

M.Sc. BIOCHEMISTRY

LOCF SYLLABUS 2023



Department of Biochemistry
School of Biological Sciences
St. Joseph's College (Autonomous)
Tiruchirappalli - 620 002, Tamil Nadu, India

Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value-driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

Programme Educational Objectives (PEOs)

1. Graduates will be able to accomplish professional standards in the global environment.
2. Graduates will be able to uphold integrity and human values.
3. Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

Programme Outcomes (POs)

1. Graduates will be able to apply the concepts learnt, in real life situations with analytical skills.
2. Graduates with acquired skills and enhanced knowledge will be employable/ become entrepreneurs or will pursue higher Education.
3. Graduates with acquired knowledge of modern tools and communicative skills will be able to contribute effectively as team members.
4. Graduates will be able to read the signs of the times analyze and provide practical solutions.
5. Graduates imbued with ethical values and social concern will be able to appreciate cultural diversity, promote social harmony and ensure sustainable environment.

Programme Specific Objectives (PSOs)

1. Graduates are prepared to be creators of new knowledge in the field of life sciences, causing innovation and entrepreneurship, employable in various sectors such as private, government, and clinical /biomedical research organizations.
2. Graduates are trained to study and evolve the biomolecular mechanisms for the life processes in health and diseases.
3. Graduates are groomed to carry on research in biology on chemical basis, by exploring their knowledge independently.
4. Graduates are encouraged to design and conduct experiments, to analyze and interpret biological problems behind the research.
5. Graduates ought to have the ability of effectively communicating the findings of Biological sciences with existing knowledge ethically.

CONTINUOUS INTERNAL ASSESSMENT

Categorizing Outcome Assessment Levels Using Bloom's Taxonomy

Level	Cognitive Domain	Description
K1	Remember	It is the ability to remember the previously learned concepts or ideas.
K2	Understand	The learner explains concepts or ideas.
K3	Apply	The learner uses existing knowledge in new contexts.
K4	Analyse	The learner is expected to draw relations among ideas and to compare and contrast.
K5	Evaluate	The learner makes judgements based on sound analysis.
K6	Create	The learner creates something unique or original.

Question Paper Blueprint for Mid and End Semester Tests

Duration: 2 Hours		Maximum Marks: 60						
Section		K level*						Marks
		K1	K2	K3	K4	K5	K6	
A (no choice)		7						$7 \times 1 = 7$
B (no choice)			5					$5 \times 3 = 15$
C (either... or type)				3				$3 \times 6 = 18$
D (2 out of 3)	Courses with K4 as the highest cognitive level				2			$2 \times 10 = 20$
	Courses with K5 as the highest cognitive level wherein one question each on K4 and K5 is compulsory. (Note:K4 has two questions whereas, K5 has no choice.)				1	1		
	Courses with K6 as the highest cognitive level wherein one question each on K5 and K6 is compulsory. (Note: Mid Sem: K4 has two questions whereas, K5 has no choice; End sem: K5 has two questions whereas, K6 has no choice)				Mid Sem			
						End Sem		
					1	1	1	
	Total							

* K4 and K5 levels will be assessed in the Mid semester test whereas K5 and K6 levels will be assessed in the End semester test.

Question Paper Blueprint for Mid and End Semester Tests *(For quantitative courses only)*

Duration: 2 Hours						Maximum Marks: 60	
Section	K level						Marks
	K1	K2	K3	K4	K5	K6	
A (no choice)	5	4					$9 \times 1 = 9$
B (either... or type)			2	1			$3 \times 5 = 15$
C (2 out of 3)					1	1*	$2 \times 18 = 36$
Total							60

NOTE: *K4 and K5 will be assessed in the Mid semester test whereas K5 and K6 will be assessed in the End semester test.*

* *K6 compulsory*

SEMESTER EXAMINATION

Question Paper Blueprint for Semester Examination

Duration: 3 Hours		Maximum Marks: 100						
Section		K level						Marks
		K1	K2	K3	K4	K5	K6	
A (no choice, two questions from each unit)		10						$10 \times 1 = 10$
B (no choice, two questions from each unit)			10					$10 \times 3 = 30$
C (either... or type, one question from each unit)				5				$5 \times 6 = 30$
D (3 out of 5, one question from each unit)	Courses with K4 as the highest cognitive level				3			$3 \times 10 = 30$
	Courses with K5 as the highest cognitive level wherein two K4 questions and one K5 question are compulsory. (Note: Three questions on K4 and two questions on K5)				2	1		
	Courses with K6 as the highest cognitive level wherein one question each on K4, K5, and K6 is compulsory. (Note: Two questions each on K4 and K5 and one question on K6)				1	1	1	
Total								100

Question Paper Blueprint for Semester Examination *(For quantitative courses only)*

Section	Marks	K level
A	$10 \times 1 = 10$	K1
B	$5 \times 6 = 30$ <i>(either...or)</i>	K2 (Q. No. 11 & 12) K3 (Q. No. 13, 14 & 15)
C	$4 \times 15 = 60$ <i>(4 out of 5)</i>	K4 (Q. No. 16 & 17) K5 (Q. No. 18 & 19) K6 (Q. No. 20 compulsory)
Total Marks: 100		

Evaluation Pattern for Part IV One/Two Credit Courses

Title of the Course	CIA	Semester Examination	Total Marks
Internship	100		100
UG Skill Enhancement Course (Non Major Elective) Foundation Course PG Ability Enhancement Course	$20 + 10 + 20 = 50$	50 <i>(External member from the Department)</i>	100
Value Education	50	50 (CoE)	100

M.Sc. BIOCHEMISTRY							
PROGRAMME PATTERN							
Course Details					Scheme of Exams		
Sem	Course Code	Title of the Course	Hours	Credits	CIA	SE	Final
1	23PBI1CC01	Core Course - 1: Basics of Biochemistry	6	6	100	100	100
	23PBI1CC02	Core Course - 2: Biochemical and Molecular Techniques	6	6	100	100	100
	23PBI1CP01	Core Practical - 1: Biomolecules and Biochemical Techniques	6	4	100	100	100
	23PBI1ES01	Elective - 1: Microbiology and Immunology	5	3	100	100	100
	23PBI1ES02	Elective - 2: Energy and Drug Metabolism	5	3	100	100	100
	23PBI1AE01	Ability Enhancement Course: Herbal Technology	2	1	100	-	100
	Total		30	23			
2	23PBI2CC03	Core Course - 3: Molecular Biology	4	4	100	100	100
	23PBI2CC04	Core Course - 4: Bioenergetics and Enzymology	4	4	100	100	100
	23PBI2CC05	Core Course - 5: Genetic Engineering	4	3	100	100	100
	23PBI2CP02	Core Practical - 2: Enzymology, Physiology and Molecular Techniques	5	4	100	100	100
	23PBI2SP01	Self-paced Learning: Advanced Nutrition*	-	2	50	50	50
	23PBI2ES03A	Elective- 3: Developmental Biology	5	4	100	100	100
	23PBI2ES03B	Elective -3: Life Sciences for Competitive Exams - 1			100	-	100
	23PSS2SE01	Skill Enhancement Course: Soft Skills	4	3	100	-	100
	23PBI2EG01	Generic Elective - 1 (WS): Biochemistry of Natural Products	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 1	-	(3)			
	Total		30	27(3)			
3	23PBI3CC06	Core Course - 6: Human Physiology	6	6	100	100	100
	23PBI3CC07	Core Course - 7: Pharmaceutics and Nanotechnology	5	5	100	100	100
	23PBI3CC08	Core Course - 8: Advances in Clinical Research	5	5	100	100	100
	23PBI3CP03	Core Practical - 3: Immunology, Andrology, Hormone Assay and Miscellaneous	5	5	100	100	100
	23SBS3CC01	Common Core: Intellectual Property Rights	5	4	100	100	100
	23PBI3EG02	Generic Elective - 2 (BS): First Aid Management	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 2	-	(3)			
	Total		30	28(3)			
4	23PBI4CC09	Core Course - 9: Clinical Biochemistry	5	5	100	100	100
	23PBI4CC10	Core Course - 10: Advanced Endocrinology	6	6	100	100	100
	23PBI4CP04	Core Practical - 4: Biochemical Analysis of Blood and Hematological Studies	8	6	100	100	100
	23PBI4ES04A	Elective - 4: Life Sciences for Competitive Exams - 2	5	4	100	100	100
	23PBI4ES04B	Elective - 4: Forensic Science			100	100	100
	23PBI4PW01	Project Work and Viva Voce	6	5	100	100	100
	23PBI4CE01	Comprehensive Examination*	-	2	50	50	50
	-	Extra Credit Courses (MOOC/Certificate Courses) - 3	-	(3)			
	Total		30	28(3)			
2 - 4	23PCW4OR01	Outreach Programme (SHEPHERD)	-	4			
1 - 4	Total (2 years)		120	110			

*- for grade calculation 50 marks are converted into 100 in the mark statements

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PBI1CC01	Core Course - 1: Basics of Biochemistry	6	5

Course Objectives
Students will be introduced to the structure of biomolecules.
The significance of carbohydrates in biological processes will be understood.
The structure, properties and biological significance of lipids in the biological system will be studied
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.
Students will gain knowledge about the structures and functional roles of nucleic acids in the biological system.
The students will study the integration of metabolism of various metabolites like carbohydrates, proteins and nucleic acids.

