THE MAHATMA GANDHI UNIVERSITY

UNDERGRADUATE PROGRAMMES (HONOURS)

SYLLABUS

MGU-UGP (Honours)

(2024 Admission Onwards)

Faculty: Science

Combined BoS: Botany & Biotechnology

Programme: Bachelor of Science (Honours) Botany and Biotechnology (Double Major Programme)

Mahatma Gandhi University
Priyadarshini Hills
Kottayam – 686560, Kerala, India

Board of Studies (Botany)

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   Baselius College, Kottayam

7. **Dr. Jayesh Antony**
   Assistant Professor
   Department of Zoology
   St. Thomas College, Palai. Kottayam.

SYLLABUS INDEX

Name of the Major: Botany and Biotechnology (Double Major Programme)

Semester: 1

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG1DSCBBT100	Fascinating world of plant sciences	DSC A	4	5	3		2	
MG1DSCBBT101	Fundamentals for biotechnology	DSC B	4	5	3		2	
MG1DSCBBT102	Biotechnology and human welfare	DSC B	4	5	3		2	
MG1MDCBBT100	Ecotourism	MDC (Any one)	3	4	2		2	
MG1MDCBBT101	Ecology and environmental science							

Semester: 2

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG2DSCBBT100	Plant resources and ventures in botany	DSC A	4	5	3		2	
MG2DSCBBT101	Applied biotechnology	DSC B	4	5	3		2	
MG2DSCBBT102	Fundamentals of enzymology and radiobiology	DSC B	4	5	3		2	
MG2MDCBBT100	Gardening and landscaping	MDC (Any one)	3	4	2		2	
MG2MDCBBT101	Tools and techniques in biotechnology							

Semester: 3

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG3DSCBBT200	Microbiology and phycology	DSC A	4	5	3		2	
MG3DSEBBT200	Mycology and plant pathology	DSE A	4	5	3		2	
MG3DSCBBT201	Cell biology and genetics	DSC B	4	5	3		2	
MG3DSEBBT201	Developmental biology and assisted reproduction technology	DSE B	4	4	4			
MG3DSEBBT202	Plant and animal physiology		4	4	4			
MG3MDCBBT200	Agri based micro enterprises	MDC (Any one)	3	3	3			
MG3MDCBBT201	Nutritional biotechnology							
MG3VACBBT200	Bioethics and IPR	VAC (Any one)	3	3	3			
MG3VACBBT201	Environmental biotechnology and human rights							

Semester: 4

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG4DSCBBT200	Plant anatomy and reproductive botany	DSC A	4	5	3		2	
MG4DSEBBT200	Food science and quality control	DSE A	4	4	4			
MG4DSEBBT201	Horticulture and post harvest technology							
MG4DSCBBT201	Molecular biology	DSC B	4	5	3		2	
MG4DSCBBT202	Immunology	DSC B	4	5	3		2	
MG4SECBBT200	Biofertilizers and bio-control agents	SEC (Any one)	3	3	3			
MG4SECBBT201	Quality control in biology							
MG4VACBBT200	Conservation biology and sustainable development	VAC (Any one)	3	3	3			
MG4VACBBT201	Human resource management in biotechnology							

Internship

	Internship		Credit					
MG4INTBBT200	Internship	INT	2					

Semester: 5

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG5DSCBBT300	Angiosperm systematics and economic botany	DSC A	4	5	3		2	
MG5DSEBBT300	Plant biotechnology	DSE A (Any three)	4	4	4			
MG5DSEBBT301	Green technology and sustainable development							
MG5DSEBBT302	Analytical techniques in plant sciences							
MG5DSEBBT303	Climate change and disaster management-botanical perspective							
MG5DSEBBT304	Recombinant DNA Technology	DSE B	4	5	3		2	
MG5SECBBT300	Mushroom production and value addition	SEC	3	3	3			
MG5SECBBT301	Scientific communication in research							

Semester: 6

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG6DSCBBT300	Plant physiology and biochemistry	DSC A	4	5	3		2	
MG6DSEBBT300	Genetics and evolutionary biology	DSE A	4	4	4			
MG6DSEBBT301	Research methodology and biometrics	DSE A (Any one)	4	5	3		2	
MG6DSEBBT302	Plant ecology, conservation and sustainable development							
MG6DSCBBT301	Plant and animal biotechnology	DSC B	4	5	3		2	
MG6SECBBT300	Entrepreneurial botany	SEC	3	3	3			
MG6VACBBT300	Environmental science and human rights	VAC (Any one)	3	3	3			
MG6VACBBT301	Biotechnology for nourishing health							

Semester: 7

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG7DCCBBT400	Research methodology and biostatistics	DCC A	4	4	4			
MG7DCCBBT401	Advances and applications in plant science - Thallophytes	DCC A	4	5	3		2	
MG7DCCBBT402	Advances and applications in plant science – Archegoniates	DCC A	4	4	4			
MG7DCEBBT400	Agronomy, horticulture and agroforesty	DCE A	4	4	4			
MG7DCEBBT401	Plant genomics							
MG7DCEBBT402	Seed technology							
MG7DCEBBT403	Agricultural biotechnology	DCE B	4	4	4			
MG7DCEBBT404	Proteomics							
MG7DCEBBT405	Genetic engineering							

Semester: 8

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG8DCCBBT400	Plant metabolism	DCC A	4	5	3		2	
MG8DCCBBT401	Plant breeding and plant propagation techniques	DCC A	4	5	3		2	
MG8DCEBBT400	Phytochemistry and pharmacognosy	DCE A (Any Two)	4	5	3		2	
MG8DCEBBT401	Omics in plant sciences							
MG8DCEBBT402	Modern trends in plant systematics							
MG8DCEBBT403	Agroecology							
MG8DCEBBT404	Forest botany	DCE A (Any One)	4	5	3		2	
MG8DCEBBT405	Aquatic botany							
MG8DCEBBT406	Plant bio-analytics and advanced instrumentation.							
MG8DCEBBT407	Advanced instrumentation technique	DCE B	4	5	3		2	
MG8PRJBBT400	Project	PRJ	12					

SEMESTER I

Mahatma Gandhi University
Kottayam

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Fascinating world of plant sciences</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG1DSCBBT100</td></tr>
<tr><td>Course Level</td><td colspan="6">100</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course entitled ‘Fascinating world of plant science and technology’ aims to impart an understanding on the significance of plants to the future generation. Students will be familiarizedwith eminent botanists and their contributions to plant science. They will be introduced to the major plant groups and their uniqueness in terms of size, shape, habitat and associations. Students are expected to develop a passion to explore the plant kingdom as well as to make serious attempts to conserve plants. Knowledge about traditional and modern approaches in plant sciences and major branches related to plant science will also be acquired.</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Prerequisite, if any</td><td colspan="6">Should have basic knowledge of Botany and Botanical Skills</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	EXPECTED COURSE OUTCOME	LEARNING DOMAINS *	PO No
01	Comprehend the relevance of plants, important milestones in the history of botany, and human efforts to realize life on Earth.	U	PO 8, PO 10
02	Illustrate the diversity and evolutionary trends throughout the plant world that lay a solid foundation for the branch of natural philosophy, botany.	An	PO 2, PO 1
03	Develop basic skills on instruments and techniques used in Botanical studies.	A	PO 2, PO 5
04	Facilitate awareness on the areas of research and potentials in the field of plant science.	C	PO 3, PO 4
05	Design experiments and communicate ideas, which would translate into a lasting and practical basis for building a career.	C	PO 10, PO 8, PO 6

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

COURSE CONTENT

MODULE	UNITS	COURSE DESCRIPTION	Hrs.	CO NO.
1	**Exploring the Plant Kingdom (15 Hours)**			
	1.1	A Journey Through Botanical History: Vistas in Plant Science / Botany. Contributions of eminent botanists: (a) Theophrastus, (b) Carl Linnaeus, (c) Janaki Ammal (d) Itty Achudan. Brief overview of Botany, citing events that changed the course of world history: Quinine Tree, Coconut, Rice, Sugarcane and *Penicillium notatum*	4	1
	1.2	Plants and the Planet: Medicine, food and fibre, timber (Natural and Processed), aesthetic value, maintaining ecological balance **Learning Activity 1:** Group Discussion on ● Usefulness and benefits of plants ● Significance of Plants as Purifiers of our planet.	5	1
	1.3	Distinguishing characters and evolutionary trends in the morphology of major groups of plants: Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. **Learning Activity 2:** An explorative nature walk to understand biodiversity of a selected locality: Paddy Field / Wetland ecosystem / Sacred Groves / Any other locality which harbors biodiversity and represents most of the major plant groups.	6	2
	Wonders in Plant Kingdom and Traditional Approaches in Plant Science (15 Hours)			

2	2.1	Awe-inspiring members of the plant world: Unusual foods: Fungi (Mushrooms), Lichen (*Parmelia*), *Chlorella* as food supplement in aerospace programmes. Psychoactive plants and zoopharmacognosy: Marula plant (*Sclerocaryabirrea*); Lemurs eating tamarind and fig leaves. Biomimicry: Nature as model: Lotus effect technology in paint industry; *Citrus maxima* fruit wall inspired design of crash absorbing structures. Special Adaptations: Insectivorous plants, Heliotropism in sunflowers, Pseudocopulation strategy in orchids. Gigantic plants: e.g. *Sequoiadendron giganteum*. Plants that live in extreme environments: volcanoes: Haleakala silversword, desert: Saguaro cactus, arctic: Arctic poppy.	7	2
	2.2	Traditional approach and methods: (A) Exploration: Field Visit. (B) Collection of plant material: significance & tools used. (C) Preservation: Killing Agent: (Formalin), Fixing Agent: (FAA). Wet Preservation: Museum jar preservation. dry preservation: herbarium. (D) Free-hand sectioning: Transverse section (TS), Longitudinal section (LS)	5	3
	2.3	(E) Description: Description of plants. (F) Classification: Artificial, Natural and Phylogenetic (Definition and One Example Each). (G) Documentation: Significance of scientific diagrams and field books.	3	3
3	**Modern Approaches and Scope of Plant Science (15 Hours)**			
	3.1	Modern Approaches: (A)Sectioning: Microtomy (Definition and purpose of rotary microtome, sledge microtome and ultramicrotome). (B) visualization techniques: parts and applications of simple & compound microscope, applications of electron microscope (SEM & TEM). (C) Separation techniques (Principle and Application): (i) Chromatography: TLC and Paper chromatography. (ii) Centrifugation: tabletop centrifuge and ultracentrifuge. (iii) Electrophoresis: agarose gel electrophoresis (AGE).	6	3

	3.2	A few current approaches and applications: (A) Molecular techniques (General Account and Applications): PCR, DNA barcoding (B) Remote Sensing (Brief Account): Application of Remote sensing and GIS for mapping of natural resources. (C) Use of Internet of Things (IoT), Deep learning and artificial intelligence (AI): Detection of water stress and disease detection in smart/precision Farming. **Learning Activity 3:** Visit to a laboratory to familiarize with a few of the instruments mentioned above.	5	3, 5
	3.3	Brief account and research potential in: Plant systematics, Ecology, Plant anatomy, Plant physiology, Genetics, Ethnobotany, Crop improvement & Plant genetic engineering	4	4, 5
4	**Practical (30 hours)**			
	4.1	Field Activities (Mandatory) Conduct a two days field trip and survey, to appreciate the diversity of plant kingdom and to identify plants belonging to all the major groups discussed in theory. Prepare a set of 12 geo-tagged photographs containing at least one representative from each Major group.	15	2
	4.2	Laboratory Activities (Conduct Any Three)		
		❖ Prepare a report and presentation on Botanists who made significant contributions to science.	2	1
		❖ Familiarize students with a compound microscope and dissecting / simple microscope. Assess the magnifications of the microscope you are examining. Compare the real image (Naked eye) with the magnified virtual image of an appropriate plant specimen and makeillustrations of magnified specimens.	3	3, 5
		❖ Prepare temporary, single stained hand sections (TS and LS; one each) of appropriate plant specimens for light microscopic studies.	2	3

		❖ Design a working model for detecting Moisture of Soil / Temperature and Humidity of Air, utilizing Arduino microcontroller kit/ Raspberry pi or other microcontroller boards and appropriate sensors. Possibilities to utilize IoT, as part of the model may be explored, if needed.	4	3, 5
		❖ Prepare an extract of leaves of appropriate plant material and perform centrifugation using a table top centrifuge, decant to separate the pigments (Supernatant) from the debris (Pellet).	4	3
5	**Teacher specific course components**			
Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.			
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty			
	B. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks			

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SUGGESTED READINGS

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Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Biotechnology**
Course Name	**Fundamentals for Biotechnology**
Type of Course	**DSC A**
Course Code	**MG1DSCBBT101**
Course Level	**100-199**
Course Summary	Fundamentals of Biotechnology covers essential concepts related to various fields of Biotechnology. Module 1 gives basic ideas about the historical background on the field cell biology Biotechnology. Module 2 covers basics of Genetics, Immunology and Microbiology. Module 3 deals with the structure and function of biomolecule and rDNA Technology and its applications. Module 4 covers various aspects of Good laboratory practices.

Semester	1	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	NA					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	On completion of the course students will be able to identify the scope of biotechnology, tracing its historical development from ancient to modern times.	K	2, 3, 6,10
2	Students will be able to discuss the various applications of biotechnology in medicine, agriculture, and industry.	U	1, 10
3	Students could apply their knowledge to solve problems like monohybrid and dihybrid crosses in genetics.	An	2, 5, 9,10
4	Students gain the knowledge of good laboratory practices.	U	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs.	CO No.
1 Introduction to Biotechnology and the Cell.	1.1	**History of Biotechnology** Biotechnology - Definition, History and scope of Biotechnology, Conventional Biotechnology and Modern Biotechnology, Milestones in the development of Biotechnology. Career aspects and applications of biotechnology.	4	1, 2
	1.2	Cell theory, Cell as a tool for biotechnology. Prokaryotic and Eukaryotic cell structure.	4	1, 2
2 Overview of Genetics, Microbiology and Immunology	2.1	Introduction to Mendelian genetics; Mendelian laws; Monohybrid and Dihybrid experiments.	4	1, 2
	2.2	Introduction to Microbiology, microbial diversity – General characteristic of bacteria, fungi, virus microscopic algae and protozoa.	6	1, 2
	2.3	An overview to immunology- antigen, antibody; Cells of immune system.	6	3
3 Biomolecules- Structure and Function	3.1	General classification of Carbohydrates, Proteins, Lipids and Nucleic acids. General structure and characteristic of Carbohydrates, Proteins, Lipids and Nucleic acids.	6	1, 2
	3.2	Structure and function of nucleic acids; An outline to DNA replication, transcription and translation.	8	2
	3.3	An introduction to Recombinant DNA technology, Basic steps in rDNA technology. Applications of rDNA technology–Vaccine-Hepatitis, Covid; Hormones- Humulin, Growth hormone.	8	2
4 Practical	4.1	Overview of laboratory safety rules and regulations, Maintenance of aseptic conditions and personal hygiene.	5	4
	4.2	Introduction to the laboratory layout and equipments. Cleanliness of laboratory wares and workspace.	6	4
	4.3	Biological safety measures and maintenance of live cells, Maintenance of Sterility.	6	4
	4.4	Sources of spillage and contamination, Methods of decontamination, Waste management practices in laboratory.	8	4
	4.5	Documentation and record keeping in laboratory.	5	4
5		**Teacher specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 5 hrs.	Major expt./ procedure/ case study analysis – 15 Minor expts./ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

Reference

1. Sathyanarayana U., (2020) Text book of Biotechnology, Books And Allied (P) Ltd. Kolkata.
2. Campbell, N. A., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2017). Biology (11th ed.). Pearson.
3. Raven, P. H., Johnson, G. B., Mason, K. A., Losos, J. B., & Singer, S. S. (2017). Biology (11th ed.). McGraw-Hill Education.
4. Mader, S. S., & Windelspecht, M. (2018). Biology (13th ed.). McGraw-Hill Education.
5. Solomon, E. P., Berg, L. R., Martin, D. W., & Villee, C. A. (2017). Biology (10th ed.). Cengage Learning.
6. Brooker, R. J., Widmaier, E. P., Graham, L. E., & Stiling, P. D. (2018). Biology (5th ed.). McGraw-Hill Education.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Biotechnology and Human Welfare**					
Type ofCourse	**DSC B**					
Course Code	**MG1DSCBBT102**					
CourseLevel	**100**					
Course Summary	This course enlightens the students with the trends and techniques in biotechnology.					
Semester	**1**	Credits			**4**	Total Hours
CourseDetails	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre- requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome** On completion of the course the student will able	**Learning Domains***	**PO No**
1	To describe the role of biotechnology in crop production and management.	K	1,2,4
2	To identify the scope of biotechnology.	U	1,2,3
3	To apply the knowledge of genetic engineering methods to health care field.	A	2,3
4	To develop novel biotech products.	E	1,2,3
*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Topics	Hrs	CO No.
1. Introduction	1.1	**Biotechnology – Definition and History** History of Biotechnology, Conventional Biotechnology and Modern Biotechnology.	5	1
	1.2	**Rainbow of Biotechnology:** Kafarski's color code. Green (agriculture), blue (Marine), white (Industry), red (Pharmaceutical), purple (IPR and Patents), gold (bioinformatics), black (bioterrorism).	5	1
2. Agriculture Biotechnology	2.1	**Agriculture biotechnology:** Crop production and management – Agriculture practices-preparation of soil by analyzing biochemical parameters, selection and preparation of seeds, adding manure and fertilizer, irrigation, biocontrol of weeds, pests and pathogens, harvesting and storage.	5	2
	2.2	**Genetically Modified Crops** Genetically modified crops –Examples: BT cotton, Golden rice, Glyphosate resistant, Merits and demerits of GM plants.	5	2
	2.3	**Environmental and ethical issues of GM crops:** Concerns related to bio-safety, health and environment-Perspectives and challenges	5	2
3. Human welfare	3.1	**Biotechnology in health care:** Role of Biotechnology in health care. Production of vitamins, insulin, antibiotics, vaccines.	4	3
	3.2	**Biotechnology in industry:** Role of Biotechnology in industry. Fermentation: Dairy (Cheese, Yogurt), Food (Nutraceuticals, SCP) & Beverage (Wine Beer) industries, Bioreactor – Definition and applications.	6	3

	3.3	**Role of Biotechnology in waste management** The methods based on biotechnology in wastewater treatment are activated sludge, trickling filters, oxidation ponds, biofilters and anaerobic digestion	5	4
	3.4	**Solid waste management:** The application of biotechnology in solid waste management involves microorganisms to enhance the decomposition process	5	4
4.Practical	4.1	Alcohol fermentation from fruit sugar	10	2
	4.2	Submit a survey report on various waste management systems adopted by the LSGD	10	2
	4.3	Design a filter for waste water treatment	5	4
	4.3	Prepare a biofertilizer formulation	5	4
5.0		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	D. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks

Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References

- Purohit and Mathur. Biotechnology Fundamentals and application. Agro Botanical Publishers, New Delhi.
- E.M.T. Mansi, C.F.A . Bryce. A.L. Dmain. Fermentation Microbiology and Biotechnology
- B.D. Singh (2023). Biotechnology Expanding Horizons 5th edition, MedTech Science Press
- Sathyanarayana U., Text book of Biotechnology, Books and Allied (P) Ltd. Kolkata.
- Aneja, K. R (2007). *Experiments in microbiology, plant pathology and biotechnology*. New Age International.
- Glick, Bernard R., and Cheryl L. Patten. *Molecular biotechnology: principles and applications of recombinant DNA*. John Wiley & Sons, 2022.
- Mader, S. S., & Windelspecht, M. (2018). Biology (13th ed.). McGraw-Hill Education.

