MAHATMA GANDHI UNIVERSITY

Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2026 Admission Onwards

SYLLABUS			
SIGNATURE COURSE			
Name of the College	Alphonsa College, Pala		
Faculty/ Discipline	Botany		
Programme	BSc (Hons) Botany		
Course Coordinator	Dani Mathew M		
Contributors	Ms Julie J Paramundayil, Dr. Jince Mary Joseph, Ms. Biby Annet Baiju		
Course Name	Plant Biochemistry 1-Biomolecules		
Type of Course	DSE		
Specialization title	Plant Biochemistry		
Course Code	MG3DSEBOTA09		
Course Level	200		
Course Summary	An integrative study of the five major biomolecule classes — carbohydrates, lipids, proteins, nucleic acids, and vitamins — focusing on how chemical structure determines biological function, and the physicochemical principles that stabilise biomolecular architecture in aqueous environments		
Semester	3	**Credits**	4
Course Details	**Learning Approach** / **Lecture** / **Total Hours** Credits / 4 / 60		
Pre-requisites, if any	Nil		

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain biophysical principles governing molecular stability and apply knowledge of carbohydrate structure, classification, and glycoconjugates to explain their biological and physiological roles in living systems.	U, A, An	PO1, PO2
2	Explain the structure, properties, and biological functions of major lipids and membrane components and membrane transport mechanisms	U	PO1, PO2
3	Explain the structural basis of amino acid properties, protein structure, and relate primary sequence to the three-dimensional organisation and function of proteins.	U, An	PO1, PO2
4	Describe the molecular architecture of nucleotides, DNA, and RNA and the roles of vitamins as coenzyme precursors	U	PO1, PO2

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	1	3	-	-	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	-	-	-	-
CO 3	2	3	-	-	-	-	-	-	-	-
CO 4	2	3	-	-	-	-	-	-	-	-

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	introduction to Biophysical Chemistry and Carbohydrates			
	1.1	Biophysical chemistry and stabilising interactions Non-covalent forces (Van der Waals, Hydrogen, Hydrophobic). Water structure, pH, and biological buffers. Thermodynamics. colligative properties — osmolarity and osmotic pressure	5	["1"]
	1.2	Classification of carbohydrates- Monosaccharides and their importance (glucose, galactose, fructose, ribose and deoxyribose with structures), Isomerism of carbohydrates - D and L forms, epimers, anomers. Disaccharides and polysaccharides α- and β-glycosidic bonds; sucrose, lactose, maltose; starch (amylose and amylopectin), glycogen, cellulose, chitin; hemicellulose and pectin in the plant primary cell wall; structural role of cellulose microfibrils.	5	["1"]
	1.3	Glycoconjugates Proteoglycans and glycosaminoglycans (hyaluronic acid, heparan sulfate, chondroitin sulfate); glycoproteins — N-linked and O-linked oligosaccharides; glycolipids; roles in cell recognition and signalling; plant-specific arabinogalactan proteins.(Brief without structure)	5	["1"]
2	Lipids and Membranes			
	2.1	Fatty acids, triacylglycerols, and waxes Saturated and unsaturated fatty acids — melting points, essential fatty acids; triacylglycerol structure and energy storage; waxes; cutin and suberin in plants — composition and barrier functions	5	["2"]
	2.2	Phospholipids and steroids (brief study)-Glycerophospholipids and sphingolipids (sphingomyelin, ceramide) — brief overview; steroids — cholesterol structure and functions; phytosterols.	3	["2"]
	2.3	Biological membranes and transport — brief study.Fluid mosaic structure and lipid asymmetry (brief); overview of passive, facilitated (aquaporins/channels), and active transport (Na+/K+-ATPase)	3	["2"]
	2.4	Plant-specific lipid metabolism and signalling-Mobilisation of storage lipids during seed germination (lipid body breakdown, β-oxidation overview); lipid-derived signalling molecules — oxylipins and jasmonates; membrane lipid remodelling under stress-	4	["2"]