UNIT I: Carbohydrates (18 Hours)

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) and plant cell wall carbohydrates.

UNIT II: Lipids (18 Hours)

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.

UNIT III: Amino Acids (18 Hours)

Overview of Amino acids - classification, structure and properties of amino acids, biological role. Non-Protein amino acids 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.

UNIT IV: Membrane Proteins

(18 Hours)

Membrane structure-fluid mosaic model. Membrane Proteins - Types and their significance. Cytoskeleton proteins - actin, tubulin, intermediate filaments. Biological role of cytoskeletal 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.

UNIT V: Nucleic Acids

(18 Hours)

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 super coiling (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.

Teaching methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study:

1. Murray, R. K. & et al. (2000). *Harper's biochemistry*. Appleton and Lange Stanford Publishers, Connecticut.
2. Lehninger, A. L. & et al. (1993). *Principles of biochemistry*. Worth Publishers. Inc.
3. Rawn, J.D. (1989). *Biochemistry*. Neil Patterson Publ.

Books for Reference

1. Stryer, I. (1988). *Biochemistry* (2nd ed.). W.H. Freeman & Co.
2. White, A. & et al. (1959). *Principles of biochemistry*. McGraw Hill Book Co.
3. Voet, D. & Voet, J. G. (2011). *Biochemistry* (4th ed.). John Wiley and Sons.

Websites and eLearning Sources

1. [https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Online_\(Jakubowski\)](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>

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PBI1CC02	Core Course - 2: Biochemical and Molecular Techniques	6	5

Course Objectives
To understand the various techniques used in biochemical investigation and microscopy.
To explain chromatographic techniques and their applications.
To explain electrophoretic techniques.
To comprehend the spectroscopic techniques and demonstrate their applications in biochemical investigations.
To acquire knowledge of radio labeling techniques and centrifugation.
To apply the knowledge to biomedical research.

UNIT I: General Approaches in Research and Microscopy (18 Hours)

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.

UNIT II: Chromatographic Techniques (18 Hours)

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, 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 and perfusion chromatography.

UNIT III: Electrophoretic Techniques (18 Hours)

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.

UNIT IV: Spectroscopic Techniques (18 Hours)

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

UNIT V: Radiolabeling Techniques and Centrifugation (18 Hours)

Nature of radioactivity-detection and measurement of radioactivity, methods based upon ionisation (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.

Teaching methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study

1. Upadhyay, A., Upadhyay, K., & Nath, N. (2014). *Biophysical chemistry principles and techniques* (4th ed.). Himalaya Publishing House.
2. Kothari, C.R. (2004). *Research methodology, methods and techniques* (2nd ed.). New Age International Publishers.
3. Freifelder, D. M. (1982). *Physical biochemistry: Applications to biochemistry and molecular biology*. W.H.Freeman.
4. Boyer, R. F. (2012). *Biochemistry laboratory: Modern theory and techniques* (2nd ed.). Prentice Hall.
5. Rajan, K. (2011). *Analytical techniques in biochemistry and molecular biology*, Springer.
6. Segel, I.H. (1976). *Biochemical calculations* (2nd ed.). John Wiley and Sons.
7. Robyt, J. F. (2015). *Biochemical techniques: Theory and practice* (1st ed.). CBS Publishers & Distributors.

Books for References

1. Daniel, W. W. (2006). *Biostatistics: A foundation for analysis in the health sciences* (9th ed.). John Willey and Sons Inc.
2. Attwood, T. K., & Parry-Smith, D.J. (1999). *Introduction to bioinformatics*. Pearson Education Ltd.
3. Boyer, R. F. (1993). *Modern experimental biochemistry* (2nd ed.), Benjamin- Cummings Publishing.

Website and eLearning Source

<https://www.kau.edu.sa/Files/0017514/Subjects/principals%20and%20techniques%20of%20biochemistry%20and%20molecular%20biology%207th%20ed%20>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will 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
CO2	demonstrate knowledge to implement the theoretical basis of chromatography in upcoming practical course work	K2
CO3	demonstrate knowledge to implement the theoretical basis of electrophoretic techniques in research work	K3
CO4	tackle more advanced and specialized spectroscopic techniques that are pertinent to research	K4
CO5	tackle more advanced and specialized radioisotope and centrifugation techniques that are pertinent to research work	K5
CO6	apply the knowledge in biomedical research	K6

Relationship Matrix											
Semester	Course code		Title of the Course							Hours	Credits
1	23PBI1CC02		Core Course - 2: Biochemical and Molecular Techniques							6	5
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	1	2	3	2	2	1	2.0
CO2	1	2	3	2	1	2	2	3	2	1	2.0
CO3	2	2	3	2	1	2	3	3	2	1	2.1
CO4	3	2	3	2	1	2	3	3	2	1	2.2
CO5	2	3	3	2	1	2	3	1	3	1	2.1
CO6	3	3	3	2	1	2	3	1	3	1	2.2
Mean overall Score											2.1 (High)

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PBI1CP01	Core Practical - 1: Biomolecules and Biochemical Techniques	6	4

Course Objectives
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 purification techniques of macromolecules like DNA, RNA, Glycogen and Starch.
To perform colorimetric estimations to quantify important metabolites like lactate and tryptophan and minerals like calcium and iron from various sources.
To achieve training in subcellular fractionation and to identify them by markers.
To achieve training in various chromatographic techniques.
To perform the isolation and identification of the organelles of a cell using differential centrifugation.
To perform phytochemical screening and quantification enabling them to give an insight on phytochemicals this will be useful for future research.

UNIT I: Biochemical Studies, Estimation of Macromolecules and UV Absorption

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.
5. Denaturation of DNA and absorption studies at 260 nm.
6. Denaturation of Protein and absorption studies at 280 nm.

UNIT II: Colorimetric estimations

1. Estimation of Pyruvate
2. Estimation of tryptophan.

UNIT III: Estimation of Minerals

1. Estimation of calcium
2. Estimation of iron

UNIT IV: Plant Biochemistry

1. Qualitative analysis Phytochemical screening
2. Estimation of Flavonoids -Quantitative analysis

UNIT V: 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 column chromatography
5. Identification of Sugars by Paper Chromatography
6. Identification of Amino acids by Paper Chromatography

Books for Study

1. Godkar, P. B. (2014). *Text book of medical laboratory technology* (3rd ed., Vol I and II). Bhalani Publishing house.
2. Gowenlock, Alan H. (2002). *Varley's practical clinical biochemistry* (6th ed.). CBS publishers.
3. Sadasivam, S. & Manickam, A. (2010). *Biochemical methods* (3rd ed.). New Age International (P) Ltd.
4. David T. Plummer. (1988). *Practical biochemistry* (3rd ed.). Tata McGraw-Hill Publishers.

Books for Reference

1. Plummer, D. (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. Debiyi, O. & Sofowora, F. A. (1978). *Phytochemical screening of medical plants*. (vol. 3). Iloyidia.
5. Chavhan, S. A. & Shinde S. A. (2019). *A guide to chromatography techniques* (1st ed.).
6. Katoch, R. (2011). *Analytical techniques in biochemistry and molecular biology*. Springer.

Web Sources

1. [https://www.researchgate.net/publication/313745155_Practical Biochemistry_A_Student_Companion](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>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will be able to	
CO1	acquire knowledge and skill in the techniques used in the isolation, purification and estimation of different biomolecules that are widely employed in research	K1
CO2	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	K2
CO3	be fine-tune in handling the instruments like colorimeter, spectrophotometer and will be able to estimate the biomolecules and minerals from the given samples	K3
CO4	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	K4
CO5	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	K5
CO6	perform phytochemical screening and quantification enabling them to give an insight on phytochemicals this will be useful for future research	K6

Relationship Matrix											
Semester	Course code		Title of the Course							Hours	Credits
1	23PBI1CP01		Core Practical - 1: Biomolecules and Biochemical Techniques							6	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	1	2	2	2	2	2	2.4
CO2	2	3	2	3	1	2	2	2	2	2	2.1
CO3	2	2	2	3	1	2	2	1	2	1	1.8
CO4	3	2	3	3	1	2	2	1	2	1	2.0
CO5	2	3	3	2	1	2	3	1	3	1	2.1
CO6	3	2	3	2	1	3	2	1	3	2	2.2
Mean overall Score											2.11 (High)

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PBI1ES01	Elective - 1: Microbiology and Immunology	5	3

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 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 to explore natural remedial measures against microbes
To be able to exploit the various features of microorganisms for the beneficial industrial production

UNIT I: Taxonomy (18 Hours)

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.