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<table>
<tr><td>Programme</td><td colspan="6"></td></tr>
<tr><td>Course Name</td><td colspan="6">Ecotourism</td></tr>
<tr><td>Type of Course</td><td colspan="6">MDC</td></tr>
<tr><td>Course Code</td><td colspan="6">MG1MDCBBT100</td></tr>
<tr><td>Course Level</td><td colspan="6">100</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course titled “Ecotourism” provides a comprehensive exploration of sustainable tourism practices and their impact on the environment. The course describes the principle, scope, and role of ecotourism in achieving conservation goals, community engagement and benefits, ecotourism resources, planning steps of ecotourism and the role of international non-governmental organizations in ecotourism.</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>2</td><td>-</td><td>1</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">There are no specific prerequisites for this course.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the fundamental principles and concepts of ecotourism	U	PO1, PO10
2	Summarize the components of ecotourism and the role of NGOs in ecotourism	U	PO1, PO 8
3	Examine the characteristics and functioning of various centers of ecotourism in India	An	PO 4
4	Explain the role of ecotourism in livelihood security	E	PO 2, PO 6
5	Design an ecotourism plan and management of ecotourism initiatives from case studies from successful ecotourism projects.	C	PO 3, PO 4, PO 9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Ecotourism and Biodiversity Conservation (15 hours)**			
	1.1	Definition, concept, principles, relevance and scope,do's and don'ts of tourists in ecotourism, ecotourism impact on the environment. Eco-friendly practices, responsible tourism, sustainable tourism.	3	1
	1.2	Components of ecotourism-biodiversity conservation, education, local people, environmental awareness, cultural diversity and respect, responsible marketing, economic and social benefits.	3	1

	1.3	Ecotourism Resources – Natural, Geographical, cultural, festivals, events and Natural heritage sites. Terms associated with ecotourism - Adventure tourism, geotourism, wildlife tourism, canopy walkway, ecolabelling, greenwashing, hydel tourism, Eco-lodges.	3	1, 3
	1..4	Ecotourism activities -Adventure sports, cultural activities, educational workshops, Photography, community development.	2	3
	1.5	Biodiversity and its conservation – significance of in situ conservation, Protected areas – national parks, wildlife and bird sanctuaries, forest reserves, marine national park (Gulf of Mannar). Endemism and biodiversity Hotspots - Western Ghats as a source of Ecotourism	4	3
	Ecotourism Prospects, Potential and Planning (15 hours)			
	2.1	Ecotourism prospects and potential of India, Ecotourism resources in India -Scope and destinations -Sundarbans, KazirangaNational Park.	3	3
	2.2	Ecotourism in Kerala, Ecotourism centres in Kerala, Wildlife tourism,	3	3
	2.3	Ecotourism Planning: Steps of Ecotourism Planning-Preliminary assessment, stakeholder engagement, ecotourism Goals and Objectives, carrying capacity, Infrastructure, visitors management, conservation of ecosystem in the area, community involvement and benefits.	4	4, 5
2	2.4	Ecotourism and livelihood security- Community-based ecotourism(CBET) a tool for conservation, challenges in CBET, Joint Forest Management	2	4
	2.5	Role of NGOs: Role of international agencies in ecotourism – The International Ecotourism Society (TIES), World Wide Fund for Nature (WWF) and United Nations World Tourism Organization (UNWTO).	3	2

	Practical/ Field visits (30 hours)			
3	3.1	Case study on Thenmala Ecotourism and Periyar Wildlife Sanctuary.	6	1, 3, 4,5
	3.2	Field visit to an ecotourism site, observe and analyse the sustainable practices and submit a detailed report.	15	1,3,4,5
	3.3	Identify and prepare a checklist of some plant species, birds and animals having economic, ecological and cultural significance as an ecotourist attraction	4	1,3
	3.4	Examine the current state of natural resources and develop suitable messages and appropriate media for educating different target groups	5	1,4
4	**Teacher-specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based studies and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 15 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ● ·Record/Any other method as may be required for specific course / student by the course faculty

	B. End Semester Evaluation (ESE) **Theory: 35 marks** Short answer (5 out of 8): 5 x 1=5 Short Essay (4 out of 6) : 4 x 5= 20 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

References

1. A K Bhattacharya, 2005. *Ecotourism and Livelihoods*. Concept Publ. company, New Delhi.
2. Kreg Lindberg, Deonal E. Hawkins, 1999. *Ecotourism: A guide for planners and managers*. Natraj Publishers, Dehradun.
3. Batta A., 2000. *Tourism and environment*. Indus Publishing Co., New Delhi.
4. Cater E, 1994. *Ecotourism in the third world: Problems and prospects for sustainability*. In: E. Cater and G. Lowman (Ed.) Ecotourism: a sustainable option, Wiley, Chichester.
5. Croall J, 1995. *Preserve or Destroy: Tourism and Environment*. Calouste Gulbenkian Foundation, London.
6. Lindberg, K. and D.E. Hawkins. (eds). (1993). *Ecotourism: a guide for planners and managers*. North Bennington: The Ecotourism Society.
7. Vinod Kumar, Sunil Kumar, Nitin Kamboj: *Biological diversity: Current Status and Conservation policies* (2021).
8. Stephen Wearing and John Neil (1999). E*cotourism: Impacts, Potentials and Possibilities*, Reed Educational and Professional Publishing Limited.
9. David A Fennell and Ross K Dowling (2003*). Ecotourism Policy and Plann*ing. CABI Publishing, Cambridge, USA.
10. David Fennell. *Ecotourism, Third edition (2008).* Published by Taylor and Francis e-Library.
11. India Eco-Development Project, http://www.periyartigerreserve.org/html
12. Community-based ecotourism, http://www.periyartigerreserve.org/html

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<table>
<tr><td>Programme</td><td colspan="6"></td></tr>
<tr><td>Course Name</td><td colspan="6">Ecology and Environmental Science</td></tr>
<tr><td>Type of Course</td><td colspan="6">MDC</td></tr>
<tr><td>Course Code</td><td colspan="6">MG1MDCBBT101</td></tr>
<tr><td>Course Level</td><td colspan="6">100-199</td></tr>
<tr><td>Course Summary</td><td colspan="6">Course enlightens with the importance of conserving and maintaining the ecosystem, appraise the impact of restoration of ecosystems around the globe</td></tr>
<tr><td>Semester</td><td>1</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>2</td><td>0</td><td>1</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome** On completion of the course the student will able to	**Learning Domains ***	**PO No**
1	Identify the basic components of ecosystem	U	1,2,3
2	Evaluate the different conservation strategies and technologies.	A	2,3
3	Compare various restoration projects happened globally	A	2,3
4	Justify the restoration policies in India	E	1,2,3
5	Compare the restored ecosystem and policies	E	1,2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	1.1	**Ecosystem features and significance**	4	1

Ecosystem and Biodiversity		Definition and characteristics of ecosystems. Biotic and abiotic components. Ecosystem services and their significance. Ecosystem Processes- Food chain, Food web		
	1.2	**Energy flow and Nutrient cycling.** Outline of Energy flow and nutrient cycling (Nitrogen and Carbon).	4	1
	1.3	**Biodiversity** Ecosystem Dynamics and Conservation: Ecological Succession. Threats to ecosystems.	4	2
	1.4	**Biodiversity conservation.** Conservation strategies- National Park, Wildlife Sanctuaries and restoration ecology, Germplasm conservation strategies.	4	2
2 Ecosystem Restoration	2.1	**Ecosystem restoration globally:** Various ecosystem restoration projects around the globe: Arabian Oryx Reintroduction (Oman).	4	3
	2.2	**Ecosystem restoration projects-India.** Ecosystem restoration projects and strategies in India: Periyar Tiger Reserve, Nilgiri Tahr Project (2023), Sundarbans Mangrove Restoration Project, Green India Mission, National River Conservation Plan (NRCP), CAMPA (Compensatory Afforestation Fund Management and Planning Authority), Himalayan Landscape Conservation and Livelihoods Support Project.	10	3
3 Practicals	3.1	**Environmental protection Movements and mission in India.** **Case study report**:- Bishnoi movement, Chipko movement, Save Silent Valley movement, Jungle Bachao movement, Save the Western Ghats Movement, Swachh Bharat Abhiyan.	12	4
	3.2	**Ecosystem Restoration Projects.** **Case study report** : Ecological rehabilitation of the Aravalli hills, Chambal River Conservation-Madhya Pradesh and Rajasthan.	8	4
	3.3	**Field study:** Visit to any National Park or wild life sanctuary and prepare the study report.	10	2
4		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Class room lecture, ICT enabled classes, Discussions, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 15 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.0 hr. Theory : 35 marks Practical : 35 marks
Pattern of questions	Total marks: 35 marks (1.0 hr.) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :3 out of 5 3x3= 9 marks Short essay (6 marks) :1 out of 2 1x6= 6 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical (35 marks) 5 hrs	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References:

1. Allison, S. K (2014). Ecological restoration and environmental change: Renewing damaged ecosystems. Routledge
2. Singh, J.S., S.P & Gupta, S.R (2006). Ecology, Environment and Resource conservation. Anamaya Publ., New Delhi
3. Chapman, J.L.& M.J. Reiss (1998). Ecology: Principles and Applications. Cambridge Univ. press. 2 nd edition.
4. Peter Stiling (2015). Ecology: Global Insights & Investigations 2nd Edition. McGraw-Hill international edition
5. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
6. Krebs, C.J. (2008). Ecology: The experimental Analysis of Distribution and Abundance (6th Edition), Benjamin Cummings Publ.
7. Anne E. Magurran, Brian J. McGill (2011) Biological Diversity: Frontiers in Measurement and Assessment. Oxford University Press. ISBN: 978-0199580675

SEMESTER II

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Plant resources and ventures in botany**					
Type of Course	DSC A					
Course Code	MG2DSCBBT100					
Course Level	100					
Course Summary	The course aims to impart knowledge on the importance of plants and plant based products in everyday life. Several plant resources based industries are successfully established in our society. Plethora of opportunities and innovations in plant science research are also discussed. Plant crafting and plant architect opportunities are explored. The course is designed to equip students with technical knowhow on business prospects and develop skills needed to successfully convert them into entrepreneurial ventures. On completion, learners will be able to develop ideas and enable them to be professionally competent so as to convert their ideas to successful business opportunities. This course aims at molding a successful entrepreneur through various avenues of Plant Science.					
Semester	II	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisite, if any	Should have basic knowledge on plants resources and its importance in everyday life					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
01	Identify and assess plant resources in various contexts.	U	PO1, PO 3, PO 4, PO 6
02	Understand the problems are approaches in agriculture, health and in environmental contexts critically	U	PO 2, PO 3, PO 4, PO 6,
03	Summarize the foundational knowledge about sustainable agriculture, horticultural activities, organic farming, nursery management and mushroom cultivation to human welfare.	U	PO 6, PO 7, PO 10
04	Develop an understanding of entrepreneurial opportunities in plant science and fostering an entrepreneurial mindset	C	PO 1, PO 2, PO 3, PO 5, PO 8
05	Reframe the significance of the plant world, gain insights into the potentials of personal prosperity and career opportunities in plant science.	E	PO 1, PO 2, PO 6, PO 10

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

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Plant Resources (15 Hours)**			
	1.1	Plants in everyday life: Importance as food, Source of medicine, Cultural and aesthetic value. Role of plants in maintenance of air water and soil quality, Plants as ecological indicators, Bio-control agents, Plant based bio manure, Plant-based bioplastics and Plant based biofuels.	2	1
	1.2	Plants as resource: A. Drug yielding plants: (General account with special reference to the following): Sarpagandha, *Vinca* and Pacific yew. B. Plant as staple food: Special reference to Rice, Cassava C. Plant as source of fiber: Cotton and Coir. D. Rubber yielding plants: India rubber figand Pará rubber tree. E. Plants yielding essential oils: Eucalyptus and lemongrass F. Plants in herbals and cosmetic formulations: Bhringaraj, Hibiscus, Red Sanders (*Ptetrocarpussantalinus*) G. Vegan Cosmetics: Cleanser: Neem, Cucumber, Rose Hair and Skin care products: Amla. Henna, Neem, Tulsi, Sandalwood, Turmeric H. Plant based Milk alternatives : Green Milk Prospects of Research and entrepreneurship	10	1

	1.3	Plant-based industries: Fruit production and processing: Dry Fruits and Canning. Fruit and Vegetable-based products: Squash, Syrup, Pulp, Paste, Ketchup, Soup, Vegetable Sauces, Jam and Jellies. Bamboo and Cane-based products. Production of Nutraceuticals.	3	1
2	**Exploring Plant Science Research and Plant Crafting (15 Hours)**			
	2.1	Introduction to plant science research: Significance in addressing global challenges like: Climate change, Food Security, Biodiversity conservation	2	2
	2.2	Innovation in plant Science: (Mention only) Crop improvement-Flood resistant rice, Green Revolution (Norman Borlaug- high Yielding Wheat), Genetic engineering- Bt. Cotton, gene editing for disease resistance, Synthetic biology	2	2
	2.3	Brief account on research institute in India, which identifies plant science / botany as a thrust area for investigation. Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), National Rice Research Institute (NRRI), Indian Institute of Sugarcane Research (IISR), Institute of Forest genetics and Tree Breeding (IFGTB), Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), Kerala Forest Research Institute (KFRI), Central Plantation Crops Research Institute (CPCRI), Central Tuber Crops Research Institute (CTCRI), Rubber Research Institute of India (RRII) and various national and state Universities	2	2
	2.4	Introduction to Farming, gardening and Horticulture, Mushroom cultivation	2	3

	2.5	Basics of Organic Farming, gardening, garden types and components, Plant Propagation- Natural and Artificial; Budding Grafting and Layering, Floriculture and Flower arrangement	3	3
	2.6	Hands-on Training (Any Two): ● Mushroom cultivation ● Ornamental Plant Production (Budding / Grafting / Layering)/ ● Development of an artificially propagated plant and submit for valuation. ● Culturing of Spirulina. ● Tissue Culture. ● Flower arrangement **Activity 1 (Optional):** Industrial Visit / Flower Show / Agricultural Fest / Farm Visit / Food or a Center that utilizes Post Harvest Processing	4	3
3	**Insights into Botanical Entrepreneurship and Green Future (Towards Sustainable Future) (15 Hours)**			
	3.1	Introduction to entrepreneurship: Definition and significance in the context of plant science. Basic traits and skills for entrepreneurs. Brief exploration of successful plant based startups and their impact- grow the Funguy, Vgrow, Jackfruit 360, Synthite, etc	3	4
	3.2	Identifying problems or opportunities within the plant science domain. Steps in the entrepreneurial journey: Overview of market assessment, enterprise selection, and resource mobilization. Schemes for Financial Assistance. Brief introduction to IPR, copyrights and GI tags.	4	4

	3.3	Role of Botanist in a Sustainable World: Who is a Botanist? How to Become a Botanist? Contrasting the life of a Botanist with a regular person? Roles of a Botanist. Skills of a Botanist (Understanding of Industry practice, Knowledge of the Core Subject, Teamwork, Problem-Solving, Analytical Skills, Domain Knowledge, Decision-Making skills, Research Abilities)	2	5
	3.4	Career paths in Botany: Few of the industries where a botanist can work: Research Lab/Institutions, Chemical Industry, Food Companies, Arboretum, Forest Services, Biotechnology Firms, Oil Industry, Land Management Agencies, Seed and Nursery Companies, Plant Health Inspection Services, National Parks, Biological Supply Houses, Plant Resources Laboratory and Educational Institutions	2	5
	3.5	Opportunities in Green World: General – (Scientific assistant, Plant geneticist, Computational biologist, Field botanist, Naturalist, Biotechnologist, Molecular Biologist, Nursery Manager, Plant Researcher, Teacher/Professor, Plant Pathologist, Ecologist, Plant Biochemist, Environmental Conservationist, Plant Microbiologist, Environment Consultant, Horticulturist, Plant explorer, Taxonomist, Cytologist, Biological Technician, Park Ranger, Nursery or GreenHouse manager, Farming consultant, Paleobotanist) Government opportunities: Staff Selection Commission (SSC), Institute of Banking Personnel Selection (IBPS) and State bank of India (SBI), Kerala Public Service Commission (PSC), Union Public Service Commission (UPSC)/Civil services, CDS exam, Junior research fellowship (JRF), senior research fellowship (SRF), National Eligibility Test (NET) and Indian Forest Service exam **Activity 2:** Conduct a one-day workshop for students to confer awareness on academic progression, research, career and entrepreneurial prospects and opportunities in Botany.	4	5

4	**Practical (30 hours)**			
	4.1	Field Activities (Mandatory)		
	4.1	❖ Conduct one day industrial visit: To plant-based industry in your near vicinity. Prepare a detailed report on functioning, products and marketing with the support of proper evidence and Geo-tagged photographs	10	3
	4.2	Laboratory Activities (Conduct five Two)		
	4.2	❖ Make collections of plant products specified in the syllabus and submit	3	1
	4.2	❖ Polybag cultivation of mushroom	2	3
	4.2	❖ Demonstrate Air layering, T-budding and patch budding	2	3
	4.2	❖ Select any start up initiative and prepare a report or present a mock up idea for an plant based entrepreneurship	2	4
	4.2	❖ Culturing of *Spirulina*.	2	3
	4.2	❖ Demonstration of tissue culture techniques: culture media, surface sterilization and inoculation of explants.	3	3
	4.2	❖ Flower arrangement – fresh and dry	4	3
	4.2	❖ Sample synopsis	2	5
5	Teacher specific course components			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)

Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory: 25 marks
·Involvement and responses in class room transactions
·Home Assignments/preparedness
·Oral presentation/Viva/Quiz/Open book test/written test
Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course
·Any other method as may be required for specific course / student by the course faculty
Practical: 15 marks
·Lab involvement and practical skills
·Record/Any other method as may be required for specific course / student by the course faculty</td></tr>
<tr><td>B. End Semester Evaluation (ESE)
Theory: 50 marks
Short answer (10 out of 12): 10 x 1=10
Short Essay (6 out of 8) : 6 x 5= 30
Essay (1 out of 2) : 1x 10= 10
Practical: 35 marks
·Practical based assessments: 30 marks
·Record: 5 marks</td></tr>
</table>

REFERENCES

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Applied Biotechnology**
Type of Course	**DSC A**
Course Code	**MG2DSCBBT101**
Course Level	**100-199**
Course Summary	The course covers a broad range of topics related to the application of biological systems, organisms, or derivatives to develop or create new products or processes beneficial to the society.

