K.M.G. COLLEGE OF ARTS AND SCIENCE

(AUTONOMOUS)

Approved by the Government of Tamil Nadu
Permanently Affiliated to Thiruvalluvar University, Vellore
Recognized under Section 2(f) and 12(B) of the UGC Act 1956
Accredited by NAAC (2nd Cycle) with (CGPA of 3.24/4) 'A' Grade

P.G. AND RESEARCH DEPARTMENT OF BIOCHEMISTRY

M.Sc., BIOCHEMISTRY

SYLLABUS

(CHOICE BASED CREDIT SYSTEM)

Under

LEARNING OUTCOMES-BASED CURRICULUM

FRAMEWORK (LOCF)

(Effective for the Batch of Students Admitted from 2024-2025)

PREFACE

The curriculum of postgraduate Biochemistry has been designed to explain the concepts in various fields of Biochemistry such as Molecular Biology, Biotechnology, Immunology etc.. And also explain both general and clinical Biochemistry. The purpose of the outcome-based education is meant to provide an exposure to the fundamental aspects in different area of Biochemistry and its applications, keeping in mind the growing needs for higher education, employability, entrepreneurship and social responsibility. The periodical restructuring of the syllabi is carried out to fulfill the requirements of graduate attributes, qualification descriptors, programme learning outcomes and course outcomes. The outcome-based education enriches the curriculum to deliver the basic principles, synthetic strategies, mechanisms and application-oriented learning for the benefit of students. It also includes self-learning module, minor projects and industrial internship to enable students to get equipped for higher studies and employment. The programme also includes training to students for seminar presentation, preparation of internship reports, hands-on training in lab courses, skills to handle instruments, synthesis and its analysis, developing leadership qualities, organization and participation in the interdepartmental academic competitions. The elective courses offer chances to learn and augment interest in other related fields. The outcome-based curriculum is intended to enrich the learning pedagogy to global standards. ICT enabled teaching-learning platforms are provided to students along with the interaction of international scientists. The OBE based evaluation methods will reflect the true cognitive levels of the students as the curriculum is designed with course outcomes and cognitive level correlations as per Biochemistry.

ABOUT THE COLLEGE

The College was founded in the new millennium 2000 by the vision of late Shri.K.M.Govindarajan fondly known as Ayah, with a mission to offer higher education in the fields of Arts and Science to the needy and the poor middle class students of this area and make them fully employable and economically self reliant. With a humble beginning of launching an elementary school named Thiruvalluvar Elementary School in the year 1952, Ayah groomed it into a Higher Secondary School and later into a college. Education was his soul & breathe. The college has grown into a full-fledged educational hub offering 12 under graduate programmes, 8 post graduate programmes, 5 M.Phil research programmes and 4 Ph.D programmes. The college has been accredited with 'A' grade by NAAC in 2nd cycle and recognized under section 2(f) & 12(B) of the UGC act 1956. The College is permanently affiliated to Thiruvalluvar University. The College is also acquired the status of Autonomous from the academic year 2024-2025. The College is an associate member of ICT Academy and registered member of NPTEL and Spoken Tutorials of IIT Bombay. The college is also a member of INFLIBNET and NDL.

VISION OF THE COLLEGE

- Empower young men and women by educating them in the pursuit of excellence, character building and responsible citizen.

MISSION OF THE COLLEGE

- Offer higher education in the fields of Arts, Science & Management to the needy and make them fully self-dependent.

QUALITY POLICY OF THE COLLEGE

KMG Students achieve the best learning results and personal growth with modern education that equip them for working life and a changing society to become deserving citizens.

ABOUT THE DEPARTMENT

The knowledge of basic science is essential for the sustainable development of the society. To get the basic knowledge in Biochemistry to young students the Department of Bio chemistry initiated in the academic year 2000-2003. The objective of our department is to motivate students to excel in Biochemistry at the global level, which is necessary for Biochemists getting placement as well as becoming an entrepreneur in future. The department was uplifted as the post graduate department in the year 2004-2006. The department has been recognized as a research department since 2008 to offer M.Phil., Followed that the Thiruvalluvar University accorded recognition to the Department as a centre for Doctoral research in Biochemistry from 2019-2020. The focus of the department is the holistic development of the students and involves them in curricular and co-curricular activities. The Bio Chemistry Department pledges itself to serve in the broadest, innovative and most liberal manner towards the advancement of Biochemistry in all of its branches through academics, research and service missions upholding the values and entrepreneurial skills. The job potential to the biochemist is very high now and opportunities to provoke research in biochemistry are ample. Needless to say that for a developing country likes ours, “BIOCHEMISTRY IS OUR LIFE AND FUTURE”.

VISION OF THE DEPARTMENT

- Produce World class academicians, Scientist, Industrialist and entrepreneurs in the field of Biochemistry.

MISSION OF THE DEPARTMENT

- To educate and inspire the young minds from the basics to the latest innovations in science.
- Inculcate strong theoretical, practical, research and analytical skills in the subject domains and thereby prepare the students for both employability and entrepreneurship.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. Professional Excellence: Graduates will demonstrate competency and excellence in their chosen fields of study, applying theoretical knowledge to practical situations effectively.

2. Character Development: Graduates will exhibit strong moral and ethical character, upholding values of integrity, honesty, and respect for others in both personal and professional endeavors.

3. Leadership and Citizenship: Graduates will emerge as responsible leaders and active citizens, contributing positively to their communities and society at large through their actions and initiatives.

4. Continuous Learning: Graduates will engage in lifelong learning and professional development activities, adapting to evolving technologies, methodologies, and societal needs.

5. Self-Dependency and Entrepreneurship: Graduates will possess the skills and mindset necessary to be self-reliant and entrepreneurial, capable of creating opportunities for themselves and others through innovation and initiative.

6. Effective Communication and Collaboration: Graduates will demonstrate proficiency in communication skills, both verbal and written, and exhibit the ability to collaborate effectively with diverse teams and stakeholders.

7. Global Perspective: Graduates will have a broad understanding of global issues and perspectives, demonstrating cultural sensitivity and adaptability in multicultural environments.

PROGRAM OUTCOMES (POs)

On successful completion of the programme, the students will be able to:

POs	Graduate Attributes	Statements
PO1	**Problem Solving Skill**	Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context
PO2	**Decision Making Skill**	Foster analytical and critical thinking abilities for data-based decision-making
PO3	**Ethical Value**	Ability to incorporate quality, ethical and legal value-basedperspectives to all organizational activities.
PO4	**Communication Skill**	Ability to develop communication, managerial and interpersonal skills
PO5	**Individual and Team Leadership Skill**	Capability to lead themselves and the team to achieve organizationalgoals.
PO6	**Employability Skill**	Inculcate contemporary business practices to enhance employabilityskills in the competitive environment.
PO7	**Entrepreneurial Skill**	Equip with skills and competencies to become an entrepreneur
PO8	**Contribution to Society**	Succeed in career endeavors and contribute significantly to society
PO 9	**Multicultural competence**	Possess knowledge of the values and beliefs of multiple cultures anda global perspective.
PO10	**Moral and ethical awareness/reasoning**	Ability to embrace moral/ethical values in conducting one's life.