UNIT II: Food Spoilage (18 Hours)

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 (கேழ்வரகு கூழ்) and bread.

UNIT III: Food Poisoning (18 Hours)

Food poisoning- bacterial food poisoning, Salmonella, Clostridium botulinum (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 sporeformers, Hazard analysis critical control point (HACCP)

UNIT IV: Chemotherapy

(18 Hours)

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).

UNIT V: Immune System

(18 Hours)

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. Antibody diversity. Immune system in health & disease, Transplantation immunology- graft rejection and HLA antigens. Immunological techniques, Flow cytometry and its application.

Teaching Methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study

1. Ananthanarayan, R. and Jayaram Paniker, C. K. (2007). *Text book of microbiology* (7th ed.). Orient Longman Ltd.
2. Prescott, L. M., Harley J. P., and Klein, D. A. (2007). *Microbiology* (7th Edition). Mc Graw-Hill.

Books for Reference

1. Michael J. Pelczar Jr.(2001). *Microbiology* (5th ed.). McGraw Hill Education (India) Private Limited.
2. Frazier, W. C., Westhoff, D. C., & Vanitha, N. M. (2010). *Food microbiology* (5th ed.). McGraw-Hill Education (India) Private Limited.
3. Willey, J., & Sherwood, L. (2011). *Prescott's microbiology* (8th ed.). McGraw-Hill Education.
4. Ananthanarayanan, Paniker & Kapil, A. (2013). *Textbook of microbiology* (9th ed.). Orient Black Swan.
5. Owen, J. , Kuby, J. P. (2013). *Immunology (Kindt, Kuby immunology)* (7th ed.). W.H. Freeman & Co.
6. Brooks, G.F., & Carroll, K. C. (2013). *Jawetz Melnick & Adelbergs medical microbiology* (26th ed.). McGraw Hill Education.
7. Greenwood, D. (2012). *Medical microbiology*. Elsevier Health.

Websites and eLearning Sources

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
3. <https://www.frontiersin.org/articles/10.3389/fphar.2020.578970/full#h9>
4. <https://www.frontiersin.org/articles/10.3389/fmicb.2018.02151/full>
5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7559905/>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will be able to	
CO1	classify (by both ancient and modern modes) different types of microorganisms and explain life cycle of the microbes	K1
CO2	recognize the microorganisms involved in decay of foods and will be able to apply various counteracting measures. The students also will be able to relate the role of certain beneficial microbes in day-to-day's food consumption.	K2
CO3	understand the common pathogenic bacterial and fungi that cause toxic effects and will be able to employ curative measures	K3
CO4	analyse various features of wide variety of antimicrobial agents along with their mode of action, in addition, being able to apprehend the valuable potentials of traditional and easily available herbs	K4
CO5	apply knowledge gained in production of industrially important products as both pharmaceutical and nutraceutical	K5
CO6	apply the knowledge of immunology in daily life	K6

Relationship Matrix											
Semester	Course code		Title of the Course							Hours	Credits
1	23PBI1ES01		Elective - 1: Microbiology and Immunology							5	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	1	2	3	2	2	1	2.0
CO2	2	2	3	2	1	2	3	3	2	1	2.2
CO3	2	2	3	2	1	2	3	3	2	1	2.1
CO4	3	2	3	2	1	2	3	3	2	1	2.2
CO5	2	3	3	2	1	2	3	1	3	1	2.1
CO6	3	2	3	2	1	2	3	2	3	1	2.2
Mean overall Score											2.13 (High)

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PBI1ES02	Elective - 2: Energy and Drug Metabolism	5	3

Course Objectives
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 energetics
Educate on the various phase I and II reactions.
Mode of transformation of xenobiotics and endobiotics.

UNIT I: Thermodynamics (18 Hours)

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.

UNIT II: Electron Transport Chain (18 Hours)

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

UNIT III: Photosynthesis and Dark Reactions (18 Hours)

Light reaction-Hills reaction, absorption of light, photochemical event. Photo ETC-cyclic and non-cyclic electron flow. Photophosphorylation-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.

UNIT IV: Metabolic Pathways (18 Hours)

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

UNIT V: Detoxification**(18 Hours)**

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.

Teaching methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study

1. Tripathi, K. D. (2010). *Essentials of medical pharmacology* (7th ed.). Jaypee Publishers.
2. Ghosh, J. (2010). *A textbook of pharmaceutical chemistry* (3rd ed.). S. Chand & Company Ltd.

Books for Reference

1. Nelson, D. L., & Cox, M. M. (2012). *Lehninger principles of biochemistry* (6th ed.). W. H. Freeman.
2. Murray, R. K., Granner, R. K., Mayes, P. A. & Rodwell, V. W. (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 Graw-Hill.
5. Devlin, R. M. (1983). *Plant physiology* (4th ed.). PWS publishers.
6. Taiz, L., & Zeiger, E. (2010). *Plant physiology* (5th ed.). Sinauer Associates, Inc.

Websites and eLearning Sources

1. <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%20hydrophili>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will 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
CO2	gain knowledge on role of mitochondria in the production of energy currency of the cell	K2
CO3	acquaint with the process of photosynthesis	K3
CO4	comprehend on the diverse role of TCA cycle and the energy obtained on complete oxidation of glucose and fatty acid	K4
CO5	correlate the phase I and phase II reactions to metabolize the xenobiotics	K5
CO6	apply the knowledge in the transformation of xenobiotics and endobiotics	K6

Relationship Matrix											
Semester	Course code		Title of the Course							Hours	Credits
1	23PBI1ES02		Elective - 2: Energy and Drug Metabolism							5	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	1	2	3	2	2	1	2.0
CO2	2	3	2	2	1	2	3	2	3	1	2.2
CO3	2	2	3	2	1	2	3	3	2	1	2.1
CO4	2	3	3	2	1	2	3	2	3	1	2.2
CO5	2	3	3	2	1	2	3	1	3	1	2.1
CO6	2	3	3	2	1	2	3	3	3	1	2.3
Mean overall Score											2.15 (High)

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PBI1AE01	Ability Enhancement Course: Herbal Technology	2	2

Course Objectives
Familiarize the indigenous systems of medicines like Ayurveda, Siddha, Unani, Homeopathy and Yoga
Study the types and formulations of drugs
Identify the active principles of Phytomedicine and their screening methods

UNIT I: Introduction

Herbal medicines: history and scope - definition of medical terms.

UNIT II: Indian System of Medicine

Role of medicinal plants in Indian systems of medicine; Ayurveda, Yoga, Siddha, Unani and Homeo.

UNIT III: Pharmacognosy

Drug Formulations- Types, Advantages and Disadvantages. Drug adulteration - types, methods of drug evaluation.

UNIT IV: Phytochemistry

Active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic). Biological testing of herbal drugs-Screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

UNIT V: Conservation of herbs

Medicinal plant banks micro propagation of important species (*Withania somnifera*).

Books for Study

1. Chopra, R. N., Nayar, S. L., and Chopra, I. C. (1956). *Glossary of Indian Medicinal Plants*. C.S.I.R
2. Kanny, L. D., and Bahadur, R. (1984). *The Indigenous Drugs of India*. International Book Distributors.

1. Agnes, A. (1999). *Herbal Plants and Drugs*. Mangal Deep Publications.
2. Sivarajan, V. V., and Balachandran, I. (1994). *Ayurvedic drugs and their plant source*. Oxford IBH publishing Co.
3. Miller, L., and Bryan, M. (1998). *Ayurveda and Aromatherapy*. Banarsidass, Delhi.
4. Green, A. (2000). *Principles of Ayurveda*. Thomsons.

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K – Level)
	On successful completion of this course, students will be able to	
CO1	Comprehend on indigenous system of medicine in their day to day life	K4
CO2	Correlate the medicinal uses with their formulations	K5
CO3	Isolate and prepare medicines from natural sources	K6

Relationship Matrix											
Semester	Course code		Title of the Course							Hours	Credits
1	23PBI1AE01		Ability Enhancement Course: Herbal Technology							2	2
Course Outcomes	Programme Outcomes (Pos)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	1	2	3	2	2	1	2.0
CO2	2	3	2	2	1	2	3	2	3	1	2.2
CO3	2	2	3	2	1	2	3	3	2	1	2.1
Mean overall Score											2.1 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBI2CC03	Core Course - 3: Molecular Biology	4	4

Course Objectives
To recall the different types of biotransformation reactions involving enzyme
To predict the bioenergetics of enzyme mediated catalysis
Apply the use of enzymes in various fields
Analyze the mechanism of action of selected enzymes
Evaluate the rate of enzyme action (kinetics) and design the methodology of purification of enzymes
Apply practical knowledge on biosensor development and enzyme engineering

UNIT I: Introduction

(12 Hours)

Terms and definitions - DNA is the Genetic Material: Griffith's Experiment, Avery, Hershey & Chase Experiment. RNA as the Genetic Material: Conrat & Singer Experiment with TMV - Central Dogma. Organization of prokaryotic genome: Bacterial genome, Viral genome - types of RNA and their role.