Semester	2	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome After completing this course, the students will	Learning Domains *	PO No
1	Understand the past, present, and future of Biotechnology, enable to critically analyze and contribute to the field's ongoing advancements.	U	1,10
2	Ability to differentiate between the diverse domains of biotechnology.	U	1,2,3,10
3	Capable of evaluating the highlighting methods in biotechnology.	E	1,2,3,8,10
4	Able to comprehend the opportunities in various biotechnological institutes and companies.	U	1,2,5,6
5	Evaluate the recent advancements and products in biotechnology and its impacts on society	E	1,2,6,8,10
6	Able to handle laboratory wares and chemicals, prepare solutions and reagents and verify the quality of reagents.	A	1,2,3,5

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Biotechnology	1	**Scope of Biotechnology** Multidisciplinary nature of Biotechnology, Trends and emerging technologies in Biotechnology- Personalized medicine, 3D-bioprinting.	3	1
2 Applied Biotechnology	2.1	**Colours of Biotechnology** Colours of Biotechnology: Green, blue, white, red, grey, gold, dark.	3	2
	2.2	**Industrial (White)Biotechnology** Enzymes for textile industry, breweries, food supplements-SCP, Vitamins, food processing-cheese, yogurt, biodegradable plastics, biofuels.	5	2
	2.3	**Environment (Grey) Biotechnology** Waste management, Biodegradation of heavy metals, water cleaning, removing oil spills, air and soil pollution, bioremediation, biomining.	4	2
	2.4	**Medical (Red) Biotechnology** Antibiotic production, molecular diagnostics, vaccines and vaccine delivery, recombinant therapeutics, insulin, forensics.	5	5
	2.5	Overview of Recombinant DNA Technology and its applications, Human Genome Project – Objectives and Features, Ethical Legal and Social Issues (ELSI), Its implications	5	5
3 Biotechnology in Human Welfare	3.1	Genetically Modified Organisms- Methodology, Merits and Demerits. Transgenic animals: Features, merits and demerits of - Polly, Rosie the cow, Glo fish, GFP animals. Golden rice, Flavr Savr Tomato.	5	4
	3.2	Animal Vaccine production, Improvement of livestock-increased milk production, artificial insemination, poultry and fisheries.	4	4
	3.3	**Recent advances in Biotechnology** CRISPR-Cas9, Synthetic biology - Artificial Cell-Types and its applications. Bio printing, Xenografts; AI and Bio-robotics, Fundamental concepts	4	5
	3.4	**Nanobiotechnology** Nanobiotechnology- Definition, Applications in health and environment.	3	5

	4.5	**Bio-startups and Industries:** An introduction to bio-entrepreneurship and bio-startups, Marketing of biotechnology products, Major Biotechnology institutes and companies in India.	4	5
4 Practicals	4.1	Introduction to Solutes and Solutions: Basic concepts of measuring solutes, solvents and solutions.	4	6
	4.2	**Calculations on unit conversions:** Weight, Volume, and Concentration; Calculations on Molarity, Molality, Normality, Percentage solutions and dilution series.	7	6
	4.3	Preparation of buffer solutions of specific pH values and strength. Preparation of laboratory reagents. Accuracy, Precision and Purity.	7	6
	4.4	Preparation of standard solutions and standard curve. Verification of prepared solutions through pH measurements, titration and Colorimetry/Spectrophotometry.	6	6
	4.5	Methods for identifying and rectifying errors during solution preparation, titration and analysis. Verification of quality of reagents and chemicals.	6	6
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs. Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs.) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical- 35 marks **5 hrs.**	Major expt./ procedure/ case study analysis – 15 Minor expts./ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Fundamentals of Enzymology and Radiobiology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC B</td></tr>
<tr><td>Course Code</td><td colspan="6">MG2DSCBBT102</td></tr>
<tr><td>Course Level</td><td colspan="6">100</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides a solid foundation in the principles and techniques of enzymology and radiobiology. Students will be equipped with the critical thinking skills necessary for applying these concepts to real-world biological scenarios. This course aims to prepare students for careers in research, medicine, and various other fields where a profound understanding of enzymatic processes and radiation biology is essential.</td></tr>
<tr><td>Semester</td><td>2</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">NA</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Students will demonstrate an understanding of the vital role of water as a solvent in biological systems, grasping its distinctive properties.	U	1, 2,3

2	Attain proficiency in foundational concepts related to solutions, encompassing a comprehensive understanding of acids, bases, pH, the pH scale, and the tools for pH measurement.	U	1,2,4
3	Acquire an understanding of the fundamental principles of enzymology, including enzyme structure, classification, nomenclature, and mechanisms of action.	U	1,2,3
4	Explain of fundamental aspects in enzyme kinetics and identify diverse factors influencing enzyme kinetics.	A	2,3
5	Develop an expertise in the analysis of various mechanisms related to enzyme inhibition and regulation.	An	1, 2, 3
6	Comprehend the fundamental principles of radioactivity, explain measurement techniques employed in its assessment, and grasp the applications of commonly used radioisotopes in biology.	A	2,3
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1.Water, solutions, and pH	1.1	Water as a solvent in biological system: polarity, cohesiveness and hydrogen bonding.	2	1
	1.2	Molarity, molality and normality of solutions. Principle of dilution, dilution factor.	3	2
	1.3	Acids and bases. pH and pH scale. Measurement of pH : pH paper and pH meter.	2	2
	1.4	Buffers-General properties. Buffer action.	3	2
2.Basic Enzymology	2.1	Enzymes: Definition, general characteristics. Structure of enzymes-Apoenzyme, coenzyme, cofactor, holoenzyme. Active site.	5	3
	2.2	Classification of enzymes: Oxidoreductases (eg.alcohol dehydrogenase), transferases(eg; Hexokinase), hydrolases (eg: chymotrypsin), lyases (pyruvate	5	3

		decarboxylase), isomerases(Alanine racemase),ligases (eg:DNA ligase)		
	2.3	Mechanism of enzyme action-lock and key hypothesis, induced fit hypothesis. Regulation of Enzyme Activity - Zymogen activation, Covalent Modification, Feedback regulation, Allosteric regulation.	3	3, 5
	2.4	Enzyme kinetics:- Michael's Menten equation, Km value and its significance. Isoenzymes. Significance of isoenzymes (LDH). Factors affecting enzyme activity- Temperature, pH, Concentration of enzymes, substrate, products, presence of inhibitors and activators	4	4
	2.5	Enzyme Inhibition and types-Competitive, Non-Competitive and Uncompetitive inhibitions.	3	5
3. Radioisotopes and their applications in biology	3.1	Basic aspects of radioactivity: alpha, beta and gamma radiations. Half life.	4	6
	3.2	Measurement of radioactivity: Geiger Muller Counter, Scintillation counters (Solid and liquid), autoradiography.	6	6
	3.3	Applications of various radioisotopes in biology: Carbon, phosphorous, Iodine, Sulphur.	5	6
4. Practical	4.1	Learn to prepare various dilutions of a given solution	3	2
	4.2	Prepare molar solutions	3	2
	4.3	Measurement of pH using pH paper and pH meter	5	2
	4.4	Adjust the pH of a given solution.	4	2
	4.5	Protein estimation using biuret method	5	3
	4.6	Protein estimation using Lowry’s method	5	3
	4.7	Submit a report on applications of radioisotopes in biology and medicine.	5	6
5.	Teacher Specific Content			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** A. Lecturing, ICT Enabled Learning, Group Discussions. B. Lab experiments, Exercises
Assessment Types	**MODE OF ASSESSMENT** **E. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Excercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	F. End Semester Examination – 1.5 hrs Theory : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks 10 One word answer questions - 10 out of 10 - 10x1= 10 marks Short answer questions - 4 out of 6 - 4x2= 8 Short essay - 3 out of 5 - 3x4= 12 Essay - 2 out of 4 - 2x10= 20

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Suggested Readings

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Programme						
Course Name	**Gardening and landscaping**					
Type of Course	MDC					
Course Code	MG2MDCBBT100					
Course Level	100					
Course Summary	This course provides a comprehensive exploration of gardening and landscaping principles, equipping students with the knowledge and skill to create and maintain beautiful sustainable outdoor spaces. Students will earn foundational knowledge in nursery management techniques, including propagation and soil preparation. The course will familiarise students with essential tools, components and structures used in garden designing. Exploring eco-friendly practices in garden design can contribute to environmental conservation.					
Semester	II	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	-	1	-	60
Pre-requisites, if any	Basic understanding of Biology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Estimate the basics of ornamental and landscape gardening	An	PO3
2	Review the principles of gardening and nursery management	U	PO3, PO10
3	Recollect the basic knowledge of plant growth structures used in gardening	K	PO3
4	Explain various propagation techniques used in a nursery	U	PO3, PO10
5	Apply the knowledge of gardening and landscaping to design a garden	C	PO3, PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Gardening and nursery techniques (15 hours)**			
	1.1	Introduction to landscaping, gardening and commercial floriculture – importance and prospects	2	1
	1.2	Types of plants in landscaping– Trees, shrubs, climbers, annuals, herbaceous perennials, bulbous crops, palms, ferns, cacti & succulents, aquatic ornamentals.	2	1, 2
	1.3	Types of gardens- fruit garden, ornamental garden, herbal garden, kitchen garden, Kids Garden Indoor plants (Money plant, Snake plant, Monstera, ZZ plant, Aglaonema)	4	1, 2

	1.4	Horticultural practices related to gardening – training, pruning and mulching, its benefits. Nursery bed preparation	2	1, 2
	1.5	Vegetative propagation methods – natural and artificial cuttings – leaf, stem and root, layering–air layering, simple layering, grafting- approach grafting, Tongue grafting, budding- T budding, patch budding	5	4
2.	**Tools and structures in gardening and principles of Landscaping (15 hours)**			
	2.1	Nursery layout & structures: Polyhouse, mist chamber, rain shelter, potting shed, composting shed. Sprinkler irrigation.	3	3
	2.2	Gardening tools & implements Garden spade, rake, fork, garden shears, secateurs, grafting & budding knife, pruning saw, mowers, brush cutter, garden tillers	2	2
	2.3	Garden components and adornments (brief account only)	2	2
	2.4	Rockery, Terrarium, Kokedema, Bonsai (brief account only)	2	2, 3
	2.5	Elements of art-colour, line, form, scale. Principles of Landscape design- Unity, Balance, transition, proportion, rhythm, focalisation, repetition, simplicity.	3	2, 5
	2.6	Steps in developing a Landscape Design Brief Account Only a) Site analysis- b) Identification of functional requirements; c) site development by exploiting natural forms; d) Elements in landscape design- form, water, garden	3	2, 5

		furniture, lights, paving etc. e) study of plant trees, shrubs and ground cover, indoor plants etc.		
3	**Practicals (30 hours)**			
	3.1	Visit to a well-established nursery/ Gardenand submit a detailed report	8	1,2,3,4,5
	3.2	TTC test for assessing seed viability	2	4
	3.3	Preparation of potting mixture	2	2
	3.4	On-hand training for air-layering, approach grafting and T-budding techniques	6	4
	3.5	Identification of Garden tools and implements.	4	2,3,4
	3.6	Designing of Terrarium	4	3,5
	3.7	Designing of Kokedama balls/ bottle gardens	4	3,5
4	**Teacher specific course components**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)

Field based studies and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT
A. Continuous Comprehensive Assessment (CCA)
Theory: 15 marks
·Involvement and responses in class room transactions
·Home Assignments/preparedness
·Oral presentation/Viva/Quiz/Open book test/written test
Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course
·Any other method as may be required for specific course / student by the course faculty
Practical: 15 marks
·Lab involvement and practical skills
● ·Record/Any other method as may be required for specific course / student by the course faculty</td></tr>
<tr><td>C. End Semester Evaluation (ESE)
Theory: 35 marks
Short answer (5 out of 8): 5 x 1=5
Short Essay (4 out of 6) : 4 x 5= 20
Essay (1 out of 2) : 1x 10= 10
Practical: 35 marks
·Practical based assessments: 30 marks
·Record: 5 marks</td></tr>
</table>

References

1. Laurie, A. & Ries, V.H. 2012. *Floriculture- Fundamentals and Practices*, Agrobios
2. Hartmann, HT. and Kester, D.E.1986. *Plant Propagation - Principles and practices*. Prentice Hall, New Delhi.
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Mahatma Gandhi University
Kottayam

Programme	
Course Name	**Tools and Techniques in Biotechnology**
Type of Course	**MDC**
Course Code	**MG2MDCBBT101**
Course Level	**100-199**
Course Summary	This course introduces students to the exciting world of biotechnology tools and techniques with a focus on accessibility and ease of understanding.

Semester	2	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		2	0	1	0	60
Pre-requisites, if any	NA					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome After completion of the course, the student will	Learning Domains *	PO No
1	Understand the fundamentals of molecular biology and its practical applications.	U	2,3,6
2	Explain basic gene manipulation techniques and their significance.	U	2,3
3	Describe various bioinformatics tools	U	2,3
4	Identify the concept of advanced biotechnological tools and their applications.	U	2,3,6
5	Able to isolate and quantify DNA, protein and retrieve DNA and protein sequences from databases.	S	2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 **Basics of Molecular Biology:Unravelling the Secrets of DNA and RNA**	1.1	Basics of DNA and RNA structure and types.	2	1
	1.2	Basic outline of Central dogma of molecular biology: Replication, Transcription and Translation – steps.	5	1
	1.3	Fundamentals of PCR and its types (Reverse Transcriptase PCR, Nested PCR, QPCR, RT PCR).	3	1,4
	1.4	Principle and applications of electrophoresis: AGE, PAGE.	2	3
2 **Recombinant DNA technology: The Art of Gene Manipulations**	2.1	An outline of Cloning vectors: Features and types.	2	2
	2.2	Introduction to Restriction enzymes-Properties and types.	2	2
	2.3	Basics steps of Gene cloning and expression.	2	2
	2.4	Overview of Site-directed mutagenesis.	2	3
3 Play with Proteins and Bioinformatics	3.1	Protein isolation and purification: Precipitation of proteins, Basic steps of SDS-PAGE and Western blotting.	2	3
	3.2	Introduction to Mass spectrometry-Principles and Applications	2	4
	3.3	Getting started with bioinformatics: Definition, Introduction and applications.	2	3
	3.4	Important databases: NCBI, GenBank, DDBJ, EMBL, PDB viewer.	4	3
4 Practicals	4.1	Isolation and electrophoresis of DNA	6	5
	4.2	Quantitative estimation of DNA	5	5
	4.3	Purification of protein by precipitation method	6	5
	4.4	Quantitative estimation of Protein	5	5
	4.5	Introduction to NCBI, GenBank, DDBJ, EMBL and retrieval of DNA and Protein sequence in FASTA format.	8	5
Module 5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Class room lecture, ICT enabled classes, Discussions, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 15 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.0 hr. Theory : 35 marks Practical : 35 marks
Pattern of questions	Total marks: 35 marks (1.0 hr.) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :3 out of 5 3x3= 9 marks Short essay (6 marks) :1 out of 2 1x6= 6 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical- 35 marks 5 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Molecular Biology of the Gene by James D. Watson
2. Essential Cell Biology by Bruce Alberts et al.
3. PCR (The Basics) by Tom Strachan and Andrew P. Read
4. Electrophoresis: Theory, Techniques, and Biochemical and Clinical Applications by G. Pasquali
5. Molecular Cloning: A Laboratory Manual by Michael R. Green and Joseph Sambrook
6. Recombinant DNA Technology and Molecular Cloning by Robert A. Meyers
7. Introduction to Genetic Analysis by Anthony J.F. Griffiths et al.
8. Site-Directed Mutagenesis: Methods and Protocols by Bimal D. Mepani
9. Protein Bioinformatics: An Algorithmic Approach to Sequence and Structure Analysis by Ingvar Eidhammer
10. Mass Spectrometry for the Novice by John Greaves and Andrew P. Jones

Suggested Readings

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount
2. Principles of Proteomics by Richard M. Twyman

3. CRISPR-Cas: A Laboratory Manual by Jennifer Doudna and Prashant Mali
4. Next-Generation DNA Sequencing Informatics by Stuart M. Brown
5. Microarray Technology and Its Applications by Uwe R. Müller
6. Nanobiotechnology: Concepts, Applications, and Perspectives by Christof M. Niemeyer
7. Molecular Biology Techniques: An Intensive Laboratory Course by Heather Miller
8. Introduction to Bioinformatics by Arthur M. Lesk
9. NCBI Handbook by National Center for Biotechnology Information (NCBI)
10. Biotechnology: Science for the New Millennium by Ellyn Daugherty

SEMESTER III

Mahatma Gandhi University
Kottayam

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Microbiology and phycology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG3DSCBBT200</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course will give an insight towards the diversity of microbes and algal flora. The study of microbiology provides a comprehensive understanding of microbes, its principles, and its applications in various fields, where as phycology deals with the study of algae. Being the primary produces, both micro and macroalgae plays a significant role in aquatic ecosystems. Students learn its salient/ diagnostic features and its importance to ecosystems. It also focuses on the economic and ecological significance and its applications.</td></tr>
<tr><td>Semester</td><td>III</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic botanical learning and laboratory skills</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand the world of microbes and its significance	U	PO2, PO6, PO7, PO10
2	Examine the range of thallus structure, pigment composition, photosynthetic end products and reproduction in various algal groups.	An	PO2, PO3, PO6, PO10

3	Demonstrate a comprehensive understanding of the economic importance of algae. Examining the ecological significance and research potential of algae	U	PO1, PO2, PO9
4	Analyse the identifying features of microbes and algae	An	PO1, PO2, PO3, PO4, PO5,PO7, PO9, PO10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
	Introduction and Application of to Microbiology (15 hours)			
1	1.1	Bacteria: General characters and classification based on staining, morphology and flagellation. Ultra structure of bacteria. Reproduction - binary fission. Genetic recombination in bacteria - conjugation, transformation and transduction.	6	1
	1.2	Viruses: General characters of viruses, viroid and prions. Structure of TMV and Bacteriophage (λ). Multiplication of λ phage – lytic and lysogenic cycle.	4	1
	1.3	Microbial interactions in ecosystems, Applications of microbes in industry, agriculture, food and medicine. Microbes in environmental conservation, waste management and as biocontrol agents.	5	1
	Introduction to Phycology (15 hours)			
2	2.1	History of algal classification, study of classification by Fritsch (1945); brief introduction to the modern classification by Lee (2016) [up to class].	2	2
	2.2	Distribution, habitat diversity, range of thallus structure, pigment composition and photosynthetic end product in various groups of algae. Reproduction - vegetative, asexual and	2	2

		sexual reproduction. Major life cycle patterns found in algae (outline only).		
	2.3	Salient features and thallus structure of algae in the following groups with special reference to the type(s) mentioned: Cyanophyceae - *Nostoc*; Chlorophyceae - *Volvox, Spirogyra, Cladophora, Chara* Bacillariophyceae - *Pinnularia*; Phaeophyceae– *Sargassum;* Rhodophyceae – *Polysiphonia*	11	2
	Economic importance of Algae, Ecology and Perspectives of Algal Research (15 hours)			
3	3.1	Useful aspects of algae: Food, SCP, Biofertilizers, Medicine Exploration of algae as source of valuable commercially important products-carrageenan, agar-agar, alginate, diatomite Harmful effects of algae: Algal blooms, eutrophication, neurotoxins.	5	3
	3.1	Algae as primary producers and ecosystem engineers Algal associations and its significance (Parasitic algae, Symbiotic algae-association of algae with fungi, bryophytes, pteridophytes, gymnosperms, angiosperms, invertebrates) Algae based wastewater treatment for biodiesel production Role of algae as bioremediation agents. Role of algae in N2 fixation	8	3
	3.2	Role of algae in scientific research -*Chlorella* Brief overview on cultivation of macroalgae and microalgae.	2	3
4	**Practical (30 hours)**			
	Microbiology (10 hours)			
	4.1	Gram staining - curd, root nodules.	8	1,4

		Isolation of microbes from soil through serial dilution		
	4.2	Demonstrate the culture of bacteria.	1	1,4
	4.3	Microbes and type of fermentation - vine, vinegar, curd	1	1,4
	Phycology (20 hours)			
	4.4	Conduct a field visit to any one of the ecosystems rich in algae to experience algal diversity. Submit a report with photographs or Collect algae from diverse habitats, observe through microscope and click photographs and submit a report.	3	2,3,4
	4.5	Make micro preparations of thallus structures of the types mentioned in the syllabus.	16	2,3,4
	4.6	Familiarizing the technique of algal collection and preservation	1	2,3,4
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness

	·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

References

1. Adetunji et al. (2023). Next generation algae. Vol. I. Application in Agriculture, food and environment. John Wiley and Sons, Beverely, USA
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6. Kim, S.K. (2011). Marine medicinal foods: Implications and Applications of micro and macroalgae. Academic Press, New York.
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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Mycology and plant pathology**					
Type of Course	DSE A					
Course Code	MG3DSEBBT200					
Course Level	200					
Course Summary	The course in Mycology and Plant Pathology provides a comprehensive exploration of the intricate worlds of fungi and plant diseases. Students delve into the morphology and ecological roles of fungi, gaining insights into their diverse functions as decomposers, symbionts, and pathogens. The curriculum also encompasses the study of plant diseases, investigating the interactions between plants and various pathogenic organisms, including fungi, bacteria, viruses, and nematodes. Through this course, students acquire the skills and knowledge necessary for disease diagnosis, prevention, and control, contributing to the sustainable management of plant populations in diverse settings.					
Semester	III	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Basic botanical laboratory skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Determine the diversity, reproductive behaviour and applications of fungi and Lichens	A	PO2, PO6, PO7, PO10
2	Identify ecological and economical significance of fungi and lichens	U	PO2, PO3, PO6, PO7, PO10
3	Describe the basic aspects of plant pathogen interaction	U	PO1, PO2, PO9
4	Recognize the plant diseases and provide control measures	K	PO1, PO2, PO3, PO4, PO7, PO9, PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Mycology (20 hours)**			
	1.1	Introduction and general characters of fungi. Classification based on Ainsworth (1973); Assembling the Fungal Tree of Life (AFTOL) - a brief account	2	1
	1.2	The thallus and reproductive structures of the genera mentioned in each group; Myxomycotina - General Characters	1	1
	1.3	The thallus and reproductive structures of the genera mentioned in each group; Mastigomycotina – *Albugo* (Difference between Oomycete and true fungi)	2	1
	1.4	The thallus and reproductive structures of the genera mentioned in each group; Zygomycotina – *Rhizopus*	1	1
	1.5	The thallus and reproductive structures of the genera mentioned in each group; Ascomycotina: • Hemiascomycetes - *Saccharomyces* • Plectomycetes - *Pencillium* • Pyrenomycetes - *Xylaria* • Discomycetes – *Peziza*	8	1
	1.6	The thallus and reproductive structures of the genera mentioned in each group; Basidiomycotina • Teliomycetes - *Puccinia* • Hymenomycetes – *Agaricus*	4	1
	1.7	The thallus and reproductive structures of the genera mentioned in each group; • Deuteromycotina – *Fusarium*	2	1