PROGRAM SPECIFIC OUTCOMES (PSOs)

On successful completion of the M.Sc., Biochemistry, the students will be able to:

PSOs	Statements
PSO1	Understand the principles and methods of various techniques in Biochemistry, Immunology, Microbiology, Enzyme kinetics and Molecular Cell Biology. Based on their understanding, the students may would be able to design and execute experiments during their final semester project, and further research programs.
PSO2	Insight on the structure-function relationship of biomolecules, their synthesis and breakdown, the regulation of these pathways, and their importance in terms of clinical correlation. Students will also acquire knowledge of the principles of nutritional biochemistry and also understand diseases and their prevention.
PSO3	To understand the concepts of cellular signal transduction pathways and the association of aberrant signal processes with various diseases. Acquire insight into the immune system and its responses, and use this knowledge in the processes of immunization, vaccine development, transplantation and organ rejection.

Correlation Rubrics:

High	Moderate	Low	No Correlation
3	2	1	-

Mapping of PSOs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	3	3	3	3	1	3	3	3	3	3
PSO2	3	2	3	2	2	3	3	3	3	3
PSO3	3	3	3	3	2	3	3	3	3	3

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Subject and Credit System- M.Sc., Biochemistry

(Effective for the Batch of Students Admitted from 2024-2025)

Semester	Part	Category	Course Code	Course Title	Ins.Hrs/ Week	Credit	Maximum Marks		
							Internal	External	Total
SEMESTER - I	Part - I	Core I	APCBC11	Basics of Biochemistry	7	5	25	75	100
		Core II	APCBC12	Biochemical and Molecular Biology Techniques	7	5	25	75	100
		Core III	APCPBC13	Laboratory course on Biomolecules and Biochemical Techniques	6	4	25	75	100
		Elective – I	APEBC14	Microbiology & Immunology	5	3	25	75	100
		Elective – II	APEBC15	Energy and Drug metabolism	5	3	25	75	100
				Semester Total	**30**	**20**			
SEMESTER - II	Part - II	Core-IV	APCBC21	Enzymology	6	5	25	75	100
		Core-V	APCBC22	Cellular Metabolism	6	5	25	75	100
		Core – VI	APCPBC23	Laboratory course in Enzymology, Microbiology and Cell Biology	6	4	25	75	100
		Discipline Centric Elective – III	APEBC24	Elective – III Biostatistics and Data Science	3	3	25	75	100
		Generic Elective - IV:	APEBC25	Elective - IV : Biosafety, Lab Safety and IPR	3	3	25	75	100
		(SEC-I)	APSBC26	(SEC-I) Nutritional Biochemistry	4	2	25	75	100
	Part II	Compulsory	APHR20	Human Rights	2	2	25	75	100
		Compulsory	APMOOC20	MOOC Course	-	2	-	100	100
				Semester Total	**30**	**26**			

SEMESTER - III	Part - I	Core-VII	APCBC31	Physiology and Cell Biology	6	5	25	75	100
		Core-VIII	APCBC32	Clinical Biochemistry	6	5	25	75	100
		Core – IX	APCPBC34	Laboratory course on Clinical Biochemistry (Lab)	6	5	25	75	100
		Core – X	APCBC33	Molecular Biology	6	4	25	75	100
		Discipline Centric Elective - V	APEBC35	Biochemical Toxicology	3	3	25	75	100
		SEC-II	APSBC36	(SEC-II) Molecular Basis of Diseases and Therapeutic strategies	3	2	25	75	100
		Compulsory	APIBC37	Internship/ Industrial Activity	-	2	100	-	100
				Semester Total	**30**	**26**			
SEMESTER - IV	Part - I	Core-XI	APCBC41	Gene editing, Cell and Gene therapy	6	5	25	75	100
		Core-XII	APCBC42	Pharmaceutical Biochemistry	6	5	25	75	100
		Project with vivavoce	APPBC43	Project and viva-voce	10	7	25	75	100
		Elective-VI (Industry Entrepreneurshi) 20% Theory 80% Practical	APEBC44	Industrial Microbiology	4	3	25	75	100
		4.5 Skill Enhancementcourse / Professional Competency Skill	APSBC45	Developmental Biology and Endocrinology	4	2	25	75	100
	Part II	Compulsory	APEA40	Extension Activity	--	1	100	-	100
				Semester Total	**30**	**23**			
				Total		**95**			

Consolidated Semester wise and Component wise Credit distribution

Parts	Semester-I	Semester-II	Semester-III	Semester-IV	Total Credits
Part-I	20	22	26	22	90
Part-I		04		1	5
Total	20	26	26	23	**95**

*****Part I and Part II components will be separately taken into account for CGPA calculation and classification for the post graduate programme and has to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree.

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COURSE DESCRIPTORS

Title of the Course	**BASICS OF BIOCHEMISTRY**	**Hours/Week**	07
Course Code	APCBC11	**Credits**	05
Category	Core I	**Year & Semester**	I & I
Prerequisites	B.Sc Biochemistry/Chemistry/Microbiology/Plant Biotechnology	**Regulation**	2024

Objectives of the course:

- Students will be introduced to the structure of biomolecules.
- The significance of carbohydrates in biologicalprocesses will be understood.
- The structure, properties and biological significance of lipids in thebiological system will be studied
- Students will learn about the concepts of protein structure and theirsignificance in biological processes and creatively comprehend therole of membrane components with their biological significance.
- Students will gain knowledge about the structures and functionalroles of nucleic acids in the biological system.

UNITS	Contents	COs	Cognitive Levels
UNIT-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. Blood group polysaccharides. Bacterial cell wall (peptidoglycans, teichoic acid).	CO1 CO3	K1 K2 K3
UNIT-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.	CO1 CO2 CO3	K1 K2 K3 K4

UNIT-III	Overview of Aminoacids - 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. Chemical synthesis of a peptide, Forces involved in stabilization of protein structure. Ramachandran plot. Folding of proteins. Molecular chaperons – Hsp 70 and Hsp 90 - biological role.	CO3 CO4	K1 K2 K3 K5
UNIT-IV	Membrane Proteins - Types and their significance. Cytoskeleton proteins - actin, tubulin, intermediate filaments. Biological role of cytoskeletal proteins. Membrane structure-fluid mosaic model	CO2 CO3 CO4	K1 K2 K3
UNIT-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. Cot curve. Major and minor classes of RNA, their structure and biological functions.	CO2 CO3 CO4 CO5	K1 K2 K3 K5 K6

Recommended Text Books

1. David L.Nelson and Michael M.Cox (2012) Lehninger, Principlesof Biochemistry (6th ed) W.H. Freeman.
2. Voet.D & 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.