Organization of Chromosome

Structural organization of eukaryotic chromosomes. Types and basic structure of chromosomes. Chromosomal Proteins - Histones and Protamines - nucleosomes - levels in the organization of Metaphase Chromosome. Special types of Chromosomes: Polytene and Lamp brush chromosomes. Duplication & segregation of Chromosomes

UNIT II: Transposons

(12 Hours)

Discovery of IS elements, Transposons in Bacteria (Tn elements), Maize (Ac/Ds and Sp/Dsp elements), Drosophila (P elements) and Yeast (Ty elements). Transposition, Genetic and evolutionary significance of transposons.

Extra chromosomal DNA

Maternal Inheritance, Structure, gene contents and functions of Chloroplast and Mitochondrial DNA, theory of prokaryotic endosymbionts. Plasmids: Definition, Types, Structure, Properties, gene content. Use in rDNA technology.

UNIT III: DNA replication

(12 Hours)

Models - Messelson & Stahl Experimental proof for Semi-conservative replication - Rules, requirements, problems and molecular mechanism of the replication of linear and circular (Rolling circle Model) DNA in prokaryotes and eukaryotes. DNA polymerases - structure and function. Replication of RNA - RNA and DNA mediated.

Recombination

Homologous and non-homologous recombination - Site specific recombinations & transposition of DNA.

UNIT IV: Transcription

(12 Hours)

RNA types (tRNA, mRNA, rRNA, Ribozyme, snRNA, hnRNA, RNAi, RNA-P and microRNA), structure and functions. Transcription mechanism in prokaryotes and eukaryotes - initiation, elongation and termination, Post transcriptional modifications. Antibiotic inhibitors of transcription.

Translation

Genetic code and its features. Wobbling hypothesis. Machinery, initiation, elongation and termination of translation in bacteria and eukaryotes. Translational proof reading, translational inhibitors, post-translational modifications, chaperones and protein targeting- translocation, heat shock proteins, glycosylation; SNAPS and SNAREs. Bacterial signal sequences.

Mitochondrial, chloroplast and nuclear protein transport. Endocytosis - viral entry. Ubiquitin TAG protein destruction.

UNIT V: Chromosomal changes and consequences (12 Hours)

Changes in the chromosome number: euploidy and aneuploidy and related genetic disorders. Changes in the chromosome structure: addition, deletion, inversion and translocation and related genetic disorders.

Mutation

Definition, chemical basis and types. Mutagens: Physical, chemical and Biological. Mutant types - lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis. DNA repair mechanism: thymine dimer, light activation, excision, recombinational, SOS and mismatch repair.

Teaching Methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study

1. Harvey, L., Arnold, B., & Chris, A. K. (2003). *Molecular cell Biology*. (5th Ed.). W. H. Freeman & Co Ltd.
UNIT-I Chapter 10 UNIT-II Chapter 10 UNIT-IV Chapter 11
2. David, F. (2008). *Molecular Biology*. (2nd Ed.). Narosa Publications.
UNIT-I Chapter VIII UNIT-II Chapter XX UNIT-III Chapter IX
UNIT-IV Chapter XII UNIT-V Chapter X, XX IV
3. Jeoffrey, M.C., & Rober E. H. (2000). *The Cell: A Molecular Approach ASM Press*
UNIT-I Chapter IV UNIT-II Chapter VI UNIT-III Chapter VI
UNIT-IV Chapter VII UNIT-V Chapter VI, XVIII

Books for References

1. Ajoy, P. (2007). *Textbook of Cell and Molecular Biology*. Books and Allied
2. De Robertis & De Robertis. (1990). *Cell and Molecular Biology*. Saunders
3. Gerald, K. (2008). *Cell and Molecular Biology*, (5th Ed.). John Wiley and Sons
4. Lewin's. (2017). *GENES XII*, (12th Ed.). Jones and Bartlett Publishers, Inc;

Websites and eLearning Sources

1. <https://ncert.nic.in/ncerts/l/lebo106.pdf>
2. <https://www.caister.com/cimb/v/v13/37.pdf>
3. https://www.researchgate.net/publication/316085336_Transposons_in_Eukaryotes_Structures_Mechanisms_and_Applications
4. https://projects.iq.harvard.edu/files/lifesciences1abookv1/files/9_-_transcription_revised_9-24-2018.pdf
5. https://projects.iq.harvard.edu/files/lifesciences1abookv1/files/10_-_the_genetic_code_and_translation_revised_9-24-2018.pdf
6. <https://www.nature.com/scitable/topicpage/ribosomes-transcription-and-translation-14120660/>
7. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6693886/>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will be able to	
CO1	recall the pioneering experiments involved in molecular biology	K1
CO2	predict the mechanisms concerned with the mobile genetic elements	K2
CO3	apply the isolation procedures of nucleic acids	K3
CO4	analyze the steps involved in the induction of transcription	K4
CO5	evaluate the errors and correction mechanisms of informational molecules and synthesize the DNA molecules artificially	K5
CO6	evaluate the chromosomal defect of the diseases and the mechanisms of DNA repair	K6

Relationship matrix											
Semester	Course Code		Title of the Course						Hours	Credits	
2	23PBI2CC05		Core Course - 5: Molecular Biology						4	4	
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	2	3	2	3	2	3	2.4
CO2	3	2	2	3	2	3	2	2	3	3	2.5
CO3	3	2	3	2	2	3	3	3	2	2	2.5
CO4	3	2	3	3	2	3	3	2	2	2	2.5
CO5	3	2	3	2	2	3	3	2	2	3	2.5
CO6	3	2	3	2	3	2	3	2	3	3	2.6
Mean Overall score											2.5 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBI2CC04	Core Course - 4: Bioenergetics and Enzymology	4	4

Course Objectives
To recall the different types of biotransformation reactions involving enzymes
To predict the bioenergetics of enzyme mediated catalysis
Apply the use of enzymes in various fields
Analyze the mechanism of action of selected enzymes
Evaluate the rate of enzyme action (kinetics) and design the methodology of purification of enzymes
Apply practical knowledge on biosensor development and enzyme engineering

UNIT I: Thermodynamics (12 Hours)

Thermodynamic terms and basic concepts - types of thermodynamic systems, intensive and extensive properties, state of system, reversible and irreversible thermodynamic processes. Biological redox reactions. Electron transport chain and oxidative phosphorylation. High- energy phosphate compounds, role of ATP in biological system; acyl-phosphate group transfer.

UNIT II: Basics of Enzymology (12 Hours)

Historical aspects of enzymology, nomenclature and classification of enzymes according to IUB-EC-1964. Units of enzyme activity. Turn over number, specific activity. Intracellular localization of enzymes, homogenization techniques, isolation and fractionation of enzymes - classical methods of purification and crystallization, separation based on molecular size (Gel filtration), electric charge (SDS PAGE and Ion Exchange), solubility difference and selective adsorption (Adsorption chromatography, Affinity Chromatography). Criteria of purity.

UNIT III: Criteria of chemical reactions (12 Hours)

Collision & transition state theories, specificity of enzymes. Active site - definition, organization and determination of active site residues. Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis. Coenzymes - structure and functions. Mechanism of enzyme action - lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Isoenzymes. Multienzymes system- mechanism of action and regulation of pyruvate dehydrogenase, LDH and fatty acid synthase complex.

UNIT IV: Kinetics of catalyzed reaction (12 Hours)

Single and bisubstrate reactions, concept and derivation of Michaelis-Menten equation. LB plot, Edihoffsti plot, Briggs Haldane relationship. Determination and significance of kinetic constants, limitations of Michaelis - Menten kinetics. Enzyme regulation - Allosteric inhibition, cooperative, cumulative, feedback inhibition. Inhibition kinetics- competitive, non-competitive and uncompetitive.

UNIT V: Applications of Enzymes (12 Hours)

Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment. Immobilized multienzyme systems. Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors. Abzymes and ribozymes. Enzymes of clinical and diagnostic significance-LDH, SGOT and SGPT. Industrial significance- Renin, Papain, Elastase. Enzyme engineering.