2	**Economic significance of Fungi and Lichenology (12 hours)**			
	2.1	Economic importance of Fungi – Beneficial (Food, antiviral, antibiotic) and detrimental aspects (Food spoilage and poisoning, Wood degradation).	2	2
	2.2	Fungi of Agricultural importance – mycoherbicides, myconematicides, mycoparasites, Mycorrhiza – diversity, function, and significance.	2	2
	2.3	Mushrooms- edible and poisonous types. Cultivation technique-Spawn production of Oyster mushroom, cultivation of Oyster mushroom (General Outline)	4	2
	2.4	General account, economic and ecological importance of lichen	1	1,2
	2.5	Classification of lichens based on thallus and its significance	2	1
	2.6	Structure and life cycle of *Parmelia*.	1	1
3	**Plant Pathology (13 hours)**			
	3.1	History of plant pathology (Brief study)	1	3
	3.2	Classification of plant diseases based on causative organisms and symptoms	2	3
	3.3	Plant-Pathogen Interaction (general outline)	1	3
	3.4	Defense mechanisms in Plants	2	3
	3.5	Mechanism of infection, transmission, and dissemination of plant diseases.	1	3
	3.6	Prophylaxis - quarantine measures, seed certification; Therapeutic – physical therapy, chemotherapy.	2	4
	3.7	Biological control of plant diseases	1	4

	3.8	Study of following diseases with emphasis on symptoms, cause, and control: ● Bunchy top of Banana ● Bacterial blight of Paddy ● Root wilt of Coconut ● Abnormal leaf falls of Rubber ● Leaf mosaic disease of Tapioca ● Quick-wilt of pepper.	3	3, 4
4	**Practical (30 hours)**			
	Mycology (20 hours)			
	4.1	Students are expected to identify the following types by making suitable micro preparations and make labelled sketches *Albugo, Rhizopus, Saccharomyces, Penicillium, Xylaria, Peziza, Puccinia, Fusarium*	8	1
	4.2	Staining of endomycorrhiza or fungus using Trypan Blue.	2	1, 2
	4.3	Collection/identification of common macrofungi (5 types).	10	1, 2
	Plant Pathology (10 hours)			
	4.4	Identify the diseases mentioned in the syllabus with respect to causal organisms and symptoms	5	3
	4.5	Submit specimens/ herbarium preparations of any three of the diseases; Imaging can be done with geo tag and recorded	4	3
	4.6	Students should be trained to prepare the fungicides – Bordeaux mixture, Tobacco decoction.	1	3, 4
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. **End Semester Evaluation (ESE)** **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

References

1. Mehrotra, R.S. and Aneja, K.R., 1990. *An introduction to mycology*. New Age International.
2. Agrios, G.N., 2005. *Plant pathology*. Elsevier.
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Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Cell Biology and Genetics**					
Type of Course	**DSC B**					
Course Code	**MG3DSCBBT201**					
Course Level	**200**					
Course Summary	The course covers a broad range of topics related to Cell structure, functions, cell cycle, Mendelian genetics, linkage, crossing over, sex determination, genetic disorders, gene mutation and population genetics.					
Semester	3	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome** Upon completion of the course the student will be able	**Learning Domains ***	**PO No**
1	Recall the salient features of living cells.	K	1,2,4
2	Explain the structure of the cell organelles	U	1,2,3
3	Identify the stages of mitosis and meiosis	U	2,3,9
4	Explain the fundamentals of Mendelian laws and Population genetics.	U	2,8,10

5	Evaluate the genetic disorder and aim to improve the genetic quality for human welfare	E	5,6,7
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Overview of cell	1.1	**Cell structure and Cell diversity:** Introduction to cell structure, Prokaryotic and eukaryotic cell, Cell Architecture. Plant cell structure, Animal cell structure, Microbial cell structure.	4	1
	1.2	**Cell membrane and Extra cellular matrix:** Models of Cell membrane. Fluid Mosaic Model - structure and composition. Extracellular Matrix (ECM)	3	1, 2
	1.3	**Membrane Transport:** Overview of membrane transport, Passive transport, Active transport, Types of membrane transport (Uniport, Symport and Antiport)	4	1, 2
2 Cellular world and Cell cycle	2.1	**Cell organelles:** Structure and functions - Nucleus, Endoplasmic reticulum, Golgi Apparatus, Lysosomes, Peroxisomes, Mitochondria, Chloroplast.	4	1, 2
	2.2	**Cytoskeleton:** Overview of Cytoskeleton, Structure and functions - Microtubules, microfilaments, intermediate filaments.	3	1, 2
	2.3	**Cell cycle and Cell death:** Introduction to the cell cycle, Phases of cell cycle (G, S, G2, M), Mitosis and Meiosis, Cell cycle checkpoints, Overview of cell death process, Apoptosis, Necrosis and Autophagy	4	2, 3
3 Hereditary wonders	3.1	**Introduction to Genetics:** Terminology and symbols in genetics. Mendelian laws with example- Testcross, Backcross Gene interactions: Co-dominance, Incomplete dominance, Epistasis, Multiple alleles-ABO blood typing, Polygenic inheritance, Pleiotropism, Lethel genes.	4	4

Genetic disorders and Advanced genetics	3.2	**Linkage and crossing over:** Linkage types- Complete and Incomplete, crossing over- Types and Mechanism, Factors affecting crossing over.	3	4
	3.3	**Sex determination:** Sex determination - Autosomes and sex chromosomes, Chromosomal basis of sex determination (XX-XY, XX-XO, ZZ-ZW types) Mechanism of sex-linked inheritance, Sex influenced, Sex limited gene expression, Dosage compensation (Barr bodies, drum stick).	5	4
	3.4	**Extrachromosomal inheritance** - Mitochondria and Chloroplast.	2	4, 5
	3.5	**Gene Mutation:** Types. Chromosomal aberations – structural and neumerical. Chromosomal anomalies and human disorders - Down's syndrome, Edwards syndrome, Klinefelter's syndrome, Turners syndrome, Sickle cell anemia, Phenyl ketonuria.	5	4, 5
	3.6	**Population Genetics:** Human genetics- Karyotype study, Pedigree analysis. Population genetics- Genetic variation, Hardy Weinberg principle, Factors affecting Hardy Weinberg equilibrium.	4	4
4 **Practical**	4.1	Identification of Cell types	4	1,2,3
	4.2	Morphological comparison of living and dead cell.	4	1,2,3
	4.3	Mitosis – Onion Root Tip	4	1,2,3
	4.4	Meiosis – Rhoeo Flower Bud	5	1,2,3
	4.5	Staining of Mitochondria Staining of Barr body and Polytene Chromosome	10	1,2,3
	4.6	ABO Blood typing	3	1,2,3
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References

1. Cell and Molecular biology by Gerlad Karp, Academic Press
2.World of the Cell, Becker, Reece, Poenie, The Benjamin /Cumming's Pub
3.Cell Biology, Lodish et al, W H Freeman and Co., NewYork.
4.Cell Biology, Thomas D Pollard and W C Earnshaw, Saunder's Publishers
5.. Principles of genetics - E J Gardner John Wiley India llp Publication
6. Genetics –M W Strick Berger, Macmillan,
7. Fundamentals of Genetics - Peter. J. Russel, Harper Collins Pub.
8.Genetics, Principles and analysis- Daniel L. Hartin and Elisabeth W. John, Jones and Bartlett Pub. US.
9. Human Genetics, - 2nd& 3rd Edn. S. D. Gangane. Elsevier/ Paras publications.
10. Essentials of Human Genetics, - 4 th Edn. S. M. Bhatnagar, M. L. Kothari and L. A. Mehta.
11.Text book of genetics, - Veer Bala Rastogi, KNRN Pub
12. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, - P. S. Verma, V.K. Agarwal., S Chand pub
13. Genetics- - P. S. Verma, S Chand pub

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Developmental Biology and Assisted Reproduction Technology**
Type of Course	**DSE B**
Course Code	**MG3DSEBBT201**
Course Level	**200-299**
Course Summary	This course in Developmental Biology provides a comprehensive exploration of the scope, historical perspectives, and fundamental aspects of reproductive biology, including gonadal structure, hormones, reproductive cycles, gametogenesis, and the structure of gametes. It further delves into covering fertilization, parthenogenesis, and placenta, focusing on early embryonic development, morphogenetic movements, and germ layer formation. Finally, addresses human embryonic development stages, invitro fertilization, and offers insights into enzyme engineering and future perspectives in the field.

Semester	3	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Able to recall the anatomy of human reproductive system and its structures.	K	1,2,4
2	Gain a comprehensive understanding of early embryonic development with its stages.	U	1,2,10
3	Gain knowledge about the Assisted Reproduction Technology	U	1,2,10

4	Equipped to comprehend genetic counselling along with an exploration of the ethical and future considerations in assisted reproductive technology.	An	1,2,3,4
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Developmental Biology	1.1	Stages of embryo development	1	1,2
	1.2	Gonads- Structure of Human testis and ovary.	3	1,2
	1.3	Gonadal hormones and their functions.	2	1,2
	1.4	Female reproductive cycle (menstrual cycle).	2	1,2
	1.5	Gametogenesis -spermatogenesis, oogenesis	4	1,2
	1.6	Structure of sperm and ovum. Different types of eggs on the basis of Yolk.	3	1,2
2 Fertilization, Parthenogenesis and Placenta	2.1	Fertilization-Mechanism and Significance.	4	2,3
	2.2	Pregnancy parturition and lactation	4	2,3
	2.3	Ectopic pregnancy. Polyspermy	2	2,3
	2.4	Parthenogenesis-Types	2	2,3
	2.5	Placenta and its hormones.	3	2,3
3 Early embryonic development	3.1	Cleavage definition types and patterns	3	3
	3.2	Blastula -Mechanism of Blastulation, Gastrulation.	3	3
	3.3	Morphogenetic movements-epiboly, extension, invagination, convergence, de-lamination	4	3
	3.4	Formation of germ layers	3	3
	3.5	Fate map (chick embryo)	2	3
4 Assisted	4.1	Introduction to Genetic counselling. Eugenics, Euthenics.	3	4

Reproduction Technology and Future Perspectives	4.2	Human embryonic development (Germinal, Embryonic and foetal stages)	5	4
	4.3	In vitro fertilization, Steps in IVF.	3	4
	4.4	Prenatal diagnosis – Amniocentesis, chorionic villi sampling (CVS), Fetoscopy.	4	4
5		Teacher specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

- Berril, N..J.; and Kars, G.; 1986. Developmental biology, Mc Graw Hills
- Majumdar N. N-1985 Vetebrate embryology; Tata McGraw-Hill, New Delhi
- Melissa A & Gibbs, 2006; A practical Guide to Developmental Biology, Oxford university press (Int. student edition)
- Scott F. Gilbert; 2003; Developmental biology; Sinauer Associates Inc., U.S.; 7th Revised edition.
- Vijayakumaran Nair, K. & George, P. V. 2002. A manual of developmental biology, Continental publications, Trivandrum

- Taylor DJ, Green NPO & G W Stout. (2008) Biological Science third edition. Cambridge university press. Ref pp 748 biology 755

Suggested Readings

- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
- Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Plant and Animal Physiology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">MG3DSEBBT202</td></tr>
<tr><td>Course Level</td><td colspan="6">200-299</td></tr>
<tr><td>Course Summary</td><td colspan="6">This physiology syllabus covers fundamental aspects of human and plant systems. Students study human digestion, blood components, circulatory and respiratory systems, as well as the nervous and endocrine systems. Renal physiology, diagnostic techniques, and clinical case studies are explored. In plant physiology, topics include water absorption, respiration, mineral nutrition, secondary metabolites, and plant growth regulators. Students also learn about plant movements, responses to stresses, and applications such as crop improvement and plant breeding. The syllabus emphasizes the practical applications of physiological principles in both human and plant contexts.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the importance of studying human physiology in the context of maintaining homeostasis	U	1.10
2	Analyze the factors influencing efficient digestion and absorption, considering both physiological and dietary aspects	K	2,3,6
3	Evaluate the factors influencing blood volume, such as hormones and kidney function	E	2,5,10
4	Diagnostic and treatment plans based on a deep understanding of human physiology	C	1,9,10

5	Develop new ideas for utilizing plant-associated microbes in biological control for enhanced plant health	C	4,6,10
6	Evaluate the impact of various factors on blood volume regulation and circulatory system function	E	2,5,10

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Human Physiology	1.1	Introduction to human physiology: Organ systems of human.	3	1,2
	1.2	Nutrition: Digestion and Absorption.	4	1,2
	1.3	Blood – Components of blood (plasma, red blood cells, white blood cells, platelets) Blood volume and its regulation.	5	1,2,3
	1.4	Circulatory system- Systemic circulation, Pulmonary circulation	4	1,2
2 Respiratory and Renal Physiology.	2.1	Respiratory system – exchange of gases, Respiratory disorders.	4	1,2
	2.2	Nervous system-Structure, Neuron structure & types, signal transduction, types of synapses and endocrine system.	5	1,2
	2.3	Renal physiology- kidney structure and function, glomerular filtration, Urine formation.	4	1,2
	2.4	Applications of human physiology: for Diagnosis and Treatment	3	1,2,6
3 Plant physiology	3.1	Introduction to plant physiology, Absorption and transport of water. Respiration in plants. Mineral nutrition in plants-Macro and Micro nutrients.	8	1,2,4
	3.2	Secondary Metabolites. Plant growth regulators-Auxins, Cytokinin, Gibberellins, Ethylene, Abscisic acid	8	2,4,5
4 Plant movement	4.1	Plant movements- trophic, tactic and nastic movements. Responses to biotic and abiotic stresses. Photoperiodism, Vernalisation.	6	4,5,6

and responses.	4.2	Applications of plant physiology-crop improvement, plant breeding. Defence mechanism in plants - plant-associated microbes for biological control of plant pathogens.	6	3,4,5
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Tortora, G. J. Principles of Human Physiology (Edition number). Wiley.
2. Widmaier, E., Raff, H., & Strang, K. Vander's Human Physiology: The Mechanism of Body Function. McGraw Hill, New York.
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5. Sembulingam, K., & Sembulingam, P. Essentials of Medical Physiology. Jaypee Brothers Medical Publishers, New Delhi.

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9. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants (2nd ed.). Wiley-Blackwell.
10. Larcher, W. (2003). Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups (4th ed.). Springer.

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Programme						
Course Name	**Agri-based micro enterprises**					
Type of Course	MDC					
Course Code	MG3MDCBBT200					
Course Level	200					
Course Summary	This course is designed to equip participants with the knowledge and skills necessary to establish and manage successful agri-based microenterprises. Focusing on key sectors such as organic farming, horticulture, tissue culture, and mushroom cultivation, the course provides a comprehensive understanding of sustainable and profitable agribusiness practices.					
Semester	III	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	-	-	45
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Summarize key principles in organic farming, horticulture, tissue culture and mushroom cultivation, fruits and vegetable technology including sustainable practices and business considerations.	U	PO3, PO6
2	Develop hands-on skills in composting techniques, artificial vegetative propagation practices, tissue culture techniques and mushroom cultivation	S	PO3, PO4
3	Apply the skills of organic farming, horticultural practices, tissue culture techniques, fruits and vegetable technology and mushroom cultivation, as an entrepreneurial venture.	A	PO3, PO10, PO9
4	Administer a mushroom cultivation project in a small scale level	A	PO3,PO10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Organic farming (7 Hours)**			
	1.1	Introduction to Organic farming- Advantages of Manures over fertilizers. NPK value- Definition and significance.	2	1
	1.2	Common organic manures – bone meal, cow dung, poultry waste, oil cakes, Green manure (special reference to major element in the composition) Preparation of compost- vermicompost, vermiwash; familiarize KAMBA compost Biofertilizers-Definition and Types –, *Rhizobium, Mycorrhiza, Blue green algae and Azolla.* Activity-Hands on training on Vermicomposting Activity-Preparation of compost and establishing a small kitchen garden. Submit a report with geotagged photos	4	1, 2, 3
	1.3	Biological control Agents- *Trichoderma, Bacillus*; Biopesticides – Tobacco and Neem decoction. Activity-Prepare and submit any one Biopesticide formulation.	1	1,3
2	**Horticulture and Plant tissue culture (21 Hours)**			
	2.1	Types of soil, preparation of potting mixture, Garden tools and implements Methods of plant propagation- Sexual (seed propagation) and Asexual; Artificial methods (cutting, grafting, budding and layering); Use of growth regulators for rooting. Hands on training on Artificial methods of propagation - budding and grafting Activity-Demonstration of budding (T and Patch)	6	1,2,3

	2.2	Gardening - Types of gardens– Ornamental and Landscape garden, kitchen garden Water garden and aquascaping, Aquarium plants and its propagation Garden components (Brief account only),Bonsai, terrarium, Kokedama. **Activity-** Submit a self made terrarium/ kokedama/ aquarium (use only natural materials)	3	1,3
	2.3	Concept of totipotency, definition of explant, callus. Infrastructure of a tissue culture laboratory. Solid and liquid media – basic components of tissue culture medium. Sterilization of explants'. inoculation and incubation. Micro propagation: different stages, organogenesis and embryogenesis Visit to a well established tissue culture lab/ nursery/ mushroom cultivation unit	12	1,2,3
3	**Mushroom cultivation and Fruit and vegetable technology(17 Hours)**			
	3.1	Scope and Significance of Mushroom cultivation, Edible and poisonous mushroom. Health benefits	2	1
	3.2	Types of commercially cultivated mushrooms - button mushroom, oyster mushroom and milky mushroom Spawn -Definition.	1	1
	3.3	Cultivation methodology of Oyster mushroom – using paddy straw and saw dust Layout and set up of a mushroom house (small scale) Processing of mushrooms and Value added products- mushroom - pickle, candy, dried mushroom	4	1,2,3, 4
	3.4	Elementary knowledge on horticultural types of fruits and vegetables, Concept of shelf life and perishable fruits, Ripening and biological ageing, Storage and preservation concerns.	2	1

	3.5	Fruits preservation-Room temperature (Juice, syrup, squash), heat treatment(Jelly, jams), Dehydration(sun drying, application of sugar syrup,salt), freezing Vegetable preservation-packaging and storage, dehydration techniques, vegetable products (flakes, chips, dried powder), frozen vegetables, Preservation by Canning and bottling. **Activity-** Prepare and submit any one fruit/vegetable product using methods prescribed in the syllabus Visit and submit an audio visual documentary on any one small scale entrepreneurship activity with reference to the skills mentioned in the syllabus Submit a proposal on any plant based entrepreneurship activity (other than mentioned in syllabus).	8	1,3
4.	**Teacher specific course component**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 25 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12) : 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10

References

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4. Gopal Chandha De, 2002. Fundamentals of Agronomy. Oxford and IBH Publishing House.
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6. Hudson T, Hartmann, Dale E Kester, 2001. Plant Propagation, Principles and Practices (VI Edn). Prentice Hall, India.
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9. Adams C R, Early M P, 2004. Principles of Horticulture. Elsevier, N. Delhi.
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SUGGESTED READINGS

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2. Purohit S S, 2005. Plant Tissue Culture. Student Edition.
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4. Kalyan Kumar De, 1996. Plant Tissue Culture. New Central Book Agency (P) Ltd.
5. Razdan M K, 1995. Introduction to Plant Tissue Culture (II Edn). Oxford and IBH Publishing Co.
6. Sharma R R, 2005. Propagation of Horticultural Crops. Kalyani Publishers.
7. Singh B D, 1996. Biotechnology. Kalyani Publishers.