Reference Books

1. Maron, S. H. and Prutton C. P. Principles of Physical Chemistry,4th ed.; The Macmillan Company: Newyork,1972.
2. Lee, J. D. Concise Inorganic Chemistry, 4th ed.; ELBS William Heinemann: London, 1991.
3. Gurudeep Raj, Advanced Inorganic Chemistry, 26thed; Goel Publishing House: Meerut, 2001.
4. Atkins, P.W. & Paula, J. Physical Chemistry, 10th ed.; Oxford University Press: New York, 2014.
5. Huheey, J. E. Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed; Addison, Wesley Publishing Company: India, 1993.

Website and e-learning source

1. https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Online_(Jakubowski)
2. 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
3. https://ocw.mit.edu/courses/biology/7-88j-protein-folding-and- human-disease-spring-2015/study-materials/
4. https://www.open.edu/openlearn/science-maths- technology/science/biology/nucleic-acids-and-chromatin/content- section- 3.4.2
5. https://www.genome.gov/genetics-glossary/Cell-Membrane
6. https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod3.pdf

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
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.	K1,K2,K4
CO3	Describe the various levels of structural organization of proteins and the role of proteins in biological system	K1,K2,K3
CO4	Apply the knowledge of proteins in cell interactions.	K3,K4
CO5	Applying the knowledge of nucleic acid sequencing in research and diagnosis	K1,K2,K6

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	-	-	-	-	-	3	3	3
CO2	3	1	2	2	2	1	1	1	-	1	3	3	3
CO3	2	2	3	3	2	-	-	2	-	1	3	3	3
CO4	3	1	3	1	2	1	-	-	-	-	3	2	2
CO5	3	3	2	3	2	2	-	-	1	1	3	3	3

COURSE DESCRIPTORS

Title of the Course	**BIOCHEMICAL AND MOLECULAR BIOLOGY TECHNIQUES**	**Hours/Week**	07
Course Code	APCBC12	**Credits**	05
Category	Core II	**Year & Semester**	I & I
Prerequisites	B.Sc Biochemistry/Chemistry/Microbiology/Plant Biotechnology	**Regulation**	2024

Objectives of the course:

- To understand the various techniques used in biochemical investigationand microscopy.
- To explain chromatographic techniques.\ and their applications
- To explain electrophoretic techniques.
- To comprehend the spectroscopic techniques and demonstrate theirapplications in biochemical investigations.
- To acquire knowledge of radio labelling techniques and centrifugation

UNITS	Contents	COs	Cognitive Levels
UNIT-I	General approaches to biochemical investigation, cell culture techniques and microscopic techniques. Organ and tissue slice technique, cell distribution and homogenization techniques, cell sorting, and cell counting, tissue Culture techniques. 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.	CO1 CO3	K1 K2 K3
UNIT-II	Chromatographic Techniques: Basic principles of chromatography- adsorption and partition techniques. Adsorption Chromatography – Hydroxyapatite 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, quantitation 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 (CEC) and perfusion chromatography.	CO1 CO2 CO3	K1 K2 K3 K4

UNIT-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, Electrophoresis of RNA, curve. Microchip electrophoresis and 2D electrophoresis, Capillary electrophoresis.	CO3 CO4	K1 K2 K3 K5
UNIT-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.	CO2 CO3 CO4	K1 K2 K3 K5
UNIT-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.	CO2 CO3 CO4 CO5	K1 K2 K3 K5 K6

Recommended Text Books

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-Black well.
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 Robyt JF (2015) Biochemical techniques: Theory and Practice (1st ed),CBS Publishers & Distributors

Reference Books

1. Kaloch Rajan (2011), Analytical techniques in Biochemistry andMolecular Biology, Springer.
2. Segel I.H (1976) Biochemical Calculations (2nd ed), John Wiley andSons.
3. Robyt JF (2015) Biochemical techniques: Theory and Practice (1st ed),CBS Publishers & Distributors.

Website and e-learning source

1. https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Online_(Jakubowski).
2. 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

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
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	K1,K2,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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	1	-	-	1	3	3	3
CO2	3	1	3	2	2	1	1	1	-	1	3	3	3
CO3	3	2	3	3	2	2	-	1	-	1	3	2	3
CO4	3	2	3	1	2	1	1	1	-	1	2	3	3
CO5	3	3	3	3	2	2	1	1	-	1	3	2	3

COURSE DESCRIPTORS

Title of the Course	**LABORATORY COURSE ON BIOMOLECULES AND BIOCHEMICAL TECHNIQUES**	**Hours/Week**	06
Course Code	APCPBC13	**Credits**	04
Category	Core II	**Year & Semester**	I & I
Prerequisites	B.Sc Biochemistry/Chemistry/Microbiology/Plant Biotechnology	**Regulation**	2024

Objectives of the course:

- To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the biomolecules under investigation.
- To inculcate the knowledge of various isolation and purificationtechniques of macromolecules like DNA, RNA, Glycogen and Starch,
- To perform colorimetric estimations to quantify important metabolites like lactate and tryptophan and minerals like calcium andiron from various sources.
- To achieve training in subcellular fractionation and to identify themby markers.
- 5 To achieve training in various chromatographic techniques.
- To perform the isolation and identification of the organelles of a cellusing differential centrifugation.
- To perform photochemical screening and quantification enabling them to give an insight on phytochemicals this will be useful forfuture research.

UNITS	Contents	COs	Cognitive Levels
UNIT-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	CO1 CO3	K1,K2 K3,K5
UNIT-II	UV absorption 1. Denaturation of DNA and absorption studies at 260nm. 2. Denaturation of Protein and absorption studies at 280nm.	CO1 CO2 CO3	K1,K2 K3,K4 K5

UNIT-III	Colorimetric estimations 1.Estimation of Pyruvate. 2.Estimation of tryptophan.	CO3 CO4	K1,K2 K3,K5
UNIT-IV	Estimation of minerals 1. Estimation of calcium. 2. Estimation of iron.	CO2 CO3 CO4	K1, K2, K3, K5
UNIT-V	Plant Biochemistry 1. Qualitative analysis Phytochemical screening. 2. Estimation of Flavonoids -Quantitative analysis Group Experiments 1. Fractionation of sub-cellular organelles by Differential centrifugation- Mitochondria and nucleus. 2. Identification of the separated sub-cellular fractions using markerenzymes (any one). 3. Separation and identification of lipids by thin layer chromatography. 4. Separation of plant pigments from leaves by column Chromatography. 5. Identification of Sugars by Paper Chromatography. 6. Identification of Amino acids by Paper Chromatography	CO2 CO3 CO4 CO5	K1 K2 K3 K5 K6

Recommended Text Books

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 agepublishers.
3. Varley H (2006) Practical Clinical Biochemistry (6th ed) , CBSPublishers.
4. O. Debiyi and F. A. Sofowora, (1978) “Phytochemical screening ofmedical plants,” Iloyidia, vol. 3, pp. 234–246.
5. Prof. Sarin A. Chavhan, Prof. Sushilkumar A. Shinde (2019) AGuide to Chromatography Techniques Edition:1
6. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

Reference Books

1. O. Debiyi and F. A. Sofowora, (1978) “Phytochemical screening ofmedical plants,” Iloyidia, vol. 3, pp. 234–246,
2. Prof. Sarin A. Chavhan, Prof. Sushilkumar A. Shinde (2019) AGuide to Chromatography Techniques Edition:1
3. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

Website and e-learning source

1. https://www.researchgate.net/publication/313745155_Practical_Bio chemistry_A_Student_Companion
2. https://doi.org/10.1186/s13020-018-0177
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

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	The student will be able to understand the isolation, purification and estimation of different biomolecules.	K1, K2, K4
CO2	The students will get acquainted the UV absorption studies of DNA and Protein.	K1,K2, K 3, K4
CO3	The student will be fine-tune in handling the instruments like colorimeter and spectrophotometer.	K1,K2,K4
CO4	The student can learn to detect the presence of phytochemicals and quantify.	K1,K2,K3,K4 & K6
CO5	The students will develop skill in analytical and Chromatography techniques.	K1, K2,K3,K4 & K6

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1	1	-	-	-	3	3	3
CO2	3	3	3	2	3	1	1	1	-	1	3	1	3
CO3	3	3	3	3	2	1	2	1	-	1	2	3	3
CO4	3	3	3	2	3	2	2	1	-	-	3	2	3
CO5	3	3	2	2	2	2	2	1	1	1	3	3	2

COURSE DESCRIPTORS

Title of the Course	MICROBIOLOGY & IMMUNOLOGY	Hours/Week	05
Course Code	APEBC14	Credits	03
Category	Elective I	Year & Semester	I & I
Prerequisites	B.Sc Biochemistry/Chemistry/Microbiology/Plant Biotechnology	Regulation	2024

Objectives of the course:

- To appreciate the classification of microorganisms based on their structure, size and shape with an insight into the ancient scripturesabout microbes.
- To understand the role of microorganisms in environment and also tolearn the culture conditions.
- To recognize the possible contamination of foods by microorganisms, to learn about counteracting preservative measures. And to know about probiotics nature of microorganisms.
- To gain knowledge on pathogenic mediation by microorganisms andpreventive measures as well.
- To comprehend the features of antimicrobial agents, their mechanism of action along with the side effects and also to explorenatural remedial measures against microbes.
- To be able to exploit the various features of microorganisms for thebeneficial industrial production.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Taxonomical classification - bacteria, viruses (DNA, RNA), algae, fungi and protozoa. Distribution and role of microorganisms in soil, water and air. Charaka's classification of microbes, lytic cycle and lysogeny. Types of culture media, isolation of pure culture, growth curve and the measurement of microbial growth.	CO1 CO3	K1 K2 K3
UNIT-II	Contamination and spoilage of foods – cereals, cereal products, fruits, vegetables, meat, fish, poultry, eggs, milk and milk products. 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, control of oxygen and enzymes. Microbes involved in preparation of fermented foods - cheese, yoghurt, curd, pickles, rice pan cake, appam, ragi porridge and bread.	CO1 CO2 CO3	K1 K2 K3 K4

UNIT-III	Food poisoning- bacterial food poisoning, *Salmonella*, *Clostridium blotulinum* (botulism), *Staphylococcus aureus*, fungal food poisoning –aflatoxin, food infection – *Clostridium, Staphylococcus* and *Salmonella*. 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).	CO3 CO4	K1 K2 K3 K5
UNIT-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 intervention (Natural immunomodulators routinely used in Indian medical philosophy).	CO2 CO3 CO4	K1 K2 K3 K5
UNIT-V	Immune system- definition and properties. 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; structure and functions. Antigens and Complement System: definition, properties- antigenicity and immunogenicity, antigenic determinants and haptens. Antigen - antibody interactions - molecular mechanism of binding. Affinity, avidity, valency, cross reactivity and multivalent binding. Immunoglobulins & Immune Response: Structure, classes and distribution of antibodies, Transplantation immunology- graft rejection and HLA antigens. Immunological techniques, Flow cytometry and its application.	CO2 CO3 CO4 CO5	K1 K2 K3 K5 K6

Recommended Text Books

1. Michael J.Pelczar Jr. (2001) Microbiology (5th ed), McGraw HillEducation (India) Private Limited.
2. Frazier WC, Westhoff DC, Vanitha NM (2010) Food Microbiology (5th ed), McGraw Hill Education (India) Private Limited.
3. Willey J and Sherwood L (2011), Prescott's Microbiology (8th ed)McGraw Hill Education (India).
4. Ananthanarayanan, Paniker and Arti Kapil (2013) Textbook ofMicrobiology (9th ed) Orient Black Swan.
5. Judy Owen, Jenni Punt Kuby (2013) ,Immunology (Kindt, Kuby Immunology) (7th ed) W. H. Freeman & Co.
6. Brooks GF and Carroll KC (2013) Jawetz Melnick & AdelbergsMedical Microbiology, (26th ed) McGraw Hill Education Greenwood D (2012) ,Medical Microbiology, Elsevier Health

Reference Text Books.

1. Michael J.Pelczar Jr. (2001) Microbiology (5th ed), McGraw HillEducation (India) Private Limited.
2. Frazier WC, Westhoff DC, Vanitha NM (2010) Food Microbiology (5th ed), McGraw Hill Education (India) Private Limited.
3. Willey J and Sherwood L (2011), Prescott's Microbiology (8th ed)McGraw Hill Education (India).
4. Ananthanarayanan, Paniker and Arti Kapil (2013) Textbook ofMicrobiology (9th ed) Orient BlackSwan.
5. Judy Owen, Jenni Punt Kuby (2013) ,Immunology (Kindt, Kuby Immunology) (7th ed) W. H. Freeman & Co.
6. Brooks GF and Carroll KC (2013) Jawetz Melnick & Adel bergs Medical Microbiology, (26th ed) McGraw Hill Education.
7. Greenwood D (2012), Medical Microbiology, Elsevier Health.
8. Richards Coico (2018) 8th edition, immunology-a short course, Wiley Black Well.
9. Abul.K.Abbass-10th edition 2019 –Cellular and molecular immunology.