Teaching Methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study

1. Hiram F. Gilbert. *Basic Concepts in Biochemistry*, (2nd Ed.). McGraw-Hill Health Professions Division.
Unit-I Chapter 14, Chapter 24
Unit-IV Chapter 7, Chapter 8
2. Rodwell, V.W., Bender, D., Botham, K.m., Kennelly, P.J., Weil, P.A. (2018) *Harper's Illustrated Biochemistry*, (26th Ed.). McGraw- Hill, Medical Publishing Division.
Unit-III Section 1
3. Price & Stevens, (1999). *Fundamentals of Enzymology*, Oxford University Press
Unit-II Chapter 3, Chapter 9
Unit-V Chapter 10
4. Dixon, M. & Webb, J.F., (1979). *Enzymes*, Longman Publishing, London.
5. Price and Stevens, (1999). *Fundamentals of Enzymology*, Oxford University Press

Books for References

1. Trevor, P. (1991). *Understanding Enzymes*, (3rd Ed.). Ellis Harwood
2. Lehninger, A. H. *et al.*, (1993). *Principles of Biochemistry*, Worth Publ. Inc.,
3. Jeremy M. Berg., & John, L. Tymoczko & Lubert Stryer, (2007). *Biochemistry*, (6th Ed.). W H Freeman and Co

Websites and eLearning Sources

1. <https://ncert.nic.in/ncerts/l/kech106.pdf>
2. <https://iubmb.org/wp-content/uploads/sites/10116/2018/11/A-Brief-Guide-to-Enzyme-Classification-and-Nomenclature-rev.pdf>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4692135/>
4. <https://www.news-medical.net/life-sciences/Enzyme-Kinetics.aspx>
5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4692135/>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will be able to	
CO1	discern the types of transformation reactions mediated by enzymes	K1
CO2	predict the bioenergetics of enzyme mediated catalysis	K2
CO3	apply the use of enzyme mechanisms and significance of isozymes	K3
CO4	evaluate the enzyme action mathematically	K4
CO5	analyse the methods of enzyme regulation	K5
CO6	exploit the enzymes for clinical purpose and for the fabrication of biosensors	K6

Relationship Matrix											
Semester	Course Code		Title of the Course						Hours	Credits	
2	23PBI2CC04		Core Course - 4: Bioenergetics and Enzymology						4	4	
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	3	3	2	2	3	2	3	1	2.4
CO2	2	2	3	2	1	2	2	3	2	1	2.0
CO3	2	3	3	3	1	3	3	3	3	1	2.5
CO4	3	3	3	2	1	2	3	3	2	2	2.4
CO5	3	3	3	3	1	3	3	1	3	1	2.4
CO6	3	3	3	2	2	3	3	2	3	1	2.5
Mean Overall Score											2.36 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBI2CC05	Core Course - 5: Genetic Engineering	4	3

Course Objectives
Remember the various underlying principles of genetic engineering and enzymes concerned with it
To understand the methodologies of gene transfer
To apply the analytical procedures involving DNA
To analyze the uptake of genes following screening procedures
To evaluate the methods of recombinant selection and construct gene cassettes and vectors
To apply the methods of protection of intellectual properties

UNIT I: Enzymes in Genetic Engineering (12 Hours)

Isolation (Mechanical, cDNA, Shot gun) & purification of nucleic acid, PCR; Enzymes in molecular biology - restriction endonuclease, ligases, reverse transcriptase, nucleases, polymerase, alkaline phosphatase, terminal transferase, T4 polynucleotide kinase; linker, adaptors & homopolymers.

UNIT II: Expression cassette (12 Hours)

Promoters (constitutive, inducible, tissue specific), terminators, reporters, markers (antibiotic resistant - Streptomycin, herbicide resistant - DDT, antimetabolite - Methotrexate), Vectors in gene cloning - Plasmids (pBR322, pUC), Bacteriophages (Phage λ , M13), cosmids, phagemids, yeast plasmid vector, viral vectors (adenovirus, adeno associated virus, baculo virus, herpes virus, retrovirus, cauliflower mosaic virus, tobacco mosaic virus, potato virus X), artificial chromosome (BAC, YAC, HAC), shuttle vector, Expression vector.

UNIT III: Gene transfer methods (12 Hours)

Transformation - physical method (electroporation, micro-injection, particle bombardment, liposome mediated transfer), chemical method (PEG mediated, DEAE Dextran mediated, CaPO₄ mediated gene transfer), Biological method (Agrobacterium mediated gene transfer). Expression systems - prokaryotes (Bacteria) and eukaryotes (yeast, mammalian and, insect cell lines).

UNIT IV: Screening and selection methods (12 Hours)

Insertional inactivation, blue-white selection, colony - in situ hybridization, in vitro selection, in vitro translation, radioactive antibody test, immunological techniques, DNA labelling, dot blot hybridization, Molecular beacons. Gene Silencing, RNA interference, antisense therapy, gene knockout. Blotting techniques - Southern, Northern, Western and South-Western.

UNIT V: Molecular Techniques (12 Hours)

Principles, methods and applications - RFLP, RAPD, AFLP, DNA Finger printing, DNA Foot printing, Microarray (DNA & Non- DNA). Libraries - Genomic library; C-DNA library & its types; BAC library; YAC library; Methyl filtration libraries; COT fractionation based libraries.

Teaching Methodology	Videos, PPT, Demonstration and Creation of models
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Book for Study

- Glick, R., & Pasternak, J.J. (2002). *Molecular Biotechnology*, (3rd Ed.). ASM Press
UNIT-II Chapter IV, VII UNIT-III Chapter V UNIT-V Chapter XX
- Old, R.W., & Primrose, S.B. (1989). *Principles of gene manipulation*, (4th Ed.). Blackwell Scientific Publications, London.
UNIT-I Chapter II, III UNIT-II Chapter IV, V UNIT-III Chapter VIII, IX, X

UNIT-V Chapter XIV

3. David, M.G., (1984). *Gene Cloning-The Mechanisms of DNA Manipulations*. Chapman and Hall
4. Ernst, L.W., (2002). *From Genes to Clones -Introduction to Gene Technology*. VCR Publication.
5. Watson, J.D. (1992). *Recombinant DNA* W. H. Freeman.

1. <https://www.sciencedirect.com/science/article/pii/S0002961005808414>
2. <https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/restriction-enzyme>
3. <https://www.mybiosource.com/learn/gene-transfer-technique/>
4. <https://pubmed.ncbi.nlm.nih.gov/15032617/>
5. <https://molecularbrain.biomedcentral.com/articles/10.1186/1756-6606-7-17>
6. <https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/66/2019/et/MCB%20Mooc%205%20Module%2035%20Academic%20script200331121203033636.pdf>
7. <https://geneticeducation.co.in/genetic-markers-rflp-rapd-aflp-issr-str-scar-est-ssr-and-snp/>
8. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4349364/>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will be able to	
CO1	apply various principles of genetic engineering and enzymes involved with it	K1
CO2	execute the methods of gene transfer in prokaryotes and eukaryotes	K2
CO3	exploit the analytical procedures involved in nucleic acid study	K3
CO4	construct gene cassettes and vectors	K4
CO5	follow the protocols of recombinant selection and screening	K5
CO6	protect their intellectual properties and use genomic library	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
2	23PB12CC05		Core Course - 5: Genetic Engineering							4	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	1	2	3	2	2	1	2.0
CO2	1	2	3	2	1	2	2	3	2	1	2.0
CO3	2	2	3	2	1	2	3	3	2	1	2.1
CO4	3	2	3	2	1	2	3	3	2	1	2.2
CO5	2	3	3	2	1	2	3	1	3	1	2.1
CO6	2	3	2	3	1	2	2	2	2	1	2.0
Mean Overall Score											2.06 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBI2CP02	Core Practical - 2: Enzymology, Physiology and Molecular Techniques	5	4

Course Objectives
To know the isolation procedure of enzymes from plant and animal tissues
To assay the activity of enzymes like acid and alkaline phosphatase
To comprehend the methods involved in the measurement of blood pressure
To measure and interpret ECG and BMI
To isolate and quantify the nucleic acids (DNA and RNA)
To synthesize synthetic seed preparation

ENZYMOLGY

1. Assay of acid phosphatase.
2. Factors influencing reaction rates of acid Phosphatase.
 - i) Effect of Temperature.
 - ii) Effect of Time.
 - iii) Effect of pH.
 - iv) Effect of Enzyme concentration.
 - v) Effect of substrate concentration (Measurements of Vmax & Km)

PHYSIOLOGY

1. Blood Pressure - Measurement - Effect of exercise and postural variation on BP.
2. ECG recording
3. Body Mass index calculation

MOLECULAR TECHNIQUES

1. Agarose gel electrophoresis of Nucleic acids (DNA & RNA)
2. Polyacrylamide gel electrophoresis (protein)
3. Isolation of chromosomal DNA from blood samples by Phenol-Chloroform method.
4. Preparation of genomic DNA from bacteria
5. Synthetic seed preparation

Books for References

1. Lansing, M. P., John, P. H., & Klein, D.A. (2007). *Microbiology*, (7th Ed.). Mc Graw Hill
2. James, G.C., & Sherman, N. (2005). *Microbiology - A Laboratory Manual*. (7th Ed.). Pearson education India
3. Glick, R. & Pasternak, J. J. (2002). *Molecular Biotechnology* (3rd Ed.). ASM Press
4. Old, R.W., & Primrose, S.B. (1989). *Principles of gene manipulation*, (4th Ed.). Blackwell Scientific Publications
5. Praful, B. G. (2014). *Text book of medical laboratory technology*, (3rd Ed.). Volume I and II, Bhalani Publishing house.
6. Alan, H. G, *Varley's Practical Clinical Biochemistry*, (6th Ed.). CBS publishers.