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<table>
<tr><td>Programme</td><td colspan="6"></td></tr>
<tr><td>Course Name</td><td colspan="6">Nutritional Biotechnology</td></tr>
<tr><td>Type of Course</td><td colspan="6">MDC</td></tr>
<tr><td>Course Code</td><td colspan="6">MG3MDCBBT201</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>45</td></tr>
<tr><td>Prerequisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Student will be able to understand the role of nutrients for a healthy life.	U	1,6,8
2	Student will able to apply biotechnology for improving the nutritional quality of plants and animal foods and managing food adulterants.	A	1,6,10
3	Student is able to assess the use of bioprocess for increasing the functionality and nutraceutical properties of foods.	E	1,9,10
4	Students are able to understand the immobilization and encapsulation process.	U	1,6
5	Students are able to understand the production and use of enzymes in food processing.	U	1,10
6	Student will able to develop skills in creating well balanced and nutritious meal plans.	C	1,6
7	Students are able to assess the reason for particular lifestyle diseases.	E	1,6

8	Student will able to comprehend reasons, management and treatment of lifestyle diseases.	E	6,9,10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Nutrition and Life style	1.1	**Overview of nutrition**: Definition, importance of nutrition, nutrients-function, sources, types-macronutrients and micronutrients, principles of balanced diet.	3	1,2,3,4
	1.2	**Overview of lifestyle diseases**: Modern lifestyle and health impacts, protein energy malnutrition, RDA, diabetes, obesity, hypertension, stroke, cancer	3	1,2,3,4
2 **Food engineering**	2.1	**Food fortification**: Enriching with protein, vitamins and minerals.	2	1,2,3,4
	2.2	Organic food and GM food.	3	1,2,3,4
	2.3	Detection of food additives and pesticides.	2	1,2
	2.4	**Preservation and storage of food-** Freezing, Refrigeration, Thermal processing, Salting, Drying and irradiation, Pasteurization.	2	3
3 Food Science, Dietetics And Nutrition	3.1	**Bioprocess**: Fermentation technology, microorganism in food fermentation, antimicrobial ingredients, nutrients and Nutraceuticals production. Immobilization -basics and applications in food processing. Microencapsulation-basics and applications in food processing.	6	3
	3.2	**Enzymes in food processing:** Application of enzymes-amylases and proteases, in food industry. Enzymes for hydrolysate and bioactive peptides, maltodextrins and corn syrup solids.	5	3
	3.3	Role of enzymes in cheese making and whey processing, fruit juices, baking.	3	5

	3.4	Detection of food pathogens by plating techniques.	2	7
	3.5	**Overview of nutrition:** Definition and importance of nutrition, Nutrients and their functions, Sources of nutrients	2	1
	3.6	**Macronutrients and Micronutrients:** Understanding Macronutrients (carbohydrates, proteins, fats), Importance of micronutrients (vitamins and minerals), Balanced nutrition and dietary guidelines.	2	1
	3.7	**Nutrition in infancy:** Breast feeding vs Formula feeding, Introduction to solid foods, Nutritional needs during growth.	2	1,6
	3.8	**Nutrition in adulthood and Later years:** Age-related changes in Nutritional requirements, Common Nutritional challenges in adulthood, Healthy eating patterns for older adults.	2	1,6
	3.9	**Recommended Dietary Allowance (RDA):** Definition and purpose of RDA, Factors influencing RDA, Interpreting and applying RDA in diet planning.	2	1,6
	3.10	**Planning a healthy diet:** Principles of balanced diet, Meal planning and portion control, Dietary guidelines for different age groups.	2	1,6
	3.11	**Protein energy malnutrition:** Types and causes of protein energy malnutrition, Effects on health and development, prevention and treatment strategies.	2	7,8
4		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars

<table>
<tr><td rowspan="2">Assessment types</td><td>MODE OF ASSESSMENT
A. Continuous Comprehensive Assessment (CCA)
MCQ, Class tests, Assignments, Viva
Total marks : 75
CCA : 25</td></tr>
<tr><td>B. End Semester examination – 1.5 hrs.
Total marks : 50</td></tr>
<tr><td>Pattern of questions</td><td>Total marks: 50 marks (1.5 hrs.)
One word answer question (1mark):10 out of 10 10x1= 10 marks
Short answer questions (3marks) :4 out of 6 4x3= 12 marks
Short essay (6 marks) :3 out of 5 3x6= 18 marks
Essay (10 marks) :1 out of 2 1x10= 10 marks</td></tr>
</table>

REFERENCES

1. Rutledge, Food and nutritional Biotechnology, Navyug publishers and distributors,2009
2. Ravishankar Rai V, Advances in Food Biotechnology, Wiley-Blackwell,2015
3. Donald Bills and Shain -Dow Kung, Biotechnology and Nutrition, Proceedings of the Third international symposium, Butterworth - Heinemann, BotsoN
4. Ferguson, L.R. (2013). Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition. Boca Raton, FL: CRC Press.
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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Bioethics and IPR**
Type of Course	**VAC**
Course Code	**MG3VACBBT200**
Course Level	**200**
Course Summary	This course focus on systematic outline of the bioethics and Intellectual Property Rights. This will provide the core principles in the interaction of IPR and Bioethics, also give overview of the domestic and international legal regime dealing with intellectual property law.

Semester	III	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	-	-	45
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply ethical principles in biological research	A	PO8
2	Utilize the intellectual property rights and its benefit to society	K	PO6
3	Choose fundamental aspects of Intellectual Property Rights in development and management of innovative projects	A	PO3
4	Interpret knowledge on IPR, patents, patent regime and registration aspects in India and abroad	U	PO1
5	Appraise the current trends in IPR and Govt. steps in fostering IPR	E	PO1 PO3

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

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to bioethics & GMO's, bioethics in research and profession (18 hours)**			
	1.1	Bioethics – Need, issues (social and cultural) and applications; Misuse of modern molecular biology tools and techniques.	3	CO1
	1.2	Bioethics &Biodiversity:Convention on protecting Biodiversity, Protocols in exchanging Biological material across borders	3	CO1
	1.3	Issues and concerns pertaining to Genetically modified foods & food crops, Harm to the environment - potential impact of GMOs on the ecosystem.	3	CO1
	1.4	Bioethics in Medicine & Cloning: Protocols of ethical concerns related to prenatal diagnosis, gene therapy, organ transplantation, Xenotransplantation, ethics in patient care, informed consent	3	CO1
	1.5	Patenting biotech inventions: objective, applications, concept of novelty, concept of inventive steps	3	CO1 CO4
	1.6	Use of plants in research, human volunteers for clinical research, moral issues in patenting biotechnological inventions, Ethics related to professional streams.	3	CO1 CO2
2	**Introduction to IPR (12 hours)**			
	2.1	Meaning of Intellectual Property Rights – Introduction to TRIPS and WTO – IPR in India and the world	3	CO3 CO4
	2.2	Kinds of Intellectual property rights - Copy Right, Patent, Trade Mark, Trade Secret and trade dress	3	CO2 CO4
	2.3	Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.	3	CO4 CO5
	2.4	**Activity – 1** Geographical Indication - Meaning & significance of GI, How to file GI.	3	CO4 CO5

3	**Patent Rights (15 hours)**			
	3.1	Origin, Meaning of Patent, Types, Inventions which are not patentable	3	CO3 CO4
	3.2	Registration Procedure, Rights and Duties of Patentee, Patent Infringement.	3	CO4 CO5
	3.3	Copyright - Definition, Terms & Types of Copyright, Piracy. Information technology related IPR (computer software, database and data protection)	3	CO4 CO5
	3.4	Trade Marks - Meaning & Nature of Trade Marks, Types, Infringement & Remedies, Offenses relating to Trade Marks.	3	CO4 CO5
	3.5	<u>**Activity – 2**</u> Traditional Knowledge - Meaning, importance of TK, Sources of TK, TKDL (Traditional Knowledge Digital Library.	3	CO4 CO5
4	**Teacher specific course components**			

<table>
<tr>
<td>Teaching and Learning Approach</td>
<td>Classroom Procedure (Mode of transaction)

Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.</td>
</tr>
<tr>
<td>Assessment Types</td>
<td>MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory/Hands on Work- 25 Marks
● Involvement and responses in class room transactions
● Home Assignments
● Oral presentation/ Viva/Quiz/Open book test
● Field study, Group discussion on a recent research or review article(<5 years) related to the course
● Any other method as may be required for specific course / student by the course faculty</td>
</tr>
</table>

	B. End Semester Evaluation(ESE) **Theory: 50 marks** Short answer (10 out of 12) : 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 1

References

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Reference Journal

1. Journal of Intellectual Property Rights (JIPR):

NISCAIR Useful Websites:

1. Cell for IPR Promotion and Management (http://cipam.gov.in/)
2. World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)
3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

	Mahatma Gandhi University **Kottayam**

Programme	
Course Name	**Environmental Biotechnology and Human Rights**
Type of Course	**VAC**
Course Code	**MG3VACBBT201**
Course Level	**200-299**
Course Summary	This interdisciplinary curriculum provides a comprehensive exploration of ecological, environmental, and human rights issues, fostering a holistic understanding of the interconnectedness between the natural world and societal well-being.

Semester	3	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	*Need to complete 100 level courses*					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome** Upon completion of this course in Industrial & Bioprocess Technology, participants should be able to:	**Learning Domains ***	**PO No**
1	Explain the concept, structure, components, and functions of ecosystem, energy resources, and environmental laws	K	1,2,4
2	Analyze the characteristics of wastewater and explore biodegradation processes.	An	1,2,3

3	Summarize wastewater treatment methods and solid waste management techniques	U	1,2,3
4	Gain insights into human rights, including their concept, history, and international dimensions.	U	1,2,3,6,10
5	Examine the role of the United Nations in promoting human rights and critically appraise its regime	An	1,2,3,6,10
6	Explore human rights from a national perspective, focusing on the Indian Constitution, fundamental rights, and specific issues related to women, children, minorities, and prisoners	An	1,2,3,6,10

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1. **Ecology and Environmental Science**	1.1	Ecosystem: Concept, Structure, Components, and Function	2	1
	1.2	Biotic Components and Abiotic Components: Ecological Succession	3	1
	1.3	Food Chains, and Food Webs, Energy flow in the ecosystem, Biogeochemical cycles- Nitrogen and Carbon.	4	1
	1.4	Energy Resources: Renewable and Nonrenewable energy resources.	3	1
2. Environmental Analysis, Biodegradation, Wastewater and Solid Waste Management	2.1	Characteristics of Wastewater:	3	2
	2.2	Bacteriological Analysis of Drinking Water:	3	2
	2.3	Biodegradation of Organic Compounds:	5	2
	2.4	Wastewater Treatment.	3	3
	2.5	Biological Treatment of Wastewater:	3	3
	2.6	Solid Waste Management	3	3

	2.7	Environmental laws	3	3
3. Human Rights and International Framework	3.1	Introduction to Human Rights	4	4
	3.2	Human Rights Coordination within the UN System	3	5
	3.3	Human Rights in the Indian Constitution	3	6
4		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	B. End Semester examination – 1.5 hrs. Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

Reference

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9. Dubey, R. C. 5 th ed (2014). Textbook of Biotechnology S Chand publishers.
10. Agarwal, S. K. (2015). Advanced Environmental Biotechnology, Ashish Publishing House.

Suggested Readings

1. Misra, S. P., Pande, S. N. (Ane Books Pvt. Ltd.). Essential Environmental Studies.
2. Sharma, P. D. Ecology and Environment.
11.

SEMESTER IV

Mahatma Gandhi University
Kottayam

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Plant anatomy and reproductive botany</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG4DSCBBT200</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course Plant anatomy and reproductive botany equips students with a deep understanding of the intricate structures and developmental processes in plants, enabling them to appreciate the complexity and beauty of plant life and its significance in the natural world.</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Identify and differentiate tissues of plant organs	K, U	PO1
2	Relate the structural complexity of the cell wall and its applications.	U	PO1
3	Differentiate various anatomical changes under developmental stages and habitat conditions.	An	PO2
4	Categorize wood samples based on anatomical features	An	PO10
5	Implement the applied aspects of anatomical studies in other branches of plant science.	A	PO3
6	Describe the structure and development of reproductive parts in angiosperms.	U	PO1 PO4

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

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Anatomical organization of plant body - Primary structure (14 hours)**			
	1.1	Compound light microscope – parts and working, hand sectioning and slide preparation for microscopy, staining and fixing of specimens.	2	1
	1.2	External secretory tissue - glands and nectaries; Internal secretory tissues – laticifer, Commercial applications – Resins, Gums, Latex .	3	1
	1.3	Cell wall: Definition, Functions, Chemical composition – Polysaccharides, pectic polysaccharides, structural polysaccharides, arabinogalactans, enzymes, minerals. Ultrastructure of the cell wall (detailed study). Structure and function of plasmodesmata, simple and bordered pits, Growth of cell wall - apposition, intussusception.	5	2
	1.4	Cellulose as a source of energy for the future; methods to produce bioethanol from cellulose, challenges, and prospects.	4	2
2	**Anatomical organization of Plant body - Secondary structure (19 hrs)**			
	2.1	Normal secondary growth in dicot stem and root. Steps in secondary thickening: Intrastelar secondary thickening, formation of cambium, structure and function of cambium, activity of cambium, Extra stelar secondary thickening: periderm – structure and development, bark, lenticels; factors affecting cambial activity, Seasonal activity of cambium, annual rings. Dendrochronology.	4	3
	2.2	Anomalous secondary thickening in *Bignonia* stem.	2	3
	2.3	Types of wood; heartwood, sapwood, hard wood - porous nature, softwood - non porous nature (Detailed study). Reaction wood: tension wood and compression wood.	4	4
	2.4	Identification of wood using anatomical features – physical, microscopic, and macroscopic features. Identification of - fragmentary plant material as adulterants in crude drugs,	9	5

		food adulterants and contaminants, archaeological plant remains and prediction of ancient climatic conditions, forensic investigations evidence, and taxonomic significance characters. Wood modification technologies for industry (Brief account only). Relevance of anatomical studies in crop science.		
3	**Reproductive Botany (12 hrs)**			
	3.1	Flower as a reproductive organ, floral components, and their roles.	1	6
	3.2	Microsporangium and male gametophyte, Microsporangium: structure and development of anther, microsporogenesis, Male gametophyte development, dehiscence of anther, structure of pollen.	2	6
	3.3	Megasporangium and female gametophyte, Megasporangium: types of ovules – anatropous, orthotropous, amphitropous, campylotropous, circinotropous. Megasporogenesis – female gametophyte – structure of a typical embryo sac, types of embryo sacs - monosporic (Polygonum type).	4	6
	3.4	Fertilization: Mechanism of pollination, agents of pollination, Pollinators and global food security, Pollen pistil interaction, germination of pollen grains; double fertilization.	3	6
	3.5	Endosperm and Embryo development: Endosperm: types – cellular, nuclear and helobial. Embryogeny, structure of dicot and monocot embryo, seed formation. Polyembryony; Apospory	2	6
4	**Practical (30 hrs)**			
	4.1	I. Select and conduct any two of the following learning activities a/b/c//d (**Individual/Group):** a. Submission of an assignment on anatomical organizationof the plant body based on the higher secondary level syllabus. b. Collect herbaceous members of dicot and monocot – prepare stained sections of root, stem, leaves, and flower bud.	20	1, 3, 4

		c. Prepare photographs of each and locate – Tissue types, epidermal, ground, and vascular tissue systems. d. Identify locally available plants with secretory tissues and prepare a report/ poster/audiovisual document. I. Micro preparation of root (*Ficus*, *Carica papaya*, *Tinospora*) and stem (*Vernonia*, *Chromalaena*, *Sida*) after secondary thickening. II. Micro preparation of *Bignonia* stem after secondary thickening. III. Identification of commercial wood of Teak, Mahogany (*Swietenia* spp), *Dalbergia* (Indian rose wood)		
	4.2	**I.** Dissect a flower and document (photograph/illustration) II. Identification of C.S of the anther. III. Identification and documentation of anther dehiscence pattern in five locally available plants. IV. Pollen viability tests – Acetocarmine test / Tetrazolium test **V.** Pollen germination test - Sugar solution test. **VI.** Dissection of dicot embryo.	10	6
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. **End Semester Evaluation (ESE)** **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** Practical based assessments: 30 marks ·Record: 5 marks

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Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Food science and quality control**					
Type of Course	**DSE A**					
Course Code	**MG4DSEBBT200**					
Course Level	**200**					
Course Summary	In this course, students will be familiarized with the components of food and the changes leading to soilage. They acquire an in-depth understanding of the technologies used to produce safe and nutritious foods as well as the importance of food security. Students will address the functionality of ingredients used in foods, while exploring the basis of nutrition and the role it has on etiology and prevention of key disorders. The course will also provide information about the regulations to be followed in food industries and food-related sectors.					
Semester	IV	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60
Pre-requisites, if any	Basic understanding of the structure of carbohydrates, proteins and fats as components of food					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify the food components and issues relevant to food processing and food quality management systems.	K	PO6
2	Discuss the spoilage and deterioration mechanisms in foods and methods to control spoilage.	U	PO2
3	Evaluate the principles of food science to assure the quality of food products.	E	PO2
4	Employ the principles of food science in practical, real-world situations and problems.	A	PO2 PO3
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT				
Module	**Units**	**Course description**	**Hrs**	**CO No.**
1	**Composition and Types of food (14 hours)**			
	1.1	Introduction and scope of Food science Composition of food: ● Carbohydrates- Major sources and functions. ● Proteins-Major sources and functions. ● Lipids-Saturated and unsaturated fatty acids, Dietary sources, functions of fats. Fiber – Dietary sources, functions	5	1
	1.2	Minerals- Calcium, Phosphorus, Magnesium, Sodium, Potassium etc Vitamins- fat soluble and water soluble	2	1
	1.3	Enzymes- Amylase, Protease, Lipase, Phytase, Lipoxygenase, Pectic enzyme Pigments-Chlorophylls, Carotenoids	3	1
	1.4	Types of food- Nutraceuticals, Probiotics, Prebiotics, GM food, Organic food, Traditional food, Fermented food	4	1
	Food additives, Food adulteration and Food borne diseases (19 hours)			
	2.1	Food additives: Food colours, Sweeteners, Gelling agents, Flavour enhancers, Surface acting agents, Bleaching agents, Stabilizers, and Thickeners Activity: Carry out a market survey of additives used in different types of foods, classify them based on their role and present your findings as PowerPoint presentations.	5	1,4
	2.2	Food adulteration: Definition, Common adulterants in food, Reasons for adulteration	1	2,3

2	2.3	Testing adulteration in milk, ghee, sugar, salt, tea, coffee, chili powder, turmeric powder, sweets, poultry and fish (Brief account) Hands on training on Adulteration testing of milk, chilli powder and tea (market sample)	9	2,3,4
	2.4	Harmful effects of food adulteration	1	2
	2.5	Food borne illness and diseases associated: Food poisoning, Botulism, Ergotism, Staphylococcal intoxication, Mycotoxicosis	3	1, 2
3	**Food spoilage and preservation (14 hours)**			
	3.1	Food spoilage: reasons for food spoilage, Physical and Chemical changes in food that affect texture, flavour, odour, stability and nutritive value during processing and storage.	2	2
	3.2	Food preservation methods: asepsis, removal of microorganisms, Drying, smoking, low temperature, high temperature, Canning, vacuum filling, UV radiation Activity: Familiarize with different preservation methods employed for preservation of vegetables, fruits, cereals, and pulses- Submission of report	8	3
	3.3	Food Preservatives: Salt, Vinegar, Sugar, Benzoates, Sorbates, Nitrates, Propionates, Antioxidants, Antibiotics, Antifungal preservatives	4	3
4	**Quality control in Food industry (13 hours)**			
	4.1	Quality control (QC) in food industry, major concepts of QC, Significance	3	1,3
	4.2	Food safety Standards and Regulations-ISO 22000, HACCP, FSSAI, GMP, AGMARK Visit any Food industry/Food processing unit that follows food safety standards and regulations and submit a report	7	1,3

	4.3	Quality control activities-Sampling and Inspection, Certification, Testing laboratories	3	1,3
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory/Hands on Work- 30 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks • Very Short Answer (10 out of 12) : 2 x 10=20 Marks • Short Answer (8 out of 10) : 8 x 5= 40 Marks • Essay (1 out of 2): 1x 10= 10marks