Website and e-learning source

1. https://www.ijam.co.in/index.php/ijam/article/view/1326 (Krumi(Microorganisms) in Ayurveda- a critical review).
2. Virtual Lectures in Microbiology and Immunology, University of Rochester https://www.frontiersin.org/articles/10.3389/fphar.2020.578970/full#h9.
3. https://www.frontiersin.org/articles/10.3389/fmicb.2018.02151/full.
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7559905/

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	To classify different types of microorganisms and explain life cycle of the microbes	K1, K2 & K5
CO2	To recognize the microorganisms involved in decay of foods.	K1, K2 & K4
CO3	To understand the common pathogenic bacterial and fungi	K1 & K2,K4
CO4	To analyze various features of wide variety of antimicrobial agents along with their mode of action	K2, K5 & K6
CO5	To apply knowledge gained in production of important immune components and transplantation immunology.	K2, K4 & K5

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	1	-	-	-	-	3	3	3
CO2	3	2	3	2	2	2	1	1	-	1	3	3	3
CO3	2	2	3	3	2	1	-	1	-	1	3	3	3
CO4	3	3	3	3	2	3	1	1	-	1	3	3	3
CO5	3	3	3	3	2	2	2	-	1	1	3	3	3

COURSE DESCRIPTORS

Title of the Course	**ENERGY AND DRUG METABOLISM**	**Hours/Week**	05
Course Code	APEBC15	**Credits**	03
Category	Core Elective I	**Year & Semester**	I & I
Prerequisites	B.Sc., Biochemistry/Chemistry/Microbiology/Plant Biotechnology	**Regulation**	2024

Objectives of the course:

- Familiarize on concepts of enthalpy, entropy, free energy, redox system, biological oxidation and high energy compounds.
- Provide an insight into the relationship between electron flow and phosphorylation.
- Inculcate knowledge on processes involved in converting light energy to chemical energy and associated food production by autotrophs.
- Provide a platform to understand the versatile role of Krebs cycle, transport of NADH across mitochondrial membrane and energetic.
- Educate on the various phases xenobiotic metabolism.

UNITS	Contents	COs	Cognitive Levels
UNIT-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.	CO1 CO3	K1 K2 K3
UNIT-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.	CO1 CO2 CO3	K1 K2 K3 K4
UNIT-III	Light reaction - Hills reaction, absorption of light, photochemical event. Photo ETC-cyclic and non-cyclic electron flow. Photo phosphorylation - role of CF0-CF1 ATPase. Dark reaction- Calvin cycle, control of C3 pathway, and Hatch-Slack pathway (C4 pathway), Photorespiration. Synthesis and degradation of starch.	CO3 CO4	K1 K2 K3 K5

UNIT-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.	CO2 CO3 CO4	K1 K2 K3 K5
UNIT-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.	CO2 CO3 CO4 CO5	K1 K2 K3 K5 K6

Recommended Text Books

1. David L.Nelson and Michael M.Cox (2012) Lehninger Principles ofBiochemistry (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.

Reference Text Books.

1. Zubay G.L (1999) Biochemistry, (4th ed), Mc Grew-Hill.
2. Devlin RM (1983) Plant Physiology (4th ed), PWS publishers
3. Taiz L , Zeiger E (2010), Plant Physiology (5th ed), Sinauer Associates, Inc

Website and e-learning source

1. https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch21/gibb s.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%20hydrop

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Appreciate the relationship between free energy and redox potential.	K1,K2,K3,K4
CO2	Gain knowledge on role of mitochondria in the production of energy currency of the cell.	K1, K2, K5,
CO3	Acquaint with the process of photosynthesis.	K1,K2,K4,K5
CO4	Comprehend on the diverse role of TCA cycle and the energy obtained on complete oxidation of glucose and fatty acid**.**	K2, K5
CO5	Correlate the avenues available to metabolize the xenobiotics.	K1, K2,K4,K5

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	-	-	-	-	-	3	3	3
CO2	3	2	3	3	2	-	1	1	-	1	3	3	3
CO3	3	2	3	3	3	-	-	2	-	1	2	2	3
CO4	3	1	3	1	2	1	1	-	-	-	3	2	3
CO5	3	2	2	2	2	2	2	-	1	1	3	2	3

COURSE DESCRIPTORS

Title of the Course	**ENZYMOLOGY**	**Hours/Week**	6
Course Code	APCBC21	**Credits**	5
Category	CORE -IV	**Year & Semester**	I & II
Prerequisites	B.Sc Biochemistry/ Chemistry/ Microbiology/ Plant Biotechnology	**Regulation**	2024

Objectives of the course:

- Students will be introduced to the theory and practice of enzymology.
- Mechanisms of catalysis and factors affecting catalysis will be understood
- 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.
- Students will learn about the applications of enzymes in research, medicine, and industry, which will prepare them for careers in industrial and biomedical research.
- The control of metabolic pathways and cellular responses through enzyme regulation will be emphasized.

UNIT-I	UNIT-I Introduction to enzymes and features of catalysis: A short history of the Discovery of enzymes and how they became powerful biochemical tools. Holo enzyme, apo enzyme, cofactors, coenzyme, prosthetic groups. Classification and Nomenclature, Enzyme Specificity - group specificity, absolute specificity, substrate specificity, stereo chemical 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.	CO1	K1,K2, K5

UNIT-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.	CO2	K1,K2 , K3,K4, K5
UNIT-III	Enzyme kinetics I: Activation energy, transition-state theory, steady-state kinetics & pre-steady-state kinetics.Single substrate enzyme catalyzed reactions-assumptions, Michaelis-Menten, derivation of Michaelis-Menten equation Double reciprocal (Line weaver-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 with kinetics. Therapeutic use of enzyme inhibitors-Aspirin, statins (irreversible inhibitors), Methotrexate (competitive inhibitor), Etoposide (non-competitive inhibitor),camptothecin (uncompetitive inhibitor).	CO3	K1, K2, K3, K4
UNIT-IV	Enzyme kinetics II: Allosteric enzymes: Cooperatively, MWC and KNF models of allosteric enzymes, Sigmoidal kinetics taking ATC ase 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, Graphical analysis (diagnostic plots) to differentiate SDR from DDR.	CO4	K1, K2, K5, K6

UNIT-V	Enzyme technology: Immobilization of enzymes – methods - Reversible immobilization (Adsorption, Affinity binding), Irreversible Immobilization (Covalent coupling, Entrapment and Microencapsulation, Cross linking, 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.	CO5	K1,K2 & K3

Recommended Text Books

1. Voet's Biochemistry, Adapted edi, 2011,Voet,D and Voet JG; Wiley,India
2. Lehninger Principles of Biochemistry, 8th edition, 2021, .Nelson DLand Cox MM; WH Freeman & Co, New York
3. Biochemistry, Berg JM, Stryer L, Gatto,G, 8th ed, 2015;WH Freeman & Co., New York.
4. Concepts in Enzymology, R.Katoch, Kalyani publishers January 2013.