Websites and eLearning Sources

1. <https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf>
2. <https://www.youtube.com/watch?v=vq759wKCCUQ>
3. <https://www.youtube.com/watch?v=f6HtqolhKqo>
4. <https://www.youtube.com/watch?v=8jVNcT5Dapk>
5. <https://www.youtube.com/watch?v=elVAkFENfxI>

Course Outcomes		
CO No.	CO- Statements	Cognitive Levels (K-level)
	On successful completion of this course, the students will be able to	
CO1	describe the isolation procedures of the enzymes	K1
CO2	explain the factors affecting the enzyme action and the importance of the blood circulation and changes in the physiology of the circulation during exercise	K2
CO3	apply the knowledge to study the effect of various factors over the activity of different enzymes	K3
CO4	analyze the patterns of cardiac cycle during normal and in exercise condition	K4
CO5	evaluate the banding pattern in protein	K5
CO6	exploit the preparation of synthetic seeds	K6

Relationship Matrix											
Semester	Course Code	Title of the Course								Hours	Credits
2	23PBI2CP02	Core Practical - 2: Enzymology, Physiology and Molecular Techniques								5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	3	3	2	2	3	2	3	3	2.6
CO2	2	2	3	2	2	2	2	3	2	3	2.3
CO3	2	3	3	3	2	3	3	3	3	3	2.8
CO4	3	3	3	2	2	2	3	3	2	3	2.6
CO5	3	3	3	3	2	3	3	3	3	3	2.9
CO6	3	3	3	2	2	3	3	2	3	3	2.7
Mean Overall Score											2.65 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBI2SP01	Self-paced Learning: Advanced Nutrition	-	2

Course Objectives
To comprehend the BMR and factors affecting the same
To study the direct and indirect methods of measuring BMR
To know the importance relations of carbohydrates, proteins and fats in normal individual
To study the biological importance of fat and water soluble vitamins
To evaluate the role of macro and micronutrients in the health of the individuals
To understand the significance of nutrition during different age groups

UNIT I: Energy Metabolism

Basal metabolism - Basal metabolic rate - Factors affecting BMR, - determination of BMR, direct and indirect methods, - Benedict's Roth apparatus, - respiratory quotient - Biological oxygen demand. Anthropometry; Height, Weight, Skin fold thickness and arm circumference - Their importance in nutrition.

UNIT II: Introduction to Nutritional Biochemistry

Carbohydrate: Source of energy; Glycogen, Fiber in diet. Proteins - essential amino acids and non-essential amino acids - sources, functions - relation with Marasmus, Kwashiorkor disease. Protein calorie malnutrition. Biological value of proteins.

Fats: Sources- Saturated and unsaturated fatty acids, essential and non-essential fatty acids - outline of disorders concerned with fatty acid metabolism.

UNIT III: Vitamins

Fat soluble and water soluble vitamins-their source, daily requirements and deficiency manifestations. Role of Vitamins as co-factors- in Electron transport chain; and enzyme reactions; Vitamins involved in haemopoiesis; Role as antioxidants.

UNIT IV: Minerals

Micro, macro and trace elements - daily requirements - functions - deficiency manifestations - Role as electrolytes - sodium and potassium. Food fads and Facts.

UNIT V: Nutrition at different Stages of life

During infancy, School children, adolescence, pregnancy, lactation and aging. Assessment of nutritional status, - methods - intake, Biochemical and clinical methods.

Books for Study

1. Swaminathan, M. (2004). *Essentials of Food and Nutrition*. The Bangalore Printing and Publishing Co. Ltd.
2. Anthony, A. A. (1972). *Newer Methods of Nutritional Biochemistry* (Academic Press)

Books for References

1. Garrow, J. S. & James, W. P. T. (2000). *Human Nutrition and Dietetics*. (10th Ed.). Churchill Livingstone Publishers

2. Wong, D. W. S. (1996). *Mechanism and Theory in Food Chemistry*. CBS

Course Outcomes		
CO No.	CO- Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	study the basic requirement of nutrition at different stages of life	K1
CO2	learn the proximate principles of nutrition with reference to rda	K2
CO3	apply the experimental procedures concerned with energy metabolism	K3
CO4	assess nutritional requirements for various disease status and age groups	K4
CO5	quantify the nutritional content of the food items	K5
CO6	evaluate the disorders associated with nutrition	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
2	23PBI2SP01		Self-paced Learning: Advanced Nutrition							-	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	1	3	1	2	3	1	2	2	2	1.9
CO2	3	1	1	1	2	3	1	3	2	3	2
CO3	3	1	3	2	3	2	1	3	3	1	2.2
CO4	2	3	3	3	2	3	1	1	3	1	2.2
CO5	3	3	1	3	1	3	2	1	1	2	2.0
CO6	3	3	2	3	2	3	2	3	2	3	2.6
Mean Overall Score											2.15(Medium)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBI2ES03A	Elective - 3: Developmental Biology	5	4

Course Objectives
To know the basic concepts involved in the cells during early development and communication
To understand the structure and physiology of gametes and sex determination
To comprehend the stages involved in the development of organs in mammals
To study the steps involved during and after fertilization
To be able to explain the various factors involved in the determination of sex
To gain knowledge on the genetic diseases

UNIT I: Basic concepts (15 Hours)

General principles of cell-cell communication in development: cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, paracrine factors. General concept of organisms development: Potency, commitment, specification, induction, competence, determination & differentiation; morphogenetic gradients; cell fate & cell lineages; genomic equivalence and cytoplasmic determinants; imprinting.

UNIT II: Fertilization, development and sex determination in humans (15 Hours)

Gametogenesis - Sperm & Egg formation; ultra-structure of sperm and ovum, egg types, egg membrane. Fertilization, cleavage, Morula, Implantation, blastulation, gastrulation, formation of germ layers, axis formation - anterior and posterior. Sex determination - chromosomes and environment.

UNIT III: Organogenesis - I (15 Hours)

Central nervous system and the epidermis - Formation of neural tube, Differentiation of the neural tube, tissue architecture of the central nervous system, origin of cutaneous structures. Neural crest cells and axonal specificity - specification, Trunk neural crest, pattern generation in the nervous system.

UNIT IV: Organogenesis - II (15 Hours)

Paraxial and intermediate mesoderm - Somites formation, Osteogenesis, Urogenital system. Lateral plate mesoderm and endoderm - Heart formation, digestive tube and its derivatives.

UNIT V: Implications of developmental biology (15 Hours)

Medical implications of developmental biology - genetic disorders in human development, environmental assaults on human development, Future therapies and developmental biology, Environmental regulation of animal development - Environment as a part of normal development, Polyphenisms and plasticity, Learning system.

Teaching Methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study

1. Chattopadhyay, S. (2016). *An Introduction to Developmental Biology*. Books and Allied (P) Ltd.
Unit I Chapter 4 (Pages 73-101)
Chapter 5 (Pages 101-117)
Chapter 7 (Pages 131-154)

- Unit II Chapter 9 (Pages 189-212)**
Chapter 10 (Pages 214-226)
Unit III Chapter 16 (Pages 351 - 384)
2. Scott, F. G.(2010). *Developmental Biology*, (9th Ed.). Sinauer Associates Inc.
Unit I Part 1 - Chapter 3, 6
Unit II Part 2 - Chapter 7, 8, 9, 11, 17
Unit III Part 3 - Chapter 12, 13
Unit IV Part 3 - Chapter 14, 15
Unit V Part 4 - Chapter 21
 3. Paul A. Iaizzo Editor, University of Minnesota Department of Surgery Minneapolis. *Handbook of Cardiac Anatomy, Physiology, and Devices*, (3rd Ed.). Springer International Publishing Switzerland (2015) (eBook).
Unit IV - Part - II Chapter - 3 - 3.1 to 3.6
 4. Schoenwolf, Bleyl, Brauer and Francis-West. “Larsen's Human Embryology” (5th Ed.). Elsevier, Churchill Livingstone, 1600 John F. Kennedy Blvd. Ste19103-2899 (Ebook).
Unit II Chapter - 1(Pages 14-38)
Unit III Chapter - 4 (Pages 82-107)

Books for Study

1. Gilbert S.F. (2010). *Developmental Biology*, (9th Ed.). Sinauer Associates Inc.
2. Chattopadhyay, S. (2016). *An Introduction to Developmental Biology*. Books and Allide (P) Ltd.