References

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24. Watson, R. R., & Victor R Preedy, V.R. (Eds.) (2015). Probiotics, Prebiotics, and Synbiotics: Bioactive Foods in Health Promotion Academic press (Elsevier) ISBN-978-0-12-802189-7
25. Willson, E. D. (1979). Principles of Nutrition, 4th edition, John Wiley & Sons Inc. New York

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Horticulture and post-harvest technology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG4DSEBBT201</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">Students are expected to gain knowledge on various Horticultural disciplines including gardening, field management and postharvest technologies. They will also develop an understanding of Regulatory Laws related to food safety and quality control along with exploring the entrepreneurial aspects within the field of Horticulture.</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Familiarity with basic plant science, soil science and environmental science</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Developa comprehensive understanding of horticulture, importance and its branches	U	PO10
2	Apply crop management techniques in horticulture including soil preparation, irrigation and pest control	A	PO2

3	Develop expertise in postharvest handling techniques to minimize losses and enhance the shelf life	A	PO2
4	Administer storage and transportation practices to maintain freshness and nutritional quality	A	PO2
5	Develop new value addition strategies based on the principles on harvesting, processing and packaging of Horticultural produces	C	PO1
6	Evaluate and implement sustainable practices in horticulture considering environmental impact resource conservation and promotion of biodiversity	E	PO6
7	Develop entrepreneurial skills including market analysis, business planning and risk management in horticultural industry	C	PO 5
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Horticulture (3 hours)**			
	1.1	Introduction, Scope and Importance, Branches of horticulture.	3	1
2.	**Soil Science and field management (12 hours)**			
	2.1	Components of soil: Organic, Inorganic & physiological-types and its importance.	2	2
	2.2	Classification of soil: Criteria for classification - soil profile- soil types - red soil, black soil, alluvial soil, laterite soil, coastal soil, sandy soil, serpentine soil, sodic soil, problematic soil, acidic and alkaline.	4	2
	2.3	Irrigation: Principles. Methods of irrigation - surface, subsoil and overhead irrigation system – types.	2	2

	2.4	Manuring: organic and Synthetic manures - Classification. Methods of manuring- broadcast, seed treatment, foliar application	3	2
	2.5	Estimation of soil pH using pH meter.	1	2
	Landscape architecture & Commercial Horticulture (25 hours)			
3	3.1	Gardening: styles of gardens - English, Mughal, Japanese, Persian, French and Italian gardens - characteristics and components (Brief account Only). Garden tools and Implements – Types. Garden designing and layout. Different types of gardens: Outdoor, indoor garden, water garden, rockery.	6	1
	3.2	Landscape architecture: types - Contemporary, Environmental, Industrial, institutional and playground landscaping.	3	1,6
	3.3	Plant propagation methods: Budding, Grafting, Layering and Tissue culture.	3	2
	3.4	Major branches of horticulture: Floriculture: definition and significance, Components – Cut flower, loose flower, dry flower, Floral oil. Olericulture: definition and significance; Types of vegetables: Warm season and cool season vegetables, types of vegetable farming - kitchen, garden, terrace garden, market garden, truck garden. Pomology: Types of fruits – Tropical, Subtropical and Temperate. General care of fruit crops - techniques for planting, pruning and training, pest management.	8	1
	3.5	Practice different types of grafting (approach, whip and tongue, cleft), T budding/ Patch Budding.	5	2
4.	**Post harvest Management; Laws & Entrepreneurship (20 hours)**			
	4.1	Importance of post-harvest management. Postharvest handling methods: Washing, Grading, Waxing. Storage methods: Pre-cooling. Controlled atmospheric storage, Modified atmospheric storage – Low pressure storage and cold chain concept	3	3,4

	4.2	Packaging of fresh and processed products: general principles and methods of preservation - dehydration, thermal processing, chemical preservatives, fermentation, ionizing, radiation, Preparation of jams, jellies, squashes, pickles, salads, syrups and beverages.	4	4,5
	4.3	Government policies, regulations and specifications for fresh and processed products, Food safety and quality control-FSSAI. Export promotion agencies and their role on export of fresh and processed products.	3	6
	4.4	Importance and scope of processing industry in India. General guidelines for the establishment of small and large scale processing units. Business opportunities, Role of Horticorp and VFPCK.	2	6,7
	4.5	Training on making jams, jellies, squashes, pickles, salads, syrups and beverages	3	5
	4.6	Visit a garden and identify the components, plants, and prepare a report. Collect, familiarize and identify ornamental plant groups.	5	7
5	**Teacher specific course components**			

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory/Hands on Work- 30 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test

	● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks ● Very Short Answer (10 out of 12) : 2 x 10=20 Marks ● Short Answer (8 out of 10) : 8 x 5= 40 Marks ● Essay (1 out of 2): 1x 10= 10marks

References

1. Sharma, S., & Nautiyal, M. C. (2009). *Postharvest Technology of Horticultural Crops*. New India Publishing.
2. Mandal, S., Nag, S., & Das, A. (2022). *Horticultural Practices and Post-Harvest Technology*. Books and Allied Pvt. Ltd.
3. Prasad, K. (2021). *Postharvest Technology of Fruit and Vegetable*. Narendra Publishing House.
4. Kumar, N. (2021). *Introduction to Horticulture* (9th ed.). Medtech Science Press.
5. Singh, R., & Singh, B. K. (2020). *Textbook on Horticulture* (1st ed.). New Indian Publishing Agency.
6. Kader, A. (2002). *Postharvest Technology of Horticultural Crops* (3rd ed.). Univ of California Agriculture & Natural Resources.

SUGGESTED READINGS

1. Yahia, E. M. (Ed.). (2021). *Postharvest Physiology and Biochemistry of Fruits and Vegetables*. Academic Press.
2. Thompson, A. K. (2017). *Fruit and Vegetables: Harvesting, Handling and Storage* (3rd ed.). Blackwell Publishing.
3. Gross, K. C., Wang, C. Y., Saltveit, M. E. (Eds.). (2018). *The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks*. U.S. Department of Agriculture

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Molecular Biology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC B</td></tr>
<tr><td>Course Code</td><td colspan="6">MG4DSCBBT201</td></tr>
<tr><td>Course Level</td><td colspan="6">200-299</td></tr>
<tr><td>Course Summary</td><td colspan="6">Molecular Biology covers essential concepts related to the study of biological molecules and their interactions within cells. Modules give basic ideas about the historical background, structure of nucleic acids and organization of genomes at various levels. It covers central dogma, reverse transcription, mutation and their repairing mechanisms and deals with regulation of gene expression and transposons and transposition.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Need to complete difficulty level 100-199 level courses</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe fundamental molecular aspects of biology.	U	1,2,10
2	Compare the organization of DNA in viral, prokaryotic, and eukaryotic genomes.	An	1,2,10
3	Illustrate the concepts of central dogma of molecular biology	U	1,2,3,10
4	Explain the cellular functions, regulation, errors occur during the cellular mechanisms and its repair.	U	1,2,3,10
5	Differentiate the role of enzymes involved in DNA replication, transcription and translation	An	1,2,3,10

6	Able to perform DNA isolation, electrophoresis of DNA and protein, estimation of DNA and RNA and restriction digestion.	A	2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO. No:
1 Fundamentals of DNA, RNA and Gene	1.1	Milestones in Molecular Biology	1	1
	1.2	Experiments demonstrating DNA and RNA as the genetic material	3	1
	1.3	Structure and types of DNA and RNA	2	1
	1.4	Physico - chemical properties of DNA	2	1
	1.5	Organization of DNA in viral, prokaryotes and eukaryotic genome and C-value paradox	3	2
	1.6	Gene structure- Structure of prokaryotic and eukaryotic genes	1	2
2 DNA Replication and Repair	2.1	Central dogma of Molecular Biology	1	3,4,5
	2.2	DNA replication – Different types. Conservative, Semiconservative, Dispersive, Theta, D-loop and Rolling circle model. Meselson and Stahl experiment	3	3,4,5
	2.3	Steps involved in DNA replication. - Initiation, Elongation and Termination.	5	3,4,5
	2.4	Structure and function of enzymes involved in DNA replication	1	3,4,5
	2.5	DNA repair mechanisms- Photo reactivation, NER, BER, SOS.	3	3,4
3 Transcription and Regulation of gene Expression	3.1	Transcription of mRNA in prokaryotes and eukaryotes, reverse transcription, post transcriptional modifications	5	1,3,4,5
	3.2	Genetic code and its properties	1	1,3,4,5
	3.3	Translation - Translation of prokaryotic and eukaryotic mRNA, post translational modifications	4	1,3,4,5
	3.4	Gene regulation in prokaryotes- Operon concept, components of operon	1	1,3,4
	3.5	Positive and negative regulation, Molecular details of Lac and Trp operon	5	1,3,4

	3.6	Transposable elements in prokaryotes and eukaryotes- Types and mechanism of transposition	4	1,3,4
4 Practicals	4.1	DNA Isolation and Agarose gel electrophoresis from *E. coli* Cells and plant cells	6	6
	4.2	Isolation of plasmid DNA from *E.coli* cells	4	6
	4.3	DNA estimation	3	6
	4.4	SDS PAGE	5	6
	4.5	Protein Gel Electrophoresis	4	6
	4.6	Restriction digestion	4	6
	4.7	RNA estimation	4	6
Module 5	Teacher specific Content			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical- 35 marks 5 hrs.	Major expt./ procedure/ case study analysis – 15 Minor expts./ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Russell, P. J. (2021). Essential genetics. Blackwell Scientific Publications.
2. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons. Watson, J. D. (2021). Molecular biology of the gene. Pearson Education India.
3. Karp, G. (2022). Cell and molecular biology: concepts and experiments. John Wiley & Sons.
4. Lodish, H. F. (2022). Molecular cell biology. Macmillan.
5. Brooker, R. J. (1999). Genetics: analysis & principles. Reading, MA, USA: Addison-Wesley.
6. Brown, T. A. (2023). Genomes V
7. Chaitanya, K. V. (2013). Cell and Molecular Biology: a lab Manual. India: PHI Learning.
8. Sambrook, J., Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. United States: Cold Spring Harbor laboratory Press.

Suggested Readings

1. Alberts, B. (2017). *Molecular biology of the cell*. Garland science.
2. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger Principles of Biochemistry. Macmillan.

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Immunology**
Type of Course	**DSC B**
Course Code	**MG4DSCBBT202**
Course Level	**200-299**
Course Summary	Immunology delves into the history and mechanisms of the immune system, covering innate and acquired immunity, B and T cell processes, antigen-antibody reactions, and immune response types. It explores practical applications, including blood grouping, immunological techniques, and complement pathways. Immunological disorders like hypersensitivity and autoimmune diseases are discussed. The course concludes with applications in immunization, vaccine types, and antibody engineering, showcasing the practical implications of immunological insights.

Semester	4	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre- requisites, if any	Need to complete difficulty level 100-199 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Students will be able to identify and describe the major cells and organs involved in the immune system	R	1,3,4,10

2	Students will be able to communicate effectively about advanced immunological techniques and antigen-antibody reactions, both in written reports and oral presentations	U	1,4,10
3	Identify the cells and organs of Immune System	U	1,2,3
4	Students will express effectively about advanced immunological techniques and antigen-antibody reactions	E	1,2,3,10
5	Students will describe the Type I to Type IV hypersensitivity reactions	An	1,10
6	Students will evaluate therapeutic interventions and immune-techniques in therapeutic applications.	E	1,2,10
7	Students will learn the steps involved in generating and characterizing hybridomas for the production of monoclonal antibodies	U	1, 2, 8, 10
8	Students will gain practical exposure to blood cell counting, blood grouping and typing and agglutination and antigen-antibody reactions.	U	1,2,3
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to immunology	1.1	History and scope of immunology. Types of immunity – Innate and acquired immunity	3	1,2
	1.2	Cells and organs of the immune system. B Cell and T Cell maturation, activation and differentiation.	6	1,4
	1.3	Antigen – Haptens and adjuvants. Antibody – General features, Classification of immunoglobulin.	4	1,2,4
	1.4	Immune response – Humeral and cell mediated immunity. MHC – Classes and function	4	1,3
	2.1	Features of antigen antibody reactions – affinity, avidity, cross reactivity.	3	1,3

2 Antigen antibody interactions	2.2	Agglutination reaction – Blood grouping, Coombs test, WIDAL, precipitation reactions – ODD, RID	4	1,6,7
	2.3	Immunological techniques – EIA, FIA, RIA, Immuno-electrophoresis, Western blotting. Complement proteins – pathways and complement fixation test.	5	6,7
3 Immunological Disorders and Applications of Immunology	3.1	Hypersensitivity, Tumor immunology, Transplantation immunology, immunohematology.	7	1,2,4,6,7
	3.2	Autoimmunity and autoimmune diseases. Immunodeficiency diseases.	4	1,5,7
	3.3	Immunization – passive and active. Vaccines – types and applications, Polyclonal and monoclonal antibody production – Hybridoma technology. Antibody engineering	5	3,4,6,7
4 Practicals	4.1	Total count and Differential count of Blood cells	6	8
	4.2	Agglutination reactions- Blood grouping, Blood typing.	5	8
	4.3	WIDAL Test- qualitative	8	8
	4.4.	RPR	6	8
	4.5	Antigen Antibody reactions- Precipitation reaction- ODD	5	8
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical- 35 marks **5 hrs.**	Major expt./ procedure/ case study analysis – 15 Minor expts./ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Kindt, T. J., Goldsby, R. A., & Osborne, B. A. (2007). Kuby Immunology (6^{th} ed.). W.H. Freeman and Company
2. Illustrated Immunology. (2022). India: New India Publishing.
3. Kumar, A. (2013). Textbook of Immunology. India: Energy and Resources Institute.
4. Anil Sharma (Edited) (2019). Immunology: An Introductory Textbook. Singapore: Pan Stanford Publishing.
5. Coico, R., Sunshine, G., Benjamini, E. (2003). Immunology: A Short Course. United Kingdom: Wiley.
6. Murphy, K., Travers, P., & Walport, M. (2012). Janeway's Immunobiology (8^{th} ed.). Garland Science.
7. Abbas, A. K., Galli, S. J., & Howley, P. M. (2020). Annual Review of Immunology. Annual Reviews.
8. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). Molecular Biology of the Cell (4^{th} ed.). Garland Science.
9. Nigam, A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. India: McGraw-Hill Education (India) Pvt Limited.
10. Speshock, J. (2019). Immunology Lab Manual. (n.p.): Kendall Hunt Publishing Company.

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Biofertilizers and biocontrol agents</td></tr>
<tr><td>Type of Course</td><td colspan="6">SEC</td></tr>
<tr><td>Course Code</td><td colspan="6">MG4SECBBT200</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course Biofertilizers and Biocontrol agents is designed in such a way to develop skills in graduate-level students to prepare various types of eco – friendly bioformulations for sustainable agriculture. The course deals with important categories of micro and macroscopic agents that can act as biofertilizers and biocontrol agents, their preparation and application methods.</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No.
1	Relate the different concepts and approaches of sustainable agriculture	U	PO3
2	Implement the knowledge of various organisms in sustainable agricultural practices.	A	PO1 PO3 PO6
3	Compare and evaluate the role of various components of bioformulations.	An	PO1 PO3 PO6 PO10
4	Practice bioformulation production and their application methods.	A	PO1 PO2
5	Implement the knowledge acquired to develop compost from household waste.	A	PO1 PO2

6	Develop various categories of bioformulations.	C	PO1 PO2 PO6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Sustainable agricultural practices (5 hours)**			
	1.1	Sustainable agricultural practices: Definition and concepts, Different approaches of sustainable agriculture/ natural farming: organic farming, Whole farm planning, Minimal cultivation, Environment-friendly agriculture . **<u>Learning activity:</u>** 1. Group discussion/Debate – conventional and sustainable agriculture. 2. Prepare and submit a report on various agricultural practices in an agricultural field based on a field visit.	5	CO1
2	**Biofertilizers and Biocontrol agents for sustainable agroecosystem (15 hours)**			
	2.1	Brief history and concept of Biofertilizers, status, scope, and importance of Biofertilizers. Classification of Biofertilizers – (a) Nitrogen-fixing (b) Phosphorus-solubilising bio-fertilizers or PSB (c) Potash-solubilising bio-fertilizers (d) Plant growth promoting microbes (PGPR). Major groups of microbial biofertilizers – Bacteria (Rhizobium, Pseudomonas) and Fungi (AM mycorrhiza and ectomycorrhiza). Blue-green algae (BGA), Plant-based biofertilizer – Azolla. **Learning activity:** 1.Field exploration for macroscopic biofertilizers.	8	CO2
	2.2	Brief history and development of Biocontrol agents, Types: Macro biocontrol agents – egg parasitoids (*Trichogramma*) and Microbial biocontrol agents – (a) Bioinsecticides – *Bacillus thuringiensis*, (b) Bio fungicides – *Trichoderma*. Plant-based biopesticides:	7	CO3

		Neem and tobacco-based products (Brief account only). Commercially available botanical biopesticides – Pyrethrum, *Eucalyptus* essential oil. **Learning activity:** 1. Collect recipes, uses and modes of action of various types of plant-based biopesticides. 2. Conduct a presentation/group discussion on the recipes they collected.		
3	**Bioformulations (25 hours)**			
	3.1	Bioformulations: Definition, components (Active ingredient, carrier material, additive), Types of bioformulations: Solid (granules, wettable powders, wettable granules, dust) liquid (suspension concentrate), encapsulation. Bioformulations for the uptake of nutrients like - Nitrogen, Phosphorus, Potassium, and Iron. Bioformulations as biocontrol agents/ biopesticides: Bacterial, Fungal and Viral. **Learning activity:** 1. Visit a biofertilizer/ pesticide manufacturing industry. 2. Make a comparison chart of the components of commercially available biofertilizers/ biopesticides.	7	CO4
	3.2	Rhizobium-based biofertilizer production steps: Selection of strain, Mass culture, Carrier preparation, Inoculant production. Formulation of *Trichoderma* as biocontrol agents. Delivery methods of various biofertilizer and biocontrol agents – seed treatment, soil amendment, soil drench, aerial spraying, root dip method. **Learning activity:** 1. Field exploration for plants with root nodules 2. Practice various methods of biofertilizer and biocontrol agent application.	10	CO4
	3.3	Types of household wastes, manufacturing of biofertilizers using household waste: Procedure – sorting of household waste, composting (biodegradation) – enzymatic method, backward method, composting by microbial inoculation and	8	CO5

		biological beneficial organisms. Methods to improve the quality of household compost – mineral additives and plant hormones. **<u>Learning activity:</u>** 1. Conduct the preparation of compost from household wastes using the Garden pot composting method or Pipe composting method.		
4	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 25 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	A. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12) : 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10

References

1. Mason, J. (2003). Sustainable agriculture. Landlinks Press.
2. Kaushik, B. D., Kumar, D., & Shamim, M. (Eds.). (2019). Biofertilizers and biopesticides in sustainable agriculture. CRC Press.
3. Rai, M. (Ed.). (2006). Handbook of microbial biofertilizers. CRC Press.
4. Borkar, S. G. (2015). Microbes as bio-fertilizers and their production technology. Woodhead Publishing India Pvt, Ltd.
5. Bosch, R., Messenger, P. S., & Gutierrez, A. P. (1982). An introduction to biological control (No. 632.96/B742). Springer US.
6. El-Wakeil, N., Saleh, M., & Abu-hashim, M. (Eds.). (2020). Cottage industry of biocontrol agents and their applications: practical aspects to deal biologically with pests and stresses facing strategic crops (pp. 133-155). Springer International Publishing.
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9. Singh, D. (Ed.). (2014). Advances in plant biopesticides. Springer.
10. Dalavayi Haritha, M., Bala, S., & Choudhury, D. (2021). Eco-friendly plant based on botanical pesticides. Plant Archives, 21(1), 2197-2204.
11. Hall, F. R., & Menn, J. J. (1999). Biopesticides: use and delivery. Humana Press Inc..
12. Nick, B. & Glare, T. (2020). Biopesticides for sustainable agriculture. Burleigh Dodds Science Publishing.
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15. Kannaiyan, S. (Ed.). (2002). Biotechnology of biofertilizers. Springer Science & Business Media.

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Programme						
Course Name	**Quality control in Biology**					
Type of Course	**SEC**					
Course Code	**MG4SECBBT201**					
Course Level	**200-299**					
Course Summary	This course focuses on imparting a thorough understanding of quality control principles within the biological sciences, emphasizing their application in biotechnology. The course is structured into five modules, each covering distinct aspects of quality control measures and their significance in ensuring the reliability and integrity of biological processes and products					
Semester	4	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Need to complete 100 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the principle and Significance of quality control in biology.	U	1,6
2	Demonstrate Knowledge of Quality Control Measures, in molecular biology techniques.	U	1
3	Apply Quality Control Techniques in Biotechnological Processes, Implementing quality control protocol.	A	1,10
4	Comprehensive understanding of regulatory agencies (such as FDA, USDA, WHO) and Hazard Analysis and Critical Control Points (HACCP) in food processing, as well as knowledge of food safety standards and certifications (ISO 22000, FSSC 22000).	U	1,2,6
5	Evaluate GMP for biopharmaceuticals.HACCP and other standards.	E	1

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs.	CO No.
1 Introduction to Quality Control in Biotechnology	1.1	Definition and scope of quality control,Basic Principles of quality control	4	1
	1.2	Importance in ensuring research reliability. Difference between Quality Control & Quality Assurance.	3	2
	1.3	Quality Control a multidisciplinary approach.	2	2
	1.4	Documentation and record-keeping requirements.	2	2
2 Various areas in Quality Control	2.1	Role of Microbiology and Molecular Biological techniques in Quality Control.PCR, Electrophoresis, Culture Based Methods, ATP Bioluminescence.	5	4
	2.2	Sterilization methods and their validation.	2	4
	2.3	Molecular Biology tools in QC,Immunological tools in QC,Contamination control in cell culture, Quality control protocols in cell culture processes	4	3
	2.4	Importance of documentation in quality control. Preparation for regulatory audits.Statistics in quality control, Control charts for data analysis	5	3
	2.5	Analytical and Software tools in Quality Control	2	3
3 Introduction to Regulatory framework in Food industry and Medicine	3.1	Historical perspective and evolution of regulations in food and bioprocessing. Overview of regulatory agencies Codex Standards.(FDA,USDA,WHO,etc.).Food Saftey Modernisation Act (FMSA).	5	5
	3.2	Regulatory frameworks in biotechnology. Regulatory Requirements in Food Processing: Good Manufacturing Practices (GMP) in food industry.	3	5
	3.3	Hazard Analysis and Critical Control Points (HACCP). Food safety standards and certifications (ISO 22000, FSSC 22000).	3	5
	3.4	Current Good Manufacturing Practice (Cgmp) for biopharmaceuticals. Good Laboratory Practice (GLP) International Council for Harmonization (ICH) Guidelines	5	3

4		Teacher Specific content

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** 1. **Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	2. **End Semester examination – 1.5 hrs.** Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

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1. Van Lenteren, J. C. (Ed.). (2003). Quality control and production of biological control agents: Theory and testing procedure.

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7. Geigert, J. (2002). Quality assurance and quality control for biopharmaceutical products: Development and manufacture of protein pharmaceuticals (Vol. 14). ISBN: 978-1-4613-5127-6

8. Jack O'Grady, Austin Community College,Copyright Year: 2019, Quality Assurance & Regulatory
Affairs for the Biosciences,Publisher: Austin Community College
9. Ralph Early,Guide to Quality Management Systems for the Food Industry By Springer Science
Business Media.

Suggested reading

1. Bioprocess Engineering Principles (1995) by Pauline M. Doran
2. Introduction to Statistical Quality Control" by Douglas C. Montgomery. WELEY Publications.
3. Relevant research articles and case studies from reputable journals and regulatory agencies.

MahatmaGandhi University
Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Conservation biology and sustainable development**					
Type of Course	**VAC**					
Course Code	**MG4VACBBT200**					
Course Level	**200**					
Course Summary	The course provides a basic overview regarding the concepts in conservation biology. It also gives a basic outlook towards the need for biodiversity conservation and sustainable development. It also creates an awareness regarding the transition to green growth.					
Semester	IV	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	-	-	45
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Recall the concepts in conservation biology	K	PO1,PO4
2	Identify a variety of tools used by conservation biologists	U	PO1,PO4,PO10
3	Outline the concept and importance of sustainability	An	PO1,PO2,PO6
4	Examine the threats and adopt creative measures for biodiversity conservation	An	PO2,PO6,PO9,PO10
5	Assess the current status of biodiversity	E	PO2,PO4
6	Create an awareness in the society for the transition to the green growth	C	PO4,PO6,PO9

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

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Conservation Biology (15 hours)**			
	1.1	Introduction to conservation Biology –Definition, career prospects in conservation biology, Conservation and management practices	3	1
	1.2	Conservation Techniques-Principles of conservation - ex-situ and in-situ conservation techniques, ecological restoration Statistical and computational tools used in conservation biology- Population Viability Analysis (PVA), Minimum Viable Population, Decision Analysis and Multiple-Criteria Approaches	7	2
	1.3	Ecotourism-Ecotourism as a tool for conservation and sustainable development, difference between ecotourism and mainstream tourism, guidelines and green practices for ecotourism, impacts of tourism on culture and environment and its management-Examples, positive and negative impacts	5	1, 4
2	**Biodiversity (15 hours)**			
	2.1	Definition, types and importance	3	4
	2.2	Biodiversity loss- Causes, extinction, IUCN account of biodiversity, red data book, rare, endangered and threatened species (RET).	5	4,5
	2.3	Concept of endemism, Biodiversity hotspots in India.	2	4,5
	2.4	Biodiversity documentation- Case study- Students have to submit a brief report with geo-tagged photographs of the biodiversity of the nearby locality.	5	5
3	**Sustainable development (15 hours)**			
	3.1	Introduction -aim and impact of sustainable development	3	6
	3.2	Sustainable development - Basic characteristics, Core elements, Principles and Goals	5	6

	3.3	Strategies and policies for sustainable development Examples of Sustainable development in daily life –Wind energy, solar energy, sustainable forestry, bio-composting, biogas production, water efficient fixtures, green spaces and sustainable construction.	7	6
4	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 25 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article (<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12) : 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10

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2. Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London.
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7. https://www.nature.com/scitable/knowledge/library/conservation-biology-16089256/
8. https://sumas.ch/5-examples-of-sustainable-development/

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2. Jain S K, Sastry A R K (1984). The Indian plant red data book. BSI, Calcutta
3. Our Common Journey: A Transition Toward Sustainability. National Academy Press, Washington D.C. Soubbotina, T. P. 2004.
4. Primack, R. B. (1993). Essentials of Conservation Biology. Sunderland, MA: Sinauer & Associates.
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<table>
<tr><td>Programme</td><td colspan="6"></td></tr>
<tr><td>Course Name</td><td colspan="6">Human Resource Management in Biotechnology</td></tr>
<tr><td>Type of Course</td><td colspan="6">VAC</td></tr>
<tr><td>Course Code</td><td colspan="6">MG4VACBBT201</td></tr>
<tr><td>Course Level</td><td colspan="6">200-299</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course is designed to equip students with the essential leadership and teamwork skills necessary for success in scientific research and collaborative projects.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Need to complete difficulty level 100-199 level courses</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the characteristics and roles of leadership, management and team-building in research institutions	U	1,5,7,8
2	Apply leadership theories or approaches to professional scenarios and case studies	A	5,6,7,8
3	Comprehend clear oral and written communication that engages the audience, team and consumers	U	2,4,6
4	Apply effective team building skills by outlining the different groups	A	3,4,6,7
5	Employ the qualities of a mentor to work in good team	A	4,5,6,7
6	Choose a team which manages the work more efficiently	E	1,4, 5, 9

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Leadership and communication skills	1.1	Overview of Leadership in Scientific Settings: Understanding the unique challenges and opportunities for leadership in scientific research, Introduction to various leadership styles and their applicability in scientific contexts	4	1
	1.2	Case study 1: Examples of successful leaders in science, Leading researcher in Biotechnology, Case study 2: Self-assessment of leadership style	4	1
	1.3	Importance of teamwork in scientific research.: Building and managing effective research teams,	4	2
	1.4	Communication skills for scientists. Clear scientific writing and presentation techniques.	3	3
2 Team Dynamics and mentorship	2.1	Conflict, Resolution and Decision Making- Identifying and addressing conflicts in research teams. Strategies for fostering a positive and collaborative team culture,	4	3
	2.2	Techniques for effective decision-making in scientific projects, Balancing individual and team perspectives	3	4
	2.3	Importance of mentorship in scientific careers and teams, Developing mentoring skills for both mentors and mentees	3	5
	2.4	Career Development in Science: Navigating career paths in academia, industry, and beyond. Networking and professional development in the scientific community	5	5
3 Team Management in Science Projects	3.1	Ethical Leadership in Science: Ethical considerations in scientific research, Responsible conduct of research and leadership	3	1
	3.2	Project Planning and Execution: Developing project plans and timelines.	3	6
	3.3	Monitoring progress and adapting to changes in scientific projects.	3	6
	3.4	Resource Management: Managing laboratory resources efficiently	3	6

	3.5	Budgeting and grant management in scientific research	3	6
4	Teacher specific content			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** 1. **Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	2. **End Semester examination – 1.5 hrs.** Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References:

1. Chopra, R. (2021). Leading Science Teams: The Basics of Collaboration and Team Leadership in Research. New Delhi: Academic Press.

2. Joshi, M. (2019). Teamwork and Innovation in Scientific Research. Mumbai: Springer.

3. Rai, S. K. (2022). Leadership in Scientific Inquiry: Strategies for Success. Chennai: Oxford University Press.

4. Sengupta, S. (2021). Effective Team Management in Research Organizations. Kolkata: Sage Publications.

Suggested Readings:

3. Pavitt, C. & Curtis, E. (2001). Small group discussion: A theoretical approach (3rd ed.). Retrieved from

http://www.uky.edu/~drlane/teams/149avitt

2. Poole, M.S., & Hollingshead, A.B. (2004). Theories of small groups: Interdisciplinary perspectives. Thousand Oaks, CA: Sage**.**

3. Hackman, J. R., & Johnson, C. E. (2013). Leading Teams: Setting the Stage for Great Performances (2nd ed.). Harvard Business Review Press.

4. Katzenbach, J. R., & Smith, D. K. (2015). The Wisdom of Teams: Creating the High-Performance Organization (2nd ed.). Harvard Business Review Press

5. Gardner, H. (2008). Five Minds for the Future. Harvard Business Review Press.

INTERNSHIP

	Mahatma Gandhi University **Kottayam**
Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Internship**
Course Code	**MG4INTBBT200**
Summary	The internship is gaining first-hand experience by an individual besides comprehending the way of working in an organization, leading to improvement in skill aptitude for specific job or job role and to build research aptitude with learning opportunities. All students shall undergo summer internship or apprenticeship in a research station, industry or organization or training centres, recognized laboratories, nurseries with artificial propagation activates, with faculty/technical staffs and researchers or other higher education institutions (HEIs) or research institutions after the completion of fourth semester.
Evaluation scheme Total **50 marks**	**A) Continuous Comprehensive Assessment (CCA): 15 marks** (Internal marks may be obtained from the organization/institution where the student is doing internship using the following format) **Undergraduate Student Evaluation Form for Internship: Botany** **Internship Details** Student name : Date of evaluation : Duration of internship : Mentor name : **Instructions:** Please rate the student's performance based on their abilities, skills, and behaviour during the internship. Provide specific examples or comments where applicable to support your ratings. **A. Continuous Comprehensive Assessment (CCA):15 marks** **1. Performance and Professionalism (4 marks)** **Criteria:** • Punctuality, attendance, and adherence to workplace norms. • Ability to work independently and collaboratively.

- Demonstration of initiative, creativity, and problem-solving skills.
- Professional behaviour and ethical conduct.

2. **Skill Application and Development (4 marks)**
   Criteria:
   - Application of academic knowledge to practical tasks and projects.
   - Development of new skills relevant to the field of study.
   - Adaptability and learning agility in new or challenging situations.
   - Use of technical tools and methodologies pertinent to the internship role.

3. **Communication Skills (4 marks)**
   Criteria:
   - Effectiveness in written and oral communication.
   - Ability to document and present work clearly and professionally.
   - Interaction with colleagues, supervisors, and clients.

4. **Supervisor's Evaluation (3 marks)**
   Criteria:
   - Feedback from the internship supervisor regarding the intern's performance, growth, and contributions.
   - Supervisor's overall satisfaction with the intern's work and professionalism.

Total (out of 15)

Comments and Recommendations: (Provide specific comments on the student's strengths, areas for improvement, and any additional feedback or recommendations for their future development.)

Mentor Signature: (Insert mentor's signature) :

Date (Insert date of evaluation) :

B) End Semester Evaluation (ESE): 35 marks

(I) Report (20 marks)

Criteria/ Components

Introduction and background	- 2 marks
Objectives and Goals	- 3 marks

	Review of Literature - 4 marks Methodology and Experiments - 4 marks Data Analysis and Interpretation - 3 marks Conclusion and Future Prospects - 2 marks Overall Presentation and formatting - 2 marks **(II) Viva voce (15 marks)** (Student's skills, work ethics, professionalism and contribution to the organization may be evaluated through viva) Understanding of learning objectives and goals of the internship - 4 marks Knowledge and application of Scientific method - 4 marks Data Analysis and Interpretation - 2 marks Communication Skills - 3 marks Professionalism - 2 marks

SEMESTER V

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Angiosperm systematics and economic botany**					
Type of Course	**DSC A**					
Course Code	**MG5DSCBBT300**					
Course Level	**300**					
Course Summary	Angiosperm systematics deals with the systematic arrangement of flowering plants, interrelation between plants and their evolutionary descent and economic botany is the study of the morphology of useful parts of economically important plants.					
Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Comprehend the general principles of angiosperm systematics and plant nomenclature	U	PO2
2	Summarize taxonomic information from available resources	U	PO4
3	Compare the morphological characters of plants belonging to different plant families	An	PO2
4	Execute field collections and plant specimen preparations scientifically	An	PO10
5	Utilize the knowledge in plant systematics for the benefit of science and society	A	PO2

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Plant Morphology (10 hours)**			
	1.1	Leaf morphology- Different types and arrangements of leaves Inflorescence types–Racemose-Simple Raceme, Spike, Catkin, Spadix, Corymb, Umbel, Head; Cymose- Simple cyme, monochasial- helicoid and scorpioid, dichasial and polychasial cymes; Special types- Cyathium, Verticillaster, Thyrsus, Hypanthodium and Panicle	4	3
	1.2	Flower – as a modified shoot Floral Whorls- arrangement, relative position-Symmetry, Aestivation, Placentation. Cohesion and adhesion of essential organs. Floral diagram and Floral Formula.	3	3
	1.3	Fruit Types- Simple fruits- Fleshy, Dry – Dehiscent, Indehiscent and Schizocarpic fruits; Aggregate fruits and Multiple fruits.	3	3
2	**Plant Taxonomy (32 hours)**			
	2.1	History of Plant Classification systems- Artificial System- (Linnaeus - Brief account),Natural System (B & H system- Detailed account), Phylogenetic Systems (E & P system- Brief study), APG (brief account).	3	2
	2.2	Herbarium technique -Steps in preparation of herbarium, Importance of Herbaria, Major Herbaria - National and International, Virtual Herbaria- Index herbariorum, Botanical Survey of India.	3	4
	2.3	Botanical Literature- Floras- Regional and National Floras, Revision & Monographs (Brief account). Online Taxonomic Databases: International Plant Names Index (IPNI), Plants Of the World Online (POWO), Botanicus.org (Brief account).	2	5
	2.4	Plant Nomenclature- Binomial, ICN - Introduction & Principles (Brief study), Rule of priority, Author citation, Homonym, Synonym, Basionym.	2	1

	2.5	Type concept- (Holotype, Isotype, Lectotype).	3	1
	2.6	Taxonomic keys- Bracketed and Indented keys (Brief account).	2	1
	2.7	Study the following families of Bentham and Hooker's System with special reference to their vegetative and floral characters; special attention should be given to common and economically important plants within the families Annonaceae, Malvaceae, Rutaceae, Anacardiaceae, Leguminosae (Mimosaceae, Caesalpiniaceae and Fabaceae), Cucurbitaceae,Apiaceae.	9	3
	2.8	Rubiaceae, Asteraceae, Sapotaceae, Apocynaceae, Convolvulaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Arecaceae, Poaceae.	8	3
3	**Economic Botany (3 hours)**			
	3.1	Study following plants with special reference to the botanical name, family and morphology of useful parts - Cereals (Rice, Wheat), Millets (Ragi, Fox tail millet), Pulses (Green gram, Bengal gram), Sugar Yielding (Sugar Cane), Fruits (Banana, Guava), Vegetables (Carrot, Ladies finger), Tuber crops (Tapioca, Greater Yam), Beverages (Tea, Coffee), Oil yielding plants (Coconut, Ground nut), Fibre yielding (Coir, Cotton), Gums and resins (White dammar, Gum Arabic, Asafoetida) Insecticide yielding plants (Tobacco, Neem).	3	2
4	**Practicals (30 hours)**			
		1. Collect and submit different types of fruits mentioned in the syllabus. 2. Collect and submit any 5 types of leaves and inflorescence mentioned in the syllabus. 3. Explore habitats to identify the inflorescence and fruit types mentioned in the syllabus. 4. Conduct field work for a period of not less than 5 days to familiarize plants under the guidance of faculties and submit a field report with geotagged photos. 5. Visit a recognized herbarium, practice herbarium technique and submit 15 herbarium sheets with a field book. 6. Examine vegetative and floral features of different plants and assign them to respective families mentioned in the	30	4

		syllabus. Collect, identify and submit morphologically useful parts of any 10 plants mentioned in economic botany.		
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning,Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

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9. Lawrence, G. H. M. (1951). Taxonomy of Vascular Plants. Macmillan, New York.
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12. Pandey, S. N. & Misra, S. P. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.
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3. Chase, M. W. *et al*., (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. J. Linn. Soc., Bot., 181(1): 1-20.
4. Henry & Chandra Bose (2001). An aid to the International Code of Botanical Nomenclature. Botanical Survey of India, Coimbatore.
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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Plant biotechnology**					
Typeof Course	**DSE A**					
Course Code	**MG5DSEBBT300**					
Course Level	**300**					
Course Summary	The course is designed as a comprehensive exploration to the field of Plant Biotechnology. The course aims to familiarize students with the key developments in the sphere of Plant Biotechnology and to discuss the potential applications of biotechnology in crop improvement and for novel uses for plants.					
Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60
Pre-requisites, if any	General overview and key concepts of Biotechnology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Choose methods for *in vitro* regeneration of plants from explants including shoot and root organogenesis	Evaluate	PO1, PO2, PO3, PO10
2	Constructvectors for specific purposes like gene expression, replication and selection markers.	Evaluate	PO1, PO2, PO3
3	Develop proficiency in fundamental gene cloning techniques.	Apply	PO1, PO2, PO3
4	Compare different gene transfer methods based on efficiency and specificity.	Analyze	PO1,PO2,PO3
5	Explain the applications of plant genetic engineering in the field of agriculture, medicine, environment, and industry.	Apply	PO1,PO2, PO3,PO6,PO7,PO8,PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Plant Tissue Culture (15 Hours)**			
	1.1	Introduction to Plant Biotechnology, concept of totipotency, callus, basic infrastructure of tissue culture lab, sterilization methods, composition, and preparation of culture media; role of hormones in morphogenesis, direct and indirect organogenesis; somatic embryogenesis (brief account only)	6	1
	1.2	Tissue culture applications -micropropagation, androgenesis, virus elimination, haploids, hybrids Secondary metabolite production – hairy root culture, bioreactors: design of simple bioreactor, application in	9	1

		secondary metabolite production-, cryopreservation for germplasm conservation. Protoplast isolation, culture and fusion, somatic hybridisation, and applications - cybrids		
2	**Recombinant DNA Technology (29 Hours)**			
	2.1	Restriction Endonucleases (Types I-IV, biological role and application); T4 DNA Ligase; cloning Vectors: properties of ideal cloning vector, features of cloning vectors -pCAMBIA, Ti plasmid, BAC, Lambda phage,Cosmid, YAC Expression vectors, Shuttle vector- Brief account only	7	2
	2.2	Recombinant DNA technology: rDNA definition, steps involved (outline), bacterial transformation and selection of recombinant clones, PCR- mediated cloning, Plasmid construct- general design; construction of genomic and cDNA libraries, screening of recombinant DNA- complementation (Blue white screening), colony hybridization Biotechnology instrumentation and Lab visit **Preferable**: Working of PCR machine, Agarose gel electrophoresis, UV transilluminator demonstration (if facilities are available)	14	3
	2.3	Methods of gene transfer: direct gene transfer - electroporation, microinjection, microprojectile /particle bombardment, In-direct gene transfer- Agrobacterium mediated gene transfer Selection of transgenic plants– selectable marker (antibiotic and herbicide) and reporter genes (GUS, GFP).	8	4
3	**Application of Biotechnology (7 Hours)**			
	3.1	Herbicide resistant plants (RoundUp Ready soybean); transgenic crops with improved quality traits (Golden rice); improved horticultural varieties (Moondust carnations)	4	5
	3.2	Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Edible vaccine.	3	5

4	**Advances in Plant Biotechnology (9 Hours)**			
	4.1	Gene editing tools (CRISPR- Cas9) and its role in transgenic plant development and gene function studies (Brief account only) Synthetic biology and plant metabolic engineering for improved crop traits, Developing climate resilient crops (Brief account only) Ethical considerations in plant biotechnology Biosafety considerations and IPR associated with GM crops	9	5
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory/Hands on Work- 30 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks • Very Short Answer (10 out of 12) : 2 x 10=20 Marks • Short Answer (8 out of 10) : 8 x 5= 40 Marks • Essay (1 out of 2): 1x 10= 10marks

References

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Suggested readings:

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2. Timir Baran Jha and Biswajit Ghosh (2016): Plant Tissue Culture. Platinum Publishers. Revised 2nd Edition. Kolkata
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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Green technology and sustainable development**
Type of Course	**DSE A**
Course Code	**MG5DSEBBT301**
Course Level	**300**
Course Summary	This program emphasizes on green systems and the environment, energy technology efficiency and sustainability. These chemical processes make hazardous products which are made green, safe and economically acceptable by using biotechnology.

<table>
<tr><td>Semester</td><td>V</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Interpret the relevance and the concept of green technology for sustainable development.	U	PO6, PO10
2	Examine the various cleaner development mechanisms.	An	PO2, PO10
3	Outline the concepts related to conventional and non-conventional energy.	K	PO2, PO10
4	Discuss and implement the environmental regulations and standards.	U	PO1, PO9
5	Identify and implement the concepts on various energy efficient systems and green buildings.	U	PO6, PO10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
	Introduction to Green chemistryand sustainability (20 hours)			
	1.1	Twelve principles of green chemistry, green technology-definition, importance, and applications.	3	1
	1.2	Green technology initiatives in India	1	1
1	1.3	Extraction procedures: Green methods of synthesis- microwave assisted synthesis, super critical fluids- extraction, process and applications.	6	1
	1.4	Introduction, Concepts- Social, economic and environmental sustainability; Sustainable development, Nexus between Technology and	5	3

		Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs).		
	1.5	Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from Oceans and Geothermal energy	5	3
2	**Cleaner development mechanism and technologies (10 hours)**			
	2.1	Cleaner development mechanism- reuse, reduce and recycle, raw material substitution; wealth from waste; Zero waste concept, carbon credits, carbon trading, carbon sequestration.	5	2
	2.2	Bioremediation: Recent Advances with special reference to Phyto nanotechnology	5	2
3	**Environmental management standards and green future (15 hours)**			
	3.1	Eco-labelling, ISO 14001:2019 framework and benefits, Scope and goal of Life Cycle Analysis (LCA), Bio-mimicking, Environment Impact Assessment (EIA), (Brief account).	5	4
	3.2	Green future: Agenda of green development; reduction of ecological footprint; Water Conservation and Audit, major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources	5	5
	3.3	Green buildings: Definition- Features and benefits, outlined examples; LEED certified building; Eco-mark certification, Eco-mark in India. Green planning: role of governmental bodies, land use planning, concept of green cities, green belts.	5	5
4	**Experiential learning (15 hour)**			
	4.1	Prepare a report on eco-friendly initiatives taking place in your locality.	3	1, 5
	4.2	Familiarizing with renewable energy gadgets.	3	1, 5

	4.3	Green Tech Trip- Visit to any well-maintained green technology institutes or establishments.	6	4, 5
	4.4	Make a report on eco-mark certification products.	3	5
5	**Teacher specific course components**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)

Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory/Hands on Work- 30 Marks

● Involvement and responses in class room transactions
● Home Assignments
● Oral presentation/ Viva/Quiz/Open book test
● Field study, Group discussion on a recent research or review article(<5 years) related to the course
● Any other method as may be required for specific course / student by the course faculty</td></tr>
<tr><td>B. End Semester Evaluation (ESE)- 70 marks

• Very Short Answer (10 out of 12) : 2 x 10=20 Marks
• Short Answer (8 out of 10) : 8 x 5= 40 Marks
• Essay (1 out of 2): 1x 10= 10marks</td></tr>
</table>

References

1. Mackenthun, K.M., (1998). *Basic Concepts in Environmental Management*, Lewis Publication, London.
2. Purohit, S. S., (2008) *Green Technology - An approach for sustainable environment*, Agrobios Publication.
3. Anastas P.T. and Wavner J.C. (1998) *Green Chemistry: Theory and Practice*, Oxford University Press.
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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Analytical techniques in plant science**					
Type of Course	**DSE A**					
Course Code	**MG5DSEBBT302**					
Course Level	**300**					
Course Summary	This course will provide a comprehensive overview of the various preparative methods and analytical techniques in plant science. Students will learn the principles of different analytical techniques and its practical applications in plant research.					
Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60
Pre-requisites, if any	Basic knowledge in science					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Outline the methods and procedures in microscopy	U	PO1, PO2, PO3, PO9, PO10
2	Articulate the principles underlying different instruments employed in plant science research	U	PO1, PO2, PO3
3	Explain working and application of various separation and analytical techniques	U	PO1, PO2, PO3, PO9, PO10
4	Apply the techniques in enumeration, analysis and purification of plant samples	A	PO1, PO2, PO3, PO9, PO10
5.	Acquire expertise in various preparative methods and analytical techniques in plant science	A,S	PO1, PO2, PO3, PO9, PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Preparative Techniques in Microscopy (19 Hours)**			
	1.1	Collection, preservation (dry & Wet) and preparation of plant materials: squash, smear, whole mount, maceration, and Sectioning. Retaining the natural colour of the plant samples (brief study).	4	1
	1.2	Killing and fixing: properties of good fixative: types of fixative and fixation; killing and fixing agents and their composition (Carnoy's fluid and FAA)	2	1
	1.3	Sectioning- free hand and microtomy, applications of microtome - rotary microtome, sledge microtome, and cryostat	3	1,2
	1.4	Stains and staining techniques – different types of stains and their composition- safranin, acetocarmine; vital stains - neutral red, evans blue, types of staining - Single staining and Double staining.	4	1
	1.5	Mounting and preparation of slides - mounting media: glycerine, DPX, and canada balsam; preparation of slides: temporary and permanent	2	1
	1.6	**Activity:** 1. Temporary mounting of a hand-sectioned single-stained specimen 2. Maceration of a given specimen (Cucurbita stem)	4	1,5
2	**Instrumentation for analysis (19 Hours)**			
	2.1	Principle, working, and application: light microscopy, phase contrast microscopy, scanning electron microscopy. Image analysis software: ImageJ (brief account)	5	1,2,3

	2.2	Photometric Analysis – principle, working, and application of colorimeter and spectrophotometer. Definition and application of UV-visible spectroscopy and FTIR in plant science and related fields.	6	2,3,4
	2.3	Principle, working, and application of pH meter	2	2,3
	2.4	Enumeration Techniques: Haemocytometer	2	4
	2.5	**Activity** 1. Prepare a standard graph and estimate the concentration of a solution using a colorimeter 2. Adjust the pH of a solution using pH meter/ pH pen	4	2,3,5
3	**Methods for sample preparation (7 Hours)**			
	3.1	Centrifugation - Principle, working, and application of high-speed centrifuge and ultracentrifuge (preparative and analytical model)	4	2,4
	3.2	Principle and application of lyophilizer and freeze-drying	3	2
4	**Techniques for analysis and separation**			
	4.1	Chromatography Techniques: - principle, working, and application of paper chromatography, TLC, column chromatography, HPLC.	5	2,3
	4.2	Electrophoresis: Electrophoretic mobility, factors affecting electrophoretic mobility. working and application of SDS-PAGE and agarose gel electrophoresis	5	2,3
	4.3	**Activity:** 1. Visit a recognized instrumentation lab or research lab and submit a report.	5	2,3,5
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 30 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks • Very Short Answer (10 out of 12) : 2 x 10=20 Marks • Short Answer (8 out of 10) : 8 x 5= 40 Marks • Essay (1 out of 2): 1x 10= 10marks

REFERENCES

1. Berlyn, G.P. &Miksche, J.P. (1976). Botanical Microtechnique and Cytochemistry. Wiley-Blackwell.
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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Climate change and disaster management-botanical perspective</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG5DSEBBT303</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course is designed to equip students
To develop awareness on climate change and types of disasters in modern world
To develop climate change mitigation and disaster resilience strategies</td></tr>
<tr><td>Semester</td><td>V</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain fundamental causes and evidence of climate change & Disasters	U	PO1, PO2
2	Evaluate the multifaceted impacts of climate change	E	PO1, PO2
3	Analyze mitigation and adaptation strategies on climate change	An	PO10
4	Apply disaster management strategies	A	PO6
5	Design and propose practical, interdisciplinary solutions for climate change mitigation and disaster resilience strategies at local, regional, and global levels	C	PO1, PO3

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

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Basic science of Climate change (10 hours)**			
	1.1	Introduction to climate change- climate, weather, greenhouse gasses, ozone formation and depletion, carbon footprint, global warming	5	1
	1.2	Causes & evidence of climate change- natural vs. anthropogenic factors Global patterns and trends of climate change	5	1
2	**Impact of climate change (12 hours)**			
	2.1	Global warming: Temperature rise, sea level rise, weather pattern change	4	2
	2.2	Impacts on biome: shifts in biodiversity	4	2
	2.3	Human health and social impacts: Heat related illness, food security, water scarcity	4	2
3	**Climate change: Mitigation and Adaptation (15 hours)**			
	3.1	Mitigation strategies: reducing greenhouse gas emissions, transition to renewable energy, international efforts, and policies	5	3
	3.2	Adaptation measures: adaptation and acclimatization mechanisms in plants	5	3
	3.3	Activity - prepare a proposal on interdisciplinary solutions for climate change mitigation at local/ regional/ global levels	5	3
4	**Introduction to disaster types and disaster management Strategies (23 hours)**			
	4.1	Natural Disasters - Meteorological disasters: hurricanes, cyclones,Geological Disasters: earthquakes, landslides; Hydrological Disasters: floods, avalanches	5	1
	4.2	Man-Made Disasters Technological disasters: industrial accidents,Environmental disasters: pollution, deforestation, habitat destruction	5	1

	4.3	Disaster preparedness and planning: Risk assessment, developing and implementing early warning systems, strategies for effective immediate response	3	4
	4.4	Mitigation and Recovery: General Mitigation strategies - Disaster mitigation by restoring and preserving natural ecosystem (Reforestation, Mangroves, Wetlands & wetland conservation laws, Installing of coastal Tetrapods).Post Disaster Recovery (Rehabilitation, reconstruction, and restoration), Community resilience (Building community capacity)	10	4
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory/Hands on Work- 30 Marks** • Involvement and responses in class room transactions • Home Assignments • Oral presentation/ Viva/Quiz/Open book test • Field study, Group discussion on a recent research or review article(<5 years) related to the course • Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks • Very Short Answer (10 out of 12) : 2 x 10=20 Marks • Short Answer (8 out of 10) : 8 x 5= 40 Marks • Essay (1 out of 2): 1x 10= 10marks

REFERENCES

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Recombinant DNA Technology**
Type of Course	**DSE B**
Course Code	**MG5DSEBBT304**
Course Level	**300-399**
Course Summary	This course delves into the principles, methodologies, and applications of recombinant DNA technology. Students will get a thorough understanding of the tools used to manipulate DNA, gene cloning processes, and the various applications of genetic engineering.

Semester	5	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Need to complete difficulty level 200-299 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the common tools used in genetic engineering, such as restriction enzymes and vectors.	U	1, 2,3
2	Read the role of cloning vectors to introduce recombinant DNA into host cells	K	1, 2,4
3	Evaluate the advantages and disadvantages of various expression systems	E	1, 2,3
4	Design and plan a gene cloning experiment, considering variables and controls	C	1, 2,9
5	Propose innovative applications of genetic engineering in emerging fields	C	1, 2,9
6	Able to perform isolation of DNA and plasmid, restriction digestion, transformation and PCR.	A	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction and Tools in Rdna technology	1.1	Introduction. History. Enzymes for in vitro modification of nucleic acids– Kinases, Phosphatases, Exonucleases, Endonucleases, Restriction Endonucleases, Ligases and Terminal Transferases.	2	1
	1.2	Modification of Ends – Adapters, Linkers, Homopolymer Tailing.	1	1
	1.3	Cloning Vectors – Plasmids and their desirable properties, E coli based vectors – Pbr, Psc, Puc, Pgem3Z. M13 based vectors. Bacteriophages λ EMBL Cosmids, Phasmid. Phagemids with special reference to pBluescript, Plitmus.	3	2
	1.4	In vitro packaging, phage display. Gateway Cloning, TA cloning. Shuttle Vectors -Pcambia, Vectors for Yeast (YEP, YIP, YRP, YCP, YAC) Artificial Chromosomes- BAC, MAC, PAC	4	2
	1.5	Viral and virus derived vectors for animal cells- SV40, Adenovirus vectors, Baculovirus. Plant vectors – geminivirus, Ti plasmid	3	2
2 Gene Transfer Techniques, Screening and Advanced technology in Rdna (17 Hours)	2.1	Gene Transfer Methods: CaCl2 mediated, Microinjection, Electroporation, Lipofection, Particle Bombardment, Gene Gun, Agrobacterium mediated	5	2
	2.2	Genetic markers in plants – Kanamycin, neomycin, Hygromycin B, Bromoxynil, Methotrexate, chloramphenicol. Genetic markers in animals-Neomycin/Geneticin Resistance, Hygromycin, Puromycin Resistance, GFP. Screening methods: Blue white assay, Insertional inactivation, colony hybridization.	3	3
	2.3	Expression vectors- Elements for expression- Protein tags, Promoters- Introduction and elements for expression.	4	3

	2.4	Fusion tagged expression system, affinity tag. Protein selection methods – hybrid arrest and hybrid release translations, immunochemical methods. Nuclear transfer technology,	2	3
	2.5	Inducible expression system and control of transgene expression through naturally inducible promoters – lac and tet. Steroid hormones as heterologous Inducers.	3	3
3 Bio instrumentation and application in Rdna	3.1	PCR types and applications. DNA foot printing, fingerprinting, gel shift analysis, DNA microarray,	3	4
	3.2	Advanced molecular markers: RFLP, RAPD, AFLP, STS, SNP, SSR, EST. chromosome walking, jumping.	4	4
	3.3	Next generation sequencing (NGS) – Illumina sequencing ABI/SOLID, Ion Torrent (Thermo Fisher), 454 Sequencing (Roche) Site directed Mutagenesis.	4	4
	3.4	Applications of recombinant DNA technology- Production and purification of recombinant proteins- insulin and somatostatin. Gene therapy. Metabolite engineering. Imparting new agronomic traits to plants to improve quality and quantity.	4	5
4 Practicals	4.1	Isolation of Genomic DNA	5	2
	4.2	Isolation of plasmid DNA	5	2
	4.3	Restriction digestion of DNA	5	2
	4.4	Bacterial Transformation	5	2
	4.5	Polymerase Chain Reaction	5	2
	4.6	RAPD/RFLP/SNP	5	2
5		**Teacher Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 5 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

Reference:

1. Brown, T. A. (2007). *Genomes 3*. Garland Science.
2. Brown, T. A. (2016). *Gene cloning and DNA analysis: An Introduction*. John Wiley & Sons.
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6. Purohit, S. S., & Mathur, S. (2002). *Biotechnology: Fundamentals and Applications*.
7. Watson, J. D., Myers, R. M., Myers, U. R. M., Caudy, A. A., & Witkowski, J. A. (2007). *Recombinant DNA: Genes and genomes: A Short Course*. Macmillan.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Mushroom production and value addition**					
Type of Course	**SEC**					
Course Code	**MG5SECBBT300**					
Course Level	**300**					
Course Summary	The present course encompasses various aspects of mushrooms focusing on its importance as a valuable food supplement. The course also deals with various aspects of mushroom cultivation including the process, requirements and post-harvest steps. The value addition and marketing strategies connected to this field is also included.					
Semester	V	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	-	-	45
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	State the importance of Mushrooms and distinguish between edible and poisonous mushrooms	U	PO1, PO10
2	Appreciate the nutritive value and health benefits of mushrooms and implement edible mushroom cultivation techniques	A	PO1, PO3, PO7, PO9, PO10
3	Outline the possibilities of value addition in mushrooms	An	PO1, PO2, PO7, PO9, PO10
4	Develop entrepreneurship skills through product design	S	PO1, PO2, PO3, PO5 PO7, PO9, PO10
5	Generate marketing strategies for value-added products of mushrooms	C	PO1, PO2, PO3, PO4, PO5 PO7, PO9, PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Mushrooms and Nutritional Value (10 hours)**			
	1.1	General characters and morphology of mushrooms. Distinguishing characters of button, oyster and milky mushrooms.	3	1
	1.2	Identification of mushrooms - edible and poisonous. Scope and significance of mushroom cultivation	3	1

	1.3	Nutritional profile of mushrooms- Carbohydrates, proteins, amino acids, vitamins, minerals, fats and fibre.	2	2
	1.4	Health benefits of Mushrooms-anti-tumour, antiviral and antibacterial effect, in therapeutic diet(brief study)	2	2
	Mushroom Cultivation and Pest Management (23 hours)			
2	2.1	Mushroom cultivation: Requirements, structure and construction of mushroom house, sanitation and sterilization	3	2, 4
	2.2	Spawn preparation- requirements, spawn substrate selection, isolation of pure culture and nutrient media for pure culture, maintenance and storage of spawn. **Learning activity**: Hands-on training on mushroom bed preparation/spawn preparation	5	2, 4
	2.3	Cultivation of Milky Mushroom (*Calocybe indica*), and Oyster Mushroom (*Pleurotus* sps.) using paddy straw. **Learning activity**: Training in Oyster mushroom cultivation	5	2,4
	2.4	Pest and disease management in mushroom cultivation (brief account), Spent mushroom substrate utilization-fodder, compost. Learning activity: Visit to a mushroom cultivation unit	10	1, 2
3	**Value Addition in Mushrooms (12 hours)**			
	3.1	Post-harvest processing of mushrooms- refrigeration / instant packing, freeze drying, dehydration, canning	3	3, 4
	3.2	Value-added products from mushrooms – soup powder, biscuits, chutney powder, pickles. **Learning activity:** Preparation of value-added products from mushrooms	5	3, 4, 5

	3.3	Marketing strategies for mushroom products	2	4, 5
	3.4	Major problems in mushroom cultivation and solutions. self-employment schemes, Government aids	2	4, 5
4	**Teacher-specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field trips and mushroom production visit, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lectures, group discussions, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 25 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12) : 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10

References

1. Kaul, T. N.(2002). *Biology and Conservation of Mushroom*, Oxford and IBH Publishing Co.
2. Aneja, K.R. *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology*. New Age International (P) Limited Publishers, Bangalore
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13. https://dmrsolan.icar.gov.in/
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Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Scientific Communication in Research**					
Type of Course	**SEC**					
Course Code	**MG5SECBBT301**					
Course Level	**300-399**					
Course Summary	The Scientific Communication in Research Course provides an introduction to various aspects of communicating scientific works. It deals with the structure, indexing , evaluation- selection , citation as well as ethical considerations both theoretically and practically.					
Semester	**5**	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Need to complete 200 level courses.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Recall fundamental principles in professional scientific communication, including hