st ed) CRC Press. M. Swaminathan (1995) Principles of Nutrition and Dietetics. Bappco Margaret Mc Williams (2012). Food Fundamentals (10th ed) Prentice Hall Tom Brody (1998) Nutritional Biochemistry (2nd ed). Academic Press, USA

Method of Evaluation:

Test I	Test II	Assignment	End Semester Examination	Total	Grade
10	10	5	75	100	

Methods of assessment:

Recall(K1)-Simple definitions, MCQ, Recall steps, Concept definitions.

Understand/Comprehend(K2)-MCQ, True/False, Short essays, Concept explanations, Short summary or overview.

Application (K3)-Suggest idea/concept with examples, Solve problems, Observe, Explain.

Analyse (K4) – Problem-saving questions, Finish a procedure in many steps, Differentiate between various ideas.

Evaluate (K5)-Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6) – Check knowledge in specific or offbeat situations and Discussion.

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	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
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CO 2	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**L**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**M**

S-Strong M-Medium L-Low

Course	**NME - II**
Title of the Course:	**HUMAN PHYSIOLOGY AND NUTRITION**
Course Code:	**23PBCNE02**
Credits:	**2**
Pre-requisites, if any:	Anatomy and Biological Compounds
Course Objectives	To understand the functions and activities of organs, tissues or cells and of physical and chemical phenomena involved in the human body To understand nutritional needs in healthy individuals
Course Outcomes	After completion of the course, the students should be able to: **CO1** Explain the digestion process, exchange of gases,design of blood vessels and cardiac cycle (K1, K2, K5, K6) **CO2.** Summarize the events in transmission of nerve impulses and mechanism of muscle contraction. (K2, K3,K4, k5, K6) **CO3.** Elaborate the structure and functions of digestive system, structure of nephron and mechanismofurineformationandroleofkidneyin maintenanceofpH. (K1, K2, K3,K4, K5, K6) **CO4.** Identify and explain nutrients in foods and the specific functions in maintaining health. (K1 , K2 , K3 ,K4, K5, K6) **CO5.** Explain the nutritional consequences in human health (K1, K2, K5)
Units	
I	Digestive system: outline of digestive system. Buccal, gastric and Intestinal digestion.Role of liver in digestion. Intestinal- Absorption and assimilation- hormonal influencein digestion. Excretory system; Structure of kidney and ultra-structure of nephron. Formation and composition of urine. Outline of excretory system - 'Micturition'.
II	Respiratory and Circulatory system: Types of respiration. - Outline of respiratory system' respiratory pigments, Transport of O_2 and CO_2. Factors affecting oxygen dissociation curve and carbondioxidedissociation curve. Chloride shift. Circulatory organs, composition of blood, systemic, pulmonary circulation, Heartbeat, cardiac cycle, origin and conduction of heart beat, Regulation of heart beat, human heart' coronary circulation, ischemic heart disease, ECG, Bloodpressureand cardiacoutput.
III	Nervous and Muscular system: outline of nervous system, structure of neuron, types of neuron, neurotransmitters. Condition of nerve impulse transmission, synaptic transmission. Muscle – Types of muscle- Role of Actin and Myosin.-Action Potential. Neuro muscular junction. Reflex action.

IV	Introduction on Nutrition: Food factors for human being. Nutritional classification, foods, Energy – Energy value of food and its determination, energy expenditure – components – basal metabolism, physical activity and thermogenesis-foods' Basal metabolism: Definition, determination of basal metabolic rate (BMR). Standards of BMR factors affecting BMR, energy utilization in cells and energy balance. Dietary fiber- Definition, types of fiber in plant foods, sources, composition, role of dietary fiber and resistant starch in nutrition, effect of over consumption of fiber.
V	Nutritional consequences and Dietary Allowances Nutritive value of protein' Protein calorie malnutrition in children. protein and energy/ requirements Nitrogen balance and imbalance. Deficiency Disease of Vitamins and Minerals (Iron, sodium, potassium, fluoride, magnesium and calcium.) Infant nutrition, nutrition for preschool children, school children, adolescents, pregnant and lactating mothers. Industrial workers. Geriatric nutrition and Lathyrism. Obesity: Aetiology and occurrence, physiological regulation of foods intake assessment, complication, treatmentand preventionofobesity. Therapeutic diets.
Recommended Texts	1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6th ed). John Wiley & Sons. Inc. 2. Bruce Alberts and Dennis Bray (2013),Essential Cell Biology,(4th ed),Garland Science. 3. De Robertis, E.D.P. and De Robertis, E.M.F. (2010). Cell and Molecular Biology.(8th ed). Lippincott Williams and Wilkins, Philadelphia. 4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. (5th ed). Sunderland, Mass. Sinauer Associates, Inc. 5. Wayne M. Baker (2008) the World of the Cell. (7th ed). Pearson Benjamin Cummings Publishing, San Francisco. Cell Biology 6. Essentials of Food and Nutrition, Vol. I & II, M.S. Swaminathan. 7. Indrani TK. 2003. Nursing Manual of Nutrition and Therapeutic Diet, 1st edition Jaypee Brothers medical publishers.

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CO 2	**S**	**S**	**S**	**S**	**S**	**L**	**S**	**S**	**S**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**M**
CO 4	**S**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**M**
CO 5	**M**	**S**	**L**	**S**	**S**	**L**	**M**	**M**	**L**	**L**

S-Strong M-Medium L-Low