Module	Units	Course Description	Hrs	CO No.
3	Amino Acids and Proteins			
	3.1	Amino acids — structure, classification, and properties General structure; 20 standard amino acids — side-chain classification (nonpolar, aromatic, polar uncharged, positively/negatively charged, special: Gly, Pro, Cys); ionisation states, pKa values, and isoelectric point (pI); Henderson–Hasselbalch equation; amino acid titration curves.	5	["3"]
	3.2	Peptide bond and primary structure-Peptide bond formation, resonance, and planarity; nomenclature; peptide sequencing overview; solid-phase peptide synthesis.	5	["3"]
	3.3	Levels of protein structure and function Secondary structure — α-helix, β-sheet, turns, collagen triple helix; tertiary structure — hydrophobic core, disulfide bonds, domains; quaternary structure — haemoglobin (T/R states, cooperative binding, Bohr effect); protein folding and denaturation; seed storage proteins in plants.	5	["3"]
4	Nucleic Acids and Vitamins			
	4.1	Nucleotide structure and function (brief study)- Purines and pyrimidines; nucleoside vs. nucleotide; 5′-phosphodiester backbone; nucleotides as monomeric units and metabolic currency.	3	["4"]
	4.2	Brief overview of RNA classes (mRNA, tRNA, rRNA) and the Central Dogma; nucleotides as ATP, NAD+, FAD, and signalling molecules. Overview of purine/pyrimidine metabolism regulation; nucleotide-derived secondary messengers (cAMP, cGMP) and their role in plant signal transduction.	6	["4"]
	4.3	Vitamins and coenzyme biochemistry Fat-soluble vitamins (A, D, E, K) — structures, functions, deficiency diseases; water-soluble vitamins — coenzyme forms: thiamine→TPP, riboflavin→FAD/FMN, niacin→NAD^+, pantothenate→CoA, pyridoxine→PLP, biotin, folate→THF, cobalamin B12; vitamin C in collagen hydroxylation	6	["4"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct instruction; interactive lectures with illustrative diagrams; collaborative problem-solving sessions; flipped classroom; guided literature reading; ICT-based animations for pathway and structural visualisation.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Written tests (short-answer, problem-solving, diagram-based); assignments and presentations; seminar/journal club; viva voce; portfolio of pathway diagrams. **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – End Semester examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ∘ PART - A ∘ One or two Sentences - (10 out of 12) – 10 × 2 = 20 ∘ PART - B ∘ Short Essays - (8 out of 10) – 8 × 5 = 40 ∘ PART - C ∘ Essays - (1 out of 2) – 1 × 10 = 10

References

- Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman & Co Ltd.
- Berg, J. M., Tymoczko, J. L., Gatto, G. J.,Stryer L (2019). Biochemistry (9th ed.). W. H. Freeman & Co Ltd.
- Voet D., Voet J., Pratt C.W.,(2018).Voet's Principles of Biochemistry (5th ed.) John Wiley & Sons.
- West E.S., Todd W.R., Mason H.S., Van Bruggen J.T., (2017) Text Book of Biochemistry (4th ed.)
- Rastogi V. B., Aneja K.R.,(2020) Zubay's Principles of Biochemistry (5th ed.)

Suggested Readings

- Karp, G. (2013). Cell and Molecular Biology: Concepts and Experiments (7th ed.). John Wiley & Sons.
- Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
- NCBI Bookshelf — Biochemistry online resources: https://www.ncbi.nlm.nih.gov/books/
- BRENDA Enzyme Database: https://www.brenda-enzymes.org/
- Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., Rodwell, V. W., & Weil, P. A. (2018). Harper's Illustrated Biochemistry (31st ed.). McGraw-Hill.
- Garrett, R. H., & Grisham, C. M. (2016). Biochemistry (6th ed.). Cengage Learning

Affidavit

- We, Alphonsa College, Pala and Dani Mathew M, agree to permit the use of our proposed course syllabus by other faculty members within the same discipline for course delivery at their respective institutions.
- We, Alphonsa College, Pala, agree to appoint a new course coordinator for the proposed Plant Biochemistry in the event of the unavailability of the currently nominated coordinator. This appointment will ensure the continued coordination of course delivery, assessments, and all related academic responsibilities necessary for the successful implementation of the specialization, for as long as the college offers this programme.
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Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2026 Admission Onwards