Reference Books

1. Enzymology by T.Devasena, Oxford University press, November 2010. ISBN13 -978- 0198064435

2. Understanding Enzymes: An Introductory Text (Muticolour) Paperback – 1 January 2018 by Dr. Aditya Arya (Author, Illustrator), Dr. Amit Kumar (Author), Jayanti Jha (Author)

3. Laboratory guide to Enzymology, by Geoffrey A. Holdgate (Author), Antonia Turberville (Author), Alice Lanne (Author), 1st Edition, March 2024. ISBN-13 978-1394179794

Website and e-learning source

1. Enzymes | MIT Open Course Ware | Free Online Course Materials
   https://ocw.mit.edu/high-school/biology/exam-prep/chemistry-oflife/enzymes/
2. Enzymology
   https://onlinecourses.swayam2.ac.in/cec20_bt20/preview
   https://mooc.es/course/enzymology/
3. The active site of enzymes
   https://dth.ac.in/medical/courses/biochemistry/block-1/1/index.php
4. 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/

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
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.	K1, K2, K3 &K4
CO4	Explain allosterism and co operativity and differentiate Michaelis-Menten kinetics from sigmoidal kinetics.	K1, K2 , K5, K6
CO5	Highlight the use of enzymes in industries and biomedicine.	K1,K2 & K3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	-	2	-	2	-	-	1	-	3	2	1
CO2	3	1	-	1	-	2	-	1	-	1	3	2	=
CO3	3	3	-	3	-	3	2	3	-	-	3	1	1
CO4	3	2	1	2	-	2	1	1	-	2	1	1	2
CO5	3	3	2	3	2	3	2	2	-	-	3	2	2

COURSE DESCRIPTORS

Title of the Course	**CELLULAR METABOLISM**	**Hours/Week**	6
Course Code	APCBC 22	**Credits**	5
Category	CORE -V	**Year & Semester**	I & II
Prerequisites	B.Sc Biochemistry/Chemistry/Microbiology/Plant Biotechnology	**Regulation**	2024

Objectives of the course:

- Familiarize on blood glucose homeostasis.
- Provide an insight into the metabolic path way of glycogen, glycoprotein, mucopolysaccharide and peptidoglycan with clinical correlation wherever required.
- Inculcate knowledge on nucleotide metabolism and disorders associated with it
- Provide a platform to understand the versatile role of PLP in amino acid degradation, formation of specialized products and disorders associated with ammonia detoxification
- Educate on heme and sulphur metabolism with associated clinical manifestation.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Glycolysis – aerobic and anaerobic, inhibitors, and regulation. Galactosemia, fructosuria, Pyruvate dehydrogenase complex mechanism and regulation. Glyoxalate cycle and its regulation. Gluconeogenesis- source, key enzymes, reaction sequence and its regulation. Pentose phosphate pathway significance and its regulation. Metabolism of glycogen – glycogenesis and Glycogenolysis – its regulation.	CO1	K1,K2,K5
UNIT-II	Oxidation of fatty acids-oxidation of saturated and unsaturated fattyacids (α, β & ω oxidation). Regulation of β oxidation. Ketogenesis and its regulation. Biosynthesis of fatty acid– saturated and unsaturated, chain elongation, regulation. Biosynthesis of prostaglandins, thromboxanes and leukotrienes. 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.	CO2	K1, K2, K5
UNIT-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.	CO3	K1,K2,K4

UNIT-IV	Biosynthesis of non- essential amino acids- Role and biological significance of glutamate dehydrogenase, glutamine and asparagine 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.	CO4	K1,K2,K4
UNIT-V	Biosynthesis and degradation of heme. Jaundice-classification, pathology and Differential diagnosis. Oxidation and reduction of inorganic sulphur compounds by microbes and plants. Sulphotransferases and their biological role-rhodanases, sulphatases, 3-mercapto pyruvate sulphur transferases. Mucopolysaccharidoses - Hunter syndrome, Sanfilippo syndrome and Maroteaux-Lamy syndrome. Oxidation of cysteine to sulphate and inter conversion of sulphur compounds.	CO5	K1,K2, K4, K5

Recommended Text Books

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. Zubay G.L (1999) Biochemistry , (4th ed), Mc Grew-Hill.

4. Textbook of Biochemistry with Clinical Correlations, 7th Edition,Thomas M. Devlin (Editor), Wiley Publication(2010).

5. Human Biochemistry – James M.Orten & Otto.W.Neuhan- 10th edn- The C.V.Mosby Company(2020).

Reference Books

1. Donald Voet, J.G. Voet, John Wiley,‖ Biochemistry", 4th edition, 2010.

2. Davidson & Sittman, ―Biochemistry NM., 3rd edition", Lippincott. Willams and Wilkins, 2005

3. Harper's Illustrated Biochemistry by Robert K.Murray,Mc Graw Hill Publishers.

4. Enzyme Regulation in metabolic pathways by Lioyd wolfinvarger ,Wiley Publication,2017.

Website and e-learning source

1. Glycolysis: https://www.embopress.org/doi/full/10.1038/msb.2013.19
2. Glycogen metabolism: https://people.wou.edu/~guralnl/450Glycogen%20metabolism.pdf
3. Urea cycle: https://www.researchgate.net/publication/334458898_Urea_Cycle
4. Hemebiosynthesis: https://www.researchgate.net/publication/51233381_Heme_biosynthesis_and_its_regulation_Towards_understanding_and_improvement_ofheme_biosynthesis_in_filamentous_fungi

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
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 breaking 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	1	2	3	3	3	3	1	-	3	3	2
CO2	3	3	2	2	1	2	2	3	-	1	2	3	-
CO3	3	-	-	1	-	2	2	-	-	-	-	3	-
CO4	2	1	-	1	-	2	-	-	-	1	3	3	3
CO5	3	2	-	3	2	3	3	3	-	-	2	3	3

COURSE DESCRIPTORS

Title of the Course	**LAB COURSE IN ENZYMOLOGY , MICROBIOLOGY AND CELL BIOLOGY**	**Hours/Week**	6
Course Code	APCPBC 23	**Credits**	4
Category	CORE-VI	**Year & Semester**	I & II
Prerequisites	B.Sc Biochemistry/Chemistry/Microbiology/Plant Biotechnology	**Regulation**	2024

Objectives of the course:

- 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.
- To inculcate the knowledge of isolation and purification techniques of enzymes using alkaline phosphatase as an example.
- To perform experiments to study the factors affecting enzyme activity.
- To achieve training in assay of enzymes.
- To achieve training in basic microbiological techniques – preparation of culture, sterilization and staining methods.
- To perform the blood grouping test and to prepare blood smear to study different types of blood cells.
- To learn molecular biology techniques like Gel electrophoresis and Blotting techniques.
- To introduce industrial visit so that students may be aware of actual need of the industry and various opportunities available.

UNITS	Contents	COs	Cognitive Levels
UNIT- I	**Enzymology** Alkaline Phosphatase a. Isolation of Alkaline Phophatase from goat kidney. b. Determination of optimum pH and temperature of alkaline phosphatase. c. Determination of specific activity and Km of alkaline phosphatase. d. Effect of activators and inhibitors on the activity of alkaline phosphatase. Assay of enzymes a. Salivary Amylase b. Acid Phosphatase	CO1	K1,K2, K4, K5

UNIT- II	**Microbiology** a. Safety measures and Good Laboratory Practices in microbiology laboratory b. Sterilization, Culture and inoculums preparation c. Staining of bacteria – Gram Staining	CO2	K1,K2,K4
UNIT-III	**Physiology & Cell Biology** a. Test for blood grouping (Haem agglutination). b. Peripheral Blood smear –Staining and Interpretation	CO3	K1,K3,K4
UNIT-IV	**Group Experiments** a. Separation of proteins based on molecular weight by SDS PAGE b. Agarose gel electrophoresis of genomic DNA	CO4	K1,K3,K4 & K6
UNIT-V	Industrial visit can be organized to students through Academia – Industry. Collaborative Program.	CO5	K1,K2, K3,K4 & K6

Recommended Text Books

1. David Plummer (2019) An Introduction to Practical Biochemistry(3rd edi) McGraw HillEducation (India) Private Ltd
2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age Publishers.
3. Fundamentals of Enzymology; 3rd Edition. Nicholas C. Price and Lewis Stevens, OxfordUniversity Press (2012).
4. Cappuccino JG & Sherman N (2005). Microbiology-A Laboratory Manual, PearsonEducation Inc
5. Practical Enzymology, Second Revised Edition: Hans Bisswanger, Wiley – Blackwell; 2 edition(2011)

Reference Books

1. H.Varley. Practical Clinical Biochemistry, 6th Edition, CBS Publishers, 2022.
2. Practical Biochemistry For Medical Students - Raghu, JAYPEE, 2006
3. Practical Clinical Biochemistry Hard cover–Harold Varley, Sixth Edition, Alan H Gowen lock.
4. Practical Biochemistry by Keith Wilson and John walker.

Website and e-learning source

1. Kinetic_studies: https://www.researchgate.net/publication/337146254_Kinetic_studies_with_alkaline_phosphatase
2. Periheral_smear: https://www.researchgate.net/publication/349318898_ABC_of_ Periheral_smear
3. Lab safety: https://ncdc.gov.in/WriteReadData/l892s/File608.pdf .
4. Gram staining: https://www.ncbi.nlm.nih.gov/books/NBK562156/

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	The student will be able to employ the relevant techniques for isolation and purification of enzymes.	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 Blood grouping and smear preparation.	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.	K1,K2,K3,K4 & K6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	3	3	2	1	-	3	2	3
CO2	3	2	1	1	3	3	3	2	-	1	3	3	3
CO3	2	2	1	1	2	3	3	2	2	-	3	2	2
CO4	3	2	1	1	2	3	3	2	-	1	3	3	3
CO5	3	3	1	3	3	3	3	2	1	-	3	3	2

COURSE DESCRIPTORS

Title of the Course	**BIOSTATISTICS & DATA SCIENCE**	**Hours/Week**	3
Course Code	**APEBC 24**	**Credits**	3
Category	**ELECTIVE –III**	**Year & Semester**	I & II
Prerequisites	B.Sc Biochemistry/ Chemistry/ Microbiology/ Plant Biotechnology	**Regulation**	2024

Objectives of the course:

- To summarize the data and to obtain its salient features from the vast mass of original data.
- To understand the concept of various measures of dispersion.
- To understand the concepts of sampling and learning test of significance.
- To understand the concept of various attributes and relate to biological studies.
- To gain knowledge in SPSS, a software package which gives a perfect graphicalrepresentation and appropriate result for the data that has been entered.

UNITS	Contents	COs	Cognitive Levels
UNIT-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.	CO1	K1,K2,K3
UNIT-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.	CO2	K1,K2,K3
UNIT-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.	CO3	K1,K2,K3,K4
UNIT-IV	Small sample tests – Students 't' test for mean, difference of twoway 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 ways. Basic concept related to biological studies	CO4	K1,K2,K3,K4

UNIT-V	Definition to Data Science, Algorithms - Machine Learning Deep Learning, Artificial Neural Networks, Artificial Intelligence (AI), Big Data and their Application in medical, health and pharma industries.	CO5	K1,K2,K3,K4, K6

Recommended Text Books

1. Basics of Biostatistics by A.P. Kalkarani 2 nd edition (pb 2020)
2. Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1st edition,Springer
3. Introduction to biostatistics Dr. Pranab kr. banerjee,4 th edition,2011

Reference Books

1. A Text book of Biostatistics by Annadurai pillai 1st edition,2007
2. Rosner, B (2005), "Fundamentals of Biostatistics", Duxbury Press
3. Introducing Data Science, Davy Cielen, Anro DB Meysman, Mohamed Ali,2016

Website and e-learning source

1. Statistics: https://www.ibm.com/docs/en/SSLVMB_28.0.0/pdf/Accessibility.pdf
2. Statistical methods for bioassay: https://pure.tue.nl/ws/portalfiles/portal/19478370/20160419_CO_Mzolo.pdf
3. Data analysis: https://students.shu.ac.uk/lits/it/documents/pdf/analysing_data_using_s pss.pdf
4. Data documentation: https://www.ibm.com/support/pages/ibm-spss-statistics-28- documentation

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
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.	K1,K2,K3
CO3	Learning different sampling methods and analyzing statistical significance.	K1,K2,K3,K4
CO4	Understanding students t test, ANOVA, Chi square test to analyze the significance of various research.	K1,K2,K3,K4
CO5	Learning on data science, artificial intelligence and big data, their applications in pharma domain.	K1,K2,K3,K4.K6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	3	3	2	-	-	3	1	1
CO2	2	2	2	2	2	3	3	2	-	-	3	1	1
CO3	2	3	2	3	2	3	3	2	-	-	3	1	1
CO4	3	3	2	3	2	3	3	1	-	-	3	2	1
CO5	3	2	2	3	2	3	3	1	-	-	3	2	1

COURSE DESCRIPTORS

Title of the Course	**BIOSAFETY, LAB SAFETY AND IPR**	**Hours/Week**	3
Course Code	**APEBC 25**	**Credits**	3
Category	**ELECTIVE-IV**	**Year & Semester**	I & II
Prerequisites	B.Sc Biochemistry/ Chemistry/ Microbiology/ Plant Biotechnology.	**Regulation**	2024

Objectives of the course:

- To assimilate the hazards associated with the handling of biological and chemical agents.
- To understand how to protect from the hazards by the implementation of various safety measures in biochemical laboratories.
- To implicate the importance of protecting the scientific intellect by filing patent and understand the various offices for filing and maintaining patents
- To understand the scope of patenting in biological research.
- To create an awareness of ethics associated with used of genetically modified organisms/cells and its rationale for use in living organisms.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Biosafety: Historical background; 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; risk management and communication; national regulations and international agreements.	CO1	K1,K2, K3,K4
UNIT-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. Good lab practice (GLP). History of Biosafety microbiology and molecular biology, Risk assessment, Personal protective equipment, Laboratory facilities and safety equipment, Disinfection, decontamination, and sterilization, Regulatory compliance, Laboratory security and emergency response and administrative controls.	CO2	K1,K2,K3

UNIT-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. The patentability of microorganisms-claims, Characterization and repeatability disposition in the culture collections, legal protection for plants and other higher organisms, new plant varieties by rights, tissue culture protocols.	CO3	K1,K2,K3
UNIT-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 Indian patents (basmati rice, turmeric, neem etc.), and patent infringement.	CO4	K1,K2, K3, K4
UNIT-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. CPCSEA guidelines.	C05	K1,K2, K4,K5

Recommended Text Books

1. Biosafety in Microbiological and Biomedical Laboratories, (2020) 6thEd. (https://www.cdc.gov/labs/pdf/SF_19_308133-A_BMBL6_00- BOOK-WEB-final3.pdf)

2. Kankanala C., (2007), Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd.,

Reference Books

1. Deepa Goel, Shomini Parashar, (2013). IPR, Biosafety and Bioethics, Pearson. (Unit II)
2. R. Ian Freshney, 2016. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Ed, John Wiley & Blackwell.
3. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007. (Unit I)
4. Bioethics and biosafety in biotechnology by V.Sree Krishna, Edition 1,2017

Website and e-learning source

1. Biosafety tools:https://www.cdc.gov/safelabs/resources-tools/biosafety-resources-and-tools.html
2. Lab safety: https://ehs.washington.edu/research-lab/laboratory-safety
3. Biosafety levels: https://www.cdc.gov/labsafety/index.html
4. Introduction to lab safety: https://www.ncbionetwork.org/iet/labsafety/

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
CO1	Understand and implement various aspects of Biosafety and carry out risk assessment of products in biological research	K1,K2,K3,K4
CO2	Understand the basic concepts of laboratory safety, safe handling of hazardous chemicals and emergency response.	K1,K2,K3
CO3	Appreciate the intellectual property rights and its implementation of on the invention related to biological research.	K1,K2,K3
CO4	Understand the statutory bodies that regulate the property rights and its validity in various countries.	K1,K2,K3K4
CO5	Critique the ethical concerns associated with modern biotechnology processes and plans accordingly.	K1,K2,K4,K5

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	3	3	2	1	-	1	1	1
CO2	3	3	3	3	2	3	3	2	2	-	1	2	1
CO3	2	2	2	2	2	2	2	2	-	1	1	1	1
CO4	2	2	3	2	2	3	2	2	-	-	1	1	1
CO5	3	3	3	3	2	2	3	2	-	1	1	1	1

COURSE DESCRIPTORS

Title of the Course	**NUTRITIONAL BIOCHEMISTRY**	**Hours/Week**	4
Course Code	**APSBC 26**	**Credits**	2
Category	**Skill Enhancement Course [SEC] - I**	**Year & Semester**	I & II
Prerequisites	B.Sc Biochemistry/ Chemistry/ Microbiology/ Plant Biotechnology**.**	**Regulation**	2024

Objectives of the course:

- To understand basic concepts involved in growth, health, nutrition, physiology and metabolism
- To discuss the concepts and applications of nutrition in correlation with biochemistry.
- To define nutritional needs in healthy individuals and modification of diet during illness.

UNITS	Contents	COs	Cognitive Levels
UNIT-I	Basic concepts - Nutrition - Food groups and balanced diet. Novel Foods. Calorific value of foods: Direct and indirect calorimeter. Empty calories. Basal metabolic rate: Factors affecting BMR. SDA and physical activity. Calculation of daily 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.	CO1	K3, K4, K5
UNIT-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 fiber. 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.	CO2	K1 to K6
UNIT-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.	CO3	K1 to K6

UNIT-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)	CO4	K3,K4
UNIT-V	Nutrition in diseases - Aetiology, signs and symptoms , treatment and dietary management during fever(Typhoid and Malaria) and infectious diseases(COVID-19), Jaundice, Liver toxicity, hyper acidity (Ulcer), Atherosclerosis, Hypertension, kidney diseases and diabetes in adults. Starvation and Obesity. Inter-relationship of nutrition,infection, immunity and poverty.	CO5	K5,K6

Recommended Text Books

1. Srilakshmi. E (2016) Nutrition Science, New Age International Publishers.
2. Mahan, Kathleen L. (2004) Krause's Food, Nutrition and Diet TherapyW.B.Saunder's11thEdition
3. Andreas M. Papas (1998). Antioxidant Status, Diet, Nutrition, and Health (1st ed) CRC Press.4. Modern Nutrition by Catharineross,Woiters Kiuwe publishers.
5. Complete food and Nutrition Guide By Robert Larson duyff ,John and Willy Publishers.

Reference Books

1. M. Swaminathan (1995) Principles of Nutrition and Dietetics.
2. Margaret Mc Williams (2012). Food Fundamentals (10th ed) Prentice Hall
3. Dr. S. Mohana sundaram ,Edition 1,2024.
4. USA4.Nutritional Biochemistry By chadcox, CRC Press Publishers
5. Nutritional Biochemistry by Sharma. D.C,2017.
6. Textbook of Human Nutrition Paperback by Ph.d.Anjana Agarwal, 2nd edition ,January 2022

Website and e-learning source

1. Nutritional biochemistry:
https://www.sciencedirect.com>book>nutritional-bioch.3.
2.Healthy diet:
https://www.ncbi.nlm.nih.gov>books>NBK554545

Course Learning Outcomes (for Mapping with POs and PSOs)

On completion of the course the students should be able to

COs	CO Description	Cognitive Level
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.	K1 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	K3,K4

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	3	3	3	1	-	2	3	2
CO2	2	3	2	2	3	3	3	3	1	1	1	3	3
CO3	3	3	1	2	3	3	3	3	1	-	2	3	3
CO4	3	3	1	2	3	3	3	3	-	1	2	3	2
CO5	2	3	1	3	3	3	3	3	1	-	2	3	2