Books for References

1. Alberts B. *et al.* (2002). *Molecular Biology of the Cell*, (3rd Ed.). Garland Science
2. Harvey, L., Arnold, B., & Paul, M. (2008). *Molecular Cell biology*, (5th Ed.). W. H. Freeman and Company

Websites and eLearning Sources

1. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000035ZO/P001308/M027365/ET/1519022717M18CellAdhesionmoleculesChemokinesQuad1.pdf
2. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001198/M011310/ET/1526902570P3M7Celladhesionandrecognition_ET.pdf
3. <https://rupress.org/jcb/article/220/10/e202102146/212606/The-cell-biology-of-fertilization-Gamete>
4. <https://www.ncbi.nlm.nih.gov/books/NBK9901/>
5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8863375/>
6. <https://www.ncbi.nlm.nih.gov/books/NBK9997/>
7. <https://ncert.nic.in/textbook/pdf/kebt108.pd>
8. <https://www.genome.gov/For-Patients-and-Families/Genetic-Disorders>
9. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7405896/>
10. https://shs.hal.science/halshs_01498604/file/NicoglouPhenotypic_Plasticity_From_Microevolutio.pdf
11. <https://scholar.archive.org/work/pgnorpq2mzh2vgx7s7jrjxhgvq/access/wayback/http://pdfs.semanticscholar.org/1e3f/5e54f12aa69d2c340049301a8942bd53f01b.pdf>

Course Outcomes		
CO No.	CO- Statements	Cognitive Levels (K-level)
	On successful completion of this course, the students will be able to	
CO1	describe the cellular basis and embryonic development	K1
CO2	elucidate the process and mechanisms of sex determination in mammals	K2
CO3	assign the gene function to the phenotype of an organism	K3
CO4	analyze mechanisms of the development of various organs	K4
CO5	evaluate the role of environment in the developmental process	K5
CO6	apprehend the various genetic diseases	K6

Relationship Matrix											
Semester	Course Code			Title of the Course						Hours	Credits
2	23PBI2ES03A			Elective - 3: Developmental Biology						5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	2	3	2	2	2	2	2	2.2
CO2	2	3	3	2	1	2	3	3	3	3	2.5
CO3	2	2	3	2	3	3	2	2	3	3	2.5
CO4	2	3	2	3	2	3	2	3	3	2	2.5
CO5	2	3	2	2	1	2	3	2	3	3	2.3
CO6	3	2	3	2	2	3	3	3	2	3	2.6
Mean Overall Score											2.43 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBI2ES03B	Elective - 3: Life Sciences for Competitive Exams - 1	5	4

Course Objectives
To gain knowledge on the basics in classification and naming plants and herbarium preparation
To comprehend systematic classification of plants and animals
To study the biosynthesis and biological role of plant hormones and ecosystem
To recognize the correlation between photosynthesis, photoperiodism and nitrogen metabolism
To appreciate the mechanism of photosynthesis and dark reactions in plants
To be able to exploit the pollutants and various method of bioremediation

UNIT I: Basics of Taxonomy (15 Hours)

Principles & methods of taxonomy, classical & modern methods of taxonomy of plants, animals and microorganisms. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Herbarium preparation.

UNIT II: System of classifications (15 Hours)

Outline classification of plants, animals & microorganisms, structural details: Important criteria used for classification in each taxon. Classification of plants (Bentham and Hooker), animals (Whitaker's) and microorganisms. Prokaryote and eukaryote cell: structural and function of cell wall, mitochondria, chloroplast, ribosomes, E.R., Golgi complex and nucleus.

UNIT III: Plant hormones and Nitrogen metabolism: (15 Hours)

Plant hormones - Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Sensory photobiology & Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks. Nitrogen metabolism- Nitrate and ammonium assimilation.

UNIT IV: Photosynthesis and plant physiology: (15 Hours)

Photosynthesis - Light reaction and dark reaction fixation C₃, C₄ and CAM pathways, photorespiratory pathway. Translocation of water, ions, solutes and macromolecules from soil-xylem and phloem, transpiration, introduction to sec metabolites. Stress physiology. Response of plants to biotic (pathogens and insects) and abiotic (water, temp and salt) stresses.

UNIT V: Environmental hazards and management: (15 Hours)

Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Bioremediation; Phytoremediation; Solid waste management: toxic effects and treatments, methods, technologies for management of hospital waste - incineration, autoclaving, mechanical/chemical, microwave, plasma torch, detoxification, advanced wet oxidation and thermal, dry heat.

Teaching Methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study

1. Verma, P. S & Agarwal, V. K. (2003). *Cytology, Genetics, Evolution and Ecology*, S. Chand & Co Ltd.,
UNIT-II Chapter 5 (Pages 112-153), Chapter 6(Pages 154-165), Chapter 7 (Pages 166-174), Chapter 10(pages 191-219), Chapter 12(Pages 243-256), Chapter 14 (Pages 280-292).
UNIT-I Section 1 (Pages 5-16), Section 3 (pages 182-192).
UNIT-III Chapter 17 (Pages 494-505), Chapter 19 (Pages 546-562), Chapter 20 (Pages 584-612), Chapter 21 (Pages 622-641), Chapter 22 (Pages 650-667), Chapter 23(pages 674-690), Chapter 25 (Pages 720-748).
2. Bir,B., Manchikatla Venkat Rajam Leela Sahijram K.V. Krishnamurthy Editors, Plant Biology and Biotechnology, Volume I: Plant Diversity, Organization, Function and Improvement.
UNIT-IV Chapter 22 (Pages 569-591).
UNIT-V Chapter 1(Pages 3-32), Chapter 2 (33-49), Chapter 4 (pages 61-103)
3. S.K.Verma,(1999).*Text Book of Plant Physiology*. S.Chand& Co Ltd.,

Books for References

1. Lawrence, G.H. M. (1995). *The Taxonomy of Vascular Plants*, Mac Millan Publishers
2. Noggle, G.R., & Fritz, G.J. (1976). *Introductory Plant Physiology*, Prentice-Hall Publishers.

Websites and eLearning Sources

1. https://collegedunia.com/exams/calvin-cycle-c-3-cycle-definition-stages-diagram-roducts_biology-articleid-1723
2. <https://www.pnas.org/doi/pdf/10.1073/pnas.68.11.2883>
3. https://www.shahucollegelatur.org.in/Department/Studymaterial/sci/Botany/Msc_I__year_botany_sem_II_Plant_physiology_and_metabolism_Unit_Iv_Notse.pdf
4. [https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/General_Biology_1e_\(OpenStax\)/6%3A_Plant_Structure_and_Function/30%3A_Plant_Form_and_Physiology/30.6%3A_Plant_Sensory_Systems_and_Responses](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/General_Biology_1e_(OpenStax)/6%3A_Plant_Structure_and_Function/30%3A_Plant_Form_and_Physiology/30.6%3A_Plant_Sensory_Systems_and_Responses)
5. <https://www.nios.ac.in/media/documents/SrSec314NewE/Lesson-10.pdf>
6. <https://testbook.com/biology/photosynthesis>
7. https://ec.europa.eu/echo/files/evaluation/watsan2005/annex_files/WEDC/es/ES07CD.pdf

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K-level)
	On successful completion of this course, the students will be able to	
CO1	describe the fundamental knowledge on plant kingdom classification	K1
CO2	demonstrate the preparation of herbarium	K2
CO3	illustrate the mechanisms of action of hormones and its role in physiology	K3
CO4	analyze the principles of ecosystems	K4
CO5	evaluate the bioremediation and phytoremediation	K5
CO6	apply the protocol for the protection of environment	K6

Relationship Matrix											
Semester	Course Code		Title of the Course							Hours	Credits
2	23PBI2ES03B		Elective - 3: Life Sciences for Competitive Exams - 1							5	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO 4	PSO 5	
CO1	2	2	1	2	3	3	3	2	3	3	2.4
CO2	2	3	3	1	1	2	3	3	2	3	2.3
CO3	2	1	3	2	3	1	2	3	3	2	2.2
CO4	2	3	1	2	3	1	2	3	1	3	2.1
CO5	2	1	2	3	2	2	3	1	3	3	2.2
CO6	2	3	2	3	3	2	3	3	2	2	2.5
Mean Overall Score											2.28 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PSS2SE01	Skill Enhancement Course: Soft Skills	4	3

Course Objectives
To provide a focused training on soft skills for students in colleges for better job prospects
To communicate effectively and professionally
To help the students take active part in group dynamics
To familiarize students with numeracy skills for quick problem solving
To make the students appraise themselves and assess others

Unit I: Effective Communication & Professional Communication (12 Hours)

Definition of communication, Barriers of Communication, Non-verbal Communication; Effective Communication - Conversation Techniques, Good manners and Etiquettes; Speech Preparations & Presentations; Professional Communication.

Unit II: Resume Writing & Interview Skills (12 Hours)

Resume Writing: What is a résumé? Types of résumés, - Chronological, Functional and Mixed Resume, Purpose and Structure of a Resume, Model Resume.

Interview Skills: Types of Interviews, Preparation for an interview, Attire, Body Language, Common interview questions, Mock interviews & Practicum

Unit III: Group Discussion & Personal effectiveness (12 Hours)

Basics of Group Discussion, Parameters of GD, Topics for Practice, Mock GD & Practicum & Team Building.

Personal Effectiveness: Self Discovery; Goal Setting with questionnaires & Exercises

Unit IV: Numerical Ability (12 Hours)

Introducing concepts Average, Percentage; Profit and Loss, Simple Interest, Compound Interest; Time and Work, Pipes and Cisterns.

Unit V: Test of Reasoning (12 Hours)

Introducing Verbal Reasoning: Series Completion, Analogy; Data Sufficiency, Assertion and Reasoning; and Logical Deduction. Non-Verbal Reasoning: Series; and Classification

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT.
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Book for study

1. Melchias G., Balaiah, J. & Joy, J. L. (Eds). (2018). *Winner in the Making: A Primer on soft Skills*. Trichy, India: St. Joseph's College.

Books for References

1. Aggarwal, R. S. (2010). *A Modern Approach to Verbal and Non-Verbal Reasoning*. S. Chand.
2. Covey, S. (2004). *7 Habits of Highly effective people*. Free Press.
3. Gerard, E. (1994). *The Skilled Helper* (5th Ed.). Brooks/Cole.
4. Khera, S. (2003). *You Can Win*. Macmillan Books.
5. Murphy, R. (1998). *Essential English Grammar*, (2nd Ed.). Cambridge University Press.
6. Sankaran, K., & Kumar, M. (2010). *Group Discussion and Public Speaking* (5th Ed.). M.I. Publications.
7. Trishna, K. S. (2012). *How to do well in GDs & Interviews?* (3rd Ed.). Pearson Education.
8. Yate, M. (2005). *Hiring the Best: A Manager's Guide to Effective Interviewing and Recruiting*

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, students will be able to	
CO1	recall various soft skill sets	K1
CO2	understand personal effectiveness in any managerial positions	K2
CO3	apply verbal and non-verbal reasoning skills to solve problems	K3
CO4	differentiate problems at work and home; and design solutions to maintain work-life balance	K4
CO5	assess growth and sustainability and infuse creativity in employment that increases professional productivity	K5
CO6	construct plans and strategies to work for better human society	K6

Relationship Matrix											
Semester	Course Code			Title of the Course					Hours	Credits	
2	23PSS2SE01			Skill Enhancement Course: Soft Skills					4	3	
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	2	3	2	3	2	3	2.7
CO2	3	3	3	2	3	3	3	3	3	3	2.9
CO3	3	2	2	3	3	3	3	3	3	3	2.8
CO4	3	3	2	2	3	3	3	3	3	3	2.8
CO5	3	3	3	2	2	3	3	3	3	3	2.8
CO6	3	3	3	2	2	3	3	3	3	3	2.8
Mean Overall Score											2.8 (High)

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PBI2EG01	Generic Elective - 1 (WS): Biochemistry of Natural Products	4	3

Course Objectives
To gain knowledge on the basics in classification and naming plants and herbarium preparation
To comprehend systematic classification of plants and animals
To study the biosynthesis and biological role of plant hormones and ecosystem
To recognize the correlation between photosynthesis, photoperiodism and nitrogen metabolism
To appreciate the mechanism of photosynthesis and dark reactions in plants
To be able to exploit the pollutants and various method of bioremediation

UNIT I: General aspect of sources of medicinal plant products (12 Hours)

Introduction to primary and secondary metabolites, types of secondary metabolites, production under stress, isolation of active constituent from plant material.

UNIT II: Alkaloids (12 Hours)

Definition, general properties, classification based on nitrogen heterocyclic ring, types - phenylalkylamines, pyridine alkaloids, tropane alkaloids, quinolizidine and pyrrolizidine alkaloids, isoquinoline alkaloids, quinoline, monoterpene, indole alkaloids, purine alkaloids, ruta alkaloids, medicinal importance of each type. Role of alkaloids in plants.

UNIT III: Saponins and Steroids (12 Hours)

Definition, general properties, medicinal importance of saponins. Important saponins of plant origin - diosgenin, hecogenin, glycyrrhizin, aescin and ginseng. Steroids: General properties, classification. Introduction and medicinal importance of - cardiac glycosides from Digitalis, Strophanthus, Urginea, steroids from Withania somnifera, Holarrhena and Solanum.

UNIT IV: Terpenoids (12 Hours)

Definition, general properties, classification, introduction and medicinal importance of terpenoids. General account and medicinal importance of myrcene, ocimene, citronellol, menthol and camphor. Tannins, lignins and pectins: General properties and classification.

UNIT V: Plant pigments (12 Hours)

Occurrence, classification, introduction and applications of carotenoids, xanthophylls, anthocyanins, flavones, flavonols. Acetate pathway and Shikimic acid pathway. Definition, general properties and importance of Pyrethroids and rotenones of plant origin. Natural products of therapeutic importance from animals - Zootherapy - Venom, Body fluids as medicines - Urine, Saliva and Feces. Isolation, qualitative and quantitative analysis of secondary metabolites (Skill component).

Teaching Methodology	Videos, PPT, Demonstration and Creation of models
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Books for Study

1. Ramawat, K. G., & Merillon, J.M. (Eds.), (2010). *Biotechnology - secondary metabolites*, Oxford & IBH publishing Co. Pvt. Ltd.
UNIT-I Chapter 2 - Pages 21 to 59, Chapter 7- pages 179 to 201
UNIT-II Chapter 8 - pages 209 to 231
2. Trease, G. E., & Evans, W. C. (2002). *Pharmacognosy and Phytochemistry*, (15th Ed.). W.B. Saunders Edinburgh
UNIT-V Chapter 13-pages-144 to 147
3. Wink, M. (2010). *Biochemistry of Plant Secondary Metabolism* (Annual Plant Reviews, Volume 40, (2nd Ed.). A John Wiley & Sons, Ltd., Publication.
UNIT-II Chapter 2-pages 20 to 66
UNIT-III Chapter 4 pages 182 to 230, Chapter 6-pages 304 to 347
UNIT-IV Chapter 5 pages 258 to 285
4. J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthorpe, J. B. Harborne, (1994). *Natural Products: Their Chemistry and Biological Significance*, Longman Pub Group.

Books for References

1. Agrawal, V. P., & Khamboj, V. P. (Eds.) *Chemistry and biology of herbal medicine*: (Society of Biosciences).
2. Gurdeep, C. (1995). *Organic chemistry of natural products*, Himalaya publishing House.

Websites and eLearning Sources

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7123774/>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8036335/>
3. <https://www.hindawi.com/journals/jchem/2021/2691525/>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7121976/>
5. <https://www.yourarticlelibrary.com/pharmacognosy/photochemical-screening/saponin-glycosides-properties-types-and-other-details/49425>
6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC160903/pdf/071015.pdf>
7. https://fac.ksu.edu.sa/sites/default/files/terpenes_1438.pdf
8. <https://harvardforest.fas.harvard.edu/leaves/pigment>
9. <https://pubmed.ncbi.nlm.nih.gov/18476875/>
10. <https://www.youtube.com/watch?v=3VxeqgXa02c>

Course Outcomes		
CO No.	CO-Statements	Cognitive Levels (K - Level)
	On successful completion of this course, the students will be able to	
CO1	describe the occurrence, properties and economic importance of natural products from plants, animals and microbes	K1
CO2	compare the medicinal properties of secondary metabolites	K2
CO3	classify the natural compounds based on chemistry and applications	K3
CO4	apply the various methods of isolation of natural products	K4
CO5	evaluate quantitatively and qualitatively the secondary plant metabolites	K5
CO6	design the methodology of isolation of secondary metabolites	K6

Relationship Matrix											
Semester	Course Code			Title of the Course						Hours	Credits
2	23PBI2EG01			Generic Elective - 1 (WS): Biochemistry of Natural Products						4	3
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	3	2	3	2	2	3	2	2.4
CO2	3	2	3	2	3	2	3	2	1	3	2.4
CO3	3	2	3	2	3	3	3	2	2	3	2.6
CO4	2	3	2	2	2	2	3	2	3	2	2.3
CO5	2	3	2	3	2	2	3	3	2	3	2.5
CO6	3	2	2	3	2	2	3	2	2	2	2.3
Mean Overall Score											2.41 (High)