SYLLABUS			
SIGNATURE COURSE			
Name of the College	Alphonsa College, Pala		
Faculty/ Discipline	Botany		
Programme	BSc (Hons) Botany		
Course Coordinator	Dani Mathew M		
Contributors	Ms Julie J Paramundayil, Dr. jince Mary Joseph, Ms Biby Annet Baiju		
Course Name	Plant Biochemistry 2: Protein and Nucleic Acid Structure		
Type of Course	DSE		
Specialization title	Plant Biochemistry		
Course Code	MG4DSEBOTA09		
Course Level	200		
Course Summary	Study of the three-dimensional architecture of proteins and nucleic acids, connecting primary sequence to higher-order structure, biological function, and molecular stability. Covers Ramachandran analysis, protein folding and chaperones, the A/B/Z forms of DNA, RNA structural diversity, and the Central Dogma of Molecular Biology.		
Semester	4	**Credits**	4
Course Details	**Learning Approach** / **Lecture** / **Total Hours** Credits / 4 / 60		
Pre-requisites, if any	Nil		

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain protein secondary structure elements and Interpret Ramachandran plots	U, An	PO1, PO2
2	Describe protein tertiary and quaternary organization, folding mechanisms, chaperone function, and factors governing protein stability, misfolding, and diseases	U	PO1, PO2
3	Compare different DNA conformations (A, B, Z), explain DNA topology and chromatin organization, and evaluate the role of topoisomerases and genome packaging in cellular function.	U	PO1, PO2, PO3
4	Describe the structural features of RNAs and outline the Central Dogma	U	PO1, PO2

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-
CO 3	1	3	2	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Protein Secondary Structure			
	1.1	Ramachandran plot and backbone conformation Peptide bond planarity; φ and ψ dihedral angles; Ramachandran plot — allowed and disallowed regions; special cases of glycine (extended allowed region) and proline (restricted φ); use in structure validation. (Brief)	5	["1"]
	1.2	Alpha-helix and collagen helix α-Helix — 3.6 residues/turn, 1.5 Å rise, i→i+4 hydrogen bonding; amphipathic helices; helix-disrupting residues; 3_{10}-helix; collagen triple helix — Gly-X-Y repeats, hydroxyproline, tensile strength; scurvy.	5	["1"]
	1.3	Beta-sheets, turns, and loops Parallel and antiparallel β-sheets — hydrogen bonding topology; β-barrel motif; β-turns Types I and II; Ω-loops; intrinsically disordered regions and their functional roles.	5	["1"]
2	Tertiary Structure, Folding, and Stability			
	2.1	Supersecondary motifs, domains, and folds Supersecondary motifs — helix-turn-helix, β-hairpin, Greek key, βαβ unit; protein domains and domain swapping; all-α, all-β, TIM barrel, α+β classes	5	["2"]
	2.2	Tertiary and quaternary structure Hydrophobic core; disulfide bonds; salt bridges; metal coordination; haemoglobin $\alpha_2\beta_2$ tetramer — T and R states, cooperative binding, Bohr effect, 2,3-BPG; sickle cell haemoglobin; viral capsid and antibody architecture.	5	["2"]
	2.3	Protein folding, chaperones, and denaturation Anfinsen's experiment and thermodynamic hypothesis; ΔGfolding and marginal stability; hydrophobic effect; Hsp70 and GroEL/GroES chaperonin mechanism; denaturation agents; molten globule; amyloid fibril formation; prion hypothesis; plant heat-stress chaperones	5	["2"]
3	DNA Conformation and Topology			
	3.1	B-DNA — helical parameters(brief); major and minor grooves and their significance for sequence-specific recognition; base stacking energetics.	3	["3"]
	3.2	A-DNA, Z-DNA, and unusual DNA structures (Brief) RNA:DNA hybrids; comparative A/B/Z parameter table; G-quadruplexes in telomeres. DNA–protein recognition motifs — brief	5	["3"]
	3.3	DNA supercoiling, chromatin, and topoisomerases — Linking number (Lk), twist (Tw), writhe (Wr); negative and positive supercoiling; Type I topoisomerase (nick-reseal); Type II topoisomerase (gyrase); nucleosome — histone octamer, 146 bp wrap, 30-nm fibre; chromatin remodelling; plant genome organisation, polyploidy, and higher-order chromatin domains.	7	["3"]

Module	Units	Course Description	Hrs	CO No.
4	RNA Structure, Stability, and the Central Dogma			
	4.1	RNA structural diversity 2′-OH and conformational consequences; A-form helix as default RNA duplex; tRNA — cloverleaf (D-loop, anticodon loop, TΨC loop, CCA-3′); L-shaped tertiary structure; mRNA — 5′-cap, poly-A tail; rRNA and peptidyl transferase activity; aminoacyl-tRNA synthetase identity elements.	5	["4"]
	4.2	Catalytic and regulatory RNAs Ribozymes — Group I/II introns, hammerhead, RNase P; RNA world hypothesis; siRNA and miRNA biogenesis (Dicer, RISC) and silencing mechanisms; RNA thermometers in plant stress; RNA–protein recognition principles.	5	["4"]
	4.3	Nucleic acid stability and the Central Dogma Base stacking vs. hydrogen bonding in duplex stability; GC content and Tm; hyperchromic effect; UV melting curves; salt effects; RNA instability (2′-OH-mediated hydrolysis); UV-induced pyrimidine dimers; Central Dogma — DNA replication, transcription, translation overview; chloroplast and mitochondrial DNA in plants.	5	["4"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct instruction; interactive lectures with illustrative diagrams; collaborative problem-solving sessions; flipped classroom; guided literature reading; ICT-based animations for pathway and structural visualisation.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Written tests (short-answer, problem-solving, diagram-based); assignments and presentations; seminar; viva voce;MCQ **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – End Semester examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ One or two Sentences - (10 out of 12) – 10 × 2 = 20 ◦ PART - B ◦ Short Essays/Problems - (8 out of 10) – 8 × 5 = 40 ◦ PART - C ◦ Essays - (1 out of 2) – 1 × 10 = 10

References

- Rastogi, S. C. (2006). Cell and molecular biology. New Age International.
- Karp, G. (2007). Cell and Molecular Biology. John Wiley & Sons Incorporated.
- Petsko, G. A., & Ringe, D. (2004). Protein Structure and Function. Sinauer Associates
- Bloomfield, V. A., Crothers, D. M., & Tinoco, I. (2000). Nucleic Acids: Structures, Properties, and Functions. University Science Books
- Berg, J. M., Tymoczko, J. L., Gatto, G. J.,Stryer L (2019). Biochemistry (9th ed.). W. H. Freeman & Co Ltd.

Suggested Readings

- Lewin, B., Krebs, J., Kilpatrick, S. T., & Goldstein, E. S. (2011). Lewin's genes X.Jones
- Das D., (2015) Biochemistry (14th ed.) Academic publishers

Affidavit

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MAHATMA GANDHI UNIVERSITY
Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2026 Admission Onwards

SYLLABUS			
SIGNATURE COURSE			
Name of the College	Alphonsa College, Pala		
Faculty/ Discipline	Botany		
Programme	BSc (Hons) Botany		
Course Coordinator	Dani Mathew M		
Contributors	Ms.Julie J Paramundayil, Dr. Jince Mary Joseph, Ms Biby Annet Baiju		
Course Name	Plant Biochemistry 3: Secondary Metabolism and Stress Biochemistry		
Type of Course	DSE		
Specialization title	Plant Biochemistry		
Course Code	MG5DSEBOTA09		
Course Level	300		
Course Summary	A plant-focused course covering photosynthesis biochemistry, secondary metabolite pathways (phenylpropanoids, terpenoids, alkaloids, glucosinolates), phytohormone biosynthesis and signalling, stress biochemistry including ROS and antioxidant systems, and applications of plant biochemistry in metabolic engineering, nutraceuticals, and agricultural biotechnology.		
Semester	5	**Credits**	4
Course Details	**Learning Approach** / **Lecture** / **Total Hours** Credits / 4 / 60		
Pre-requisites, if any	Nil		

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain classification, distribution, importance, and extraction methods of plant secondary metabolites and plant-derived enzymes..	A	PO1, PO2
2	Describe biosynthesis of phenolics, terpenoids, alkaloids, glucosinolates and relate structures to ecological and human uses.	U	PO1, PO2, PO3
3	Explain phytohormone signaling and biochemical mechanisms underlying plant responses to abiotic and biotic stress.	U	PO1, PO2
4	Explain industrial and nutraceutical applications of phytochemicals, enzymes, plant pharmaceuticals, biopesticides, and biofuels.	U	PO1, PO2, PO3

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	1	3	-	-	-	-	-	-	-	-
CO 2	1	1	1	-	-	-	-	-	-	-
CO 3	1	1	-	-	-	-	-	-	-	-
CO 4	1	2	2	-	-	-	-	-	-	-

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Plant metabolites.			
	1.1	Classification of secondary metabolites and its uses Distinction between primary and secondary metabolites, Occurrence and distribution of secondary metabolites in taxonomically distinct plants, Distribution in various plant parts and at different developmental stages in plants. Plant derived enzymes.	5	["1"]
	1.2	Major chemical classes of secondary metabolites: A brief account of the following classes: Alkaloids, terpenoids, flavonoids, phenolics and phenolic acids, steroids, coumarins, quinines, acetylenes,cyanogenic glycosides, amines and non-protein amino acids, gums, mucilages, resins etc.. Give examples of the compounds and the plants in which present and their importance. (Structures not necessary)	5	["1"]
	1.3	Extraction Methods- 1. Solvent extraction- alcohol, acetone, benzene, chloroform, acid. Aqueous extraction, supercritical fluid extraction-CO2, microwave assisted extraction	5	["1"]
2	Secondary Metabolite Pathways			
	2.1	Phenolic Pathways Shikimate Pathway, ; phenolics,flavonoids, lignin — biosynthesis, regulation, and ecological roles.	6	["2"]
	2.2	Terpenoid pathways MVA and MEP pathways; IPP/DMAPP; mono-, sesqui-, di-, triterpenes;carotenoids — classification, key enzymes, and commercial importance.	6	["2"]
	2.3	Nitrogen-Containing Compounds Alkaloids, glucosinolates, cyanogenic glycosides — biosynthesis from amino acids, diversity, and medicinal significance.	3	["2"]
3	Phytohormones and Stress Biochemistry			
	3.1	Phytohormone biosynthesis (Brief); Trp-dependent auxin (IAA) biosynthesis; GA biosynthesis; ABA biosynthesis from carotenoid precursors; ethylene biosynthesis; cytokinin biosynthesis (IPT).	5	["3"]
	3.2	Abiotic stress responses Drought — ABA signalling, LEA proteins, osmoprotectants (proline, glycine betaine, mannitol), aquaporin regulation; heat stress — membrane fluidity changes, HSP induction, heat shock transcription factors (HSFs), thermomemory; cold acclimation — cryoprotectants, membrane unsaturation, salinity — Na^+ toxicity, SOS pathways, vacuolar Na^+ compartmentalization.	5	["3"]
	3.3	Biotic stress and ROS signalling Pattern-Triggered Immunity & Effector-Triggered Immunity. Role of ROS and NADPH Oxidase. Systemic Resistance and Hormones. Antioxidant Defense: The Halliwell–Asada Cycle	5	["3"]

Module	Units	Course Description	Hrs	CO No.
4	Industrial and nutraceutical applications			
	4.1	Phytochemicals as nutraceuticals — polyphenols (resveratrol, quercetin, curcumin), carotenoids (lycopene, β-carotene, lutein), glucosinolates (sulforaphane). enzyme applications in food processing.	5	["4"]
	4.2	Plant-based pharmaceuticals — paclitaxel (Taxus), vinblastine/vincristine (Catharanthus), morphine (Papaver), artemisinin (Artemisia); flavour/fragrance compounds — monoterpenes, vanillin, eugenol	5	["4"]
	4.3	Biopesticides — azadirachtin, pyrethrin, rotenone; lignocellulosic ethanol;	5	["4"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: interactive lectures with illustrative diagrams; Interactive Session: Seminar, Group Assignments, Library work and Group discussion, Presentation by individual student.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** 1. Written tests (short-answer, problem-solving, diagram-based);10 marks 2. MCQ test for half an hour (5 marks) 3. Seminar Presentation (5 marks) 4. Assignment and group discussion (5 marks) 5. Quiz (5 marks) **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – End Semester examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ One or two Sentences - (10 out of 12) – 10 × 2 = 20 ◦ PART - B ◦ Short Essays - (8 out of 10) – 8 × 5 = 40 ◦ PART - C ◦ Essays - (1 out of 2) – 1 × 10 = 10

References

- Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). Plant physiology and development (No. Ed. 6). Sinauer Associates Incorporated.
- Hopkins, W. G. (2008). Introduction to plant physiology. John Wiley & Sons.
- Hopkins, W. G. (2008). Introduction to plant physiology. John Wiley & Sons.
- Verma, S. K., & Verma, M. (2008). A textbook of plant physiology, biochemistry and biotechnology. S. Chand Publishing.
- Heldt, H. W., & Piechulla, B. (2021). Plant biochemistry. Academic Press.
- Harborne, J. B. (1998). Phytochemical Methods (3rd ed.). Chapman & Hall
- Verpoorte, R., & Memelink, J. (2002). Engineering secondary metabolite production in plants. Current Opinion in Biotechnology, 13(2), 181–187.

Suggested Readings

- PlantCyc / MetaCyc pathway databases: https://plantcyc.org/

- Nature Plants and Plant Cell journals — current research in plant biochemistry.
- Springob, K., & Kutchan, T. M. (2009). Introduction to the different classes of natural products. In Plant-derived Natural Products. Springer
- Rhodes, D., & Nadolska-Orczyk, A. (2001). Plant stress physiology. e LS.
- Gupta, D. K., & Corpas, F. J. (Eds.). (2021). Hormones and Plant Response (Vol.2). Springer Nature.
- KEGG Plant Metabolic Pathway resources: https://www.genome.jp/kegg/

Affidavit

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SIGNATURE COURSE			
Name of the College	Alphonsa College, Pala		
Faculty/ Discipline	Botany		
Programme	BSc (Hons) Botany		
Course Coordinator	Dani Mathew M		
Contributors	Julie J Paramundayil, Dr. Jince Mary Joseph, Biby Annet Baiju		
Course Name	Plant Biochemistry 4: Enzymology, Bioenergetics, and Metabolic Pathways		
Type of Course	DSE		
Specialization title	Plant Biochemistry		
Course Code	MG6DSEBOTA09		
Course Level	300		
Course Summary	Study of enzyme structure, kinetics, and catalytic mechanisms; thermodynamic principles of biological energy transactions; and the major metabolic pathways of carbohydrates and lipids — with plant-specific adaptations including alternative oxidase, C4/CAM metabolism, and the glyoxylate cycle.		
Semester	6	**Credits**	4

Course Details

Learning Approach	Lecture	Practical/Lab-P	Total Hours
Credits	3	1	75

Pre-requisites, if any	NIL

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Classify enzymes, explain cofactors, apply Michaelis–Menten kinetics, interpret parameters, and identify inhibition types from data	A, An	PO1, PO2, PO3
2	Explain mechanism of Enzyme action and allosteric regulation and isozyme concepts.	U	PO1, PO2, PO3
3	Explain bioenergetics principles and carbohydrate and lipid metabolism pathways.	U	PO1, PO2, PO3
4	Demonstrate biochemical analytical skills (extraction, separation, quantitative estimation, and enzyme assay) to real plant samples.	S	PO1, PO2, PO3

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CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	2	-	-	-	-	-	-	-
CO 2	3	3	3	-	-	-	-	-	-	-
CO 3	1	2	2	-	-	-	-	-	-	-
CO 4	1	2	2	-	-	-	-	-	-	-

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Enzymology — Classification, Kinetics, and Inhibition			
	1.1	Enzyme classification, structure, and cofactors EC classification — six primary classes, four-digit numbers; apoenzyme vs. holoenzyme; coenzymes (NAD^+, FAD, CoA, PLP, TPP, THF) and prosthetic groups; metal ion cofactors (Zn^{2+}, Mg^{2+}, $Fe^{2+}/^{3+}$); active site features — binding pocket, induced-fit model; effects of pH and temperature.	5	["1"]
	1.2	Michaelis–Menten kinetics and linearisation Transition state theory and activation energy; Michaelis–Menten derivation (Briggs–Haldane steady-state); Km, Vmax, kcat, and catalytic efficiency (kcat/Km);	5	["1"]
	1.3	Enzyme inhibition-Competitive inhibition ,uncompetitive inhibition; non-competitive (mixed) inhibition; irreversible inhibition, mechanism-based (suicide) inhibitors; transition state analogues as drugs.	5	["1"]
2	Catalytic Mechanisms and Enzyme Regulation			
	2.1	Mechanisms of enzyme catalysis. Introduction to Catalysis & The Active Site; Acid-Base & Proximity Effects, covalent catalysis, metal ion catalysis	6	["2"]
	2.2	Allosteric regulation-Allosteric Sites, Types of Allosteric Regulation-Feedback inhibition, Allosteric activation, Co-operativity	5	["2"]
	2.3	Isozymes — definition and genetic origin, LDH isoforms. Covalent modification-phosphorylation/dephosphorylation; zymogen activation	4	["2"]
3	Bioenergetics and Metabolic Pathways			
	3.1	Principles of Bioenergetics(brief)-Thermodynamics in Biology, ATP and Phosphoryl Group Transfer. Biological Oxidation-Reduction	4	["3"]
	3.2	Photophosphorylation, Oxidative phosphorylation (Brief)	3	["3"]
	3.3	Carbohydrate and lipid metabolic pathways-Brief overview of glycolysis, TCA cycle, gluconeogenesis, and glycogen metabolism. Fatty acid oxidation and biosynthesis (overview); glyoxylate cycle in germinating seeds; plant respiratory and photosynthetic adaptations — alternative oxidase (AOX), C4, and CAM metabolism.	8	["3"]

Module	Units	Course Description	Hrs	CO No.
4	Practical			
	4.1	1. Qualitative Screening of Phytochemicals Tests for the presence of secondary metabolites. 2. Biochemical Separation Techniques -Chromatography- Demonstration Thin Layer Chromatography (TLC) for separation of amino acids / phytochemicals 3.Biochemical Separation Techniques -Electrophoresis- Demonstration Agarose Gel Electrophoresis (AGE) for separation of nucleic acids	14	["4"]
	4.2	1. Extraction (Demonstration) Working of Soxhlet apparatus for continuous solvent extraction of plant material 2. Estimation of Leghaemoglobin from the root nodule of leguminous plants	8	["4"]
	4.3	Enzymology- 1. Assay of catalase enzyme activity in plant tissue 2. Assay of amylase enzyme activity	8	["4"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Interactive lectures with illustrative diagramms, E-learning- ICT-based animations for pathway and structural visualisation Interactive Session: Seminar, Group Assignments, Library work and Group discussion, Presentation by individual student, Laboratory Involvement and hands on activity
Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Both **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 25 Marks** 1. Written tests (short-answer, problem-solving, diagram-based);10 marks 2. MCQ test for half an hour (5 marks) 3. Seminar Presentation (5 marks) 4. Assignment and group discussion (5 marks) 5. Quiz (5 marks) **• Practical – 15 Marks** Lab involvement, Record, practical skills **B. End Semester Evaluation (ESE)** **• Theory – 50 Marks** Assessment Methods – End Semester examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ∘ PART - A ∘ One or two Sentences - (10 out of 12) – 10 × 1 = 10 ∘ PART - B ∘ Short Essays - (6 out of 8) – 6 × 5 = 30 ∘ PART - C ∘ Essays - (1 out of 2) – 1 × 10 = 10 **• Practical – 35 Marks** Assessment Methods – practical based assessment Duration of Examination – 2.00 Hrs

References

- Palmer, T., & Bonner, P. (2007). Enzymes: Biotechnology, Clinical Chemistry (2nd ed.). Horwood Publishing Limited.
- Price, N. C., & Stevens, L. (1999). Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins. Oxford University Press.

- Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). Plant Physiology and Development (6th ed.). Sinauer Associates.
- Stryer, L., Berg, J. M., Tymoczko, J. L., & Gatto, G. J. (2019). Biochemistry (9th ed.). W. H. Freeman.
- Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). (2015). Biochemistry and Molecular Biology of Plants (2nd ed.). Wiley-Blackwell.

Suggested Readings

- Cornish-Bowden, A. (2012). Fundamentals of Enzyme Kinetics (4th ed.). Wiley-Blackwell.
- Palmer, T. (1991). Understanding Enzymes (4th ed.). Ellis Horwood.
- Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., Rodwell, V. W., & Weil, P. A. (2018). Harper's Illustrated Biochemistry (31st ed.). McGraw-Hill.

Affidavit

- We, Alphonsa College, Pala and Dani Mathew M, agree to permit the use of our proposed course syllabus by other faculty members within the same discipline for course delivery at their respective institutions.
- We, Alphonsa College, Pala, agree to appoint a new course coordinator for the proposed Plant Biochemistry in the event of the unavailability of the currently nominated coordinator. This appointment will ensure the continued coordination of course delivery, assessments, and all related academic responsibilities necessary for the successful implementation of the specialization, for as long as the college offers this programme.
- We, Alphonsa College, Pala and Dani Mathew M, declare that no part of this signature course submitted here for approval has been taken from the course content developed by, or from any of the course titles prepared by, the BoS/expert committee in the same discipline under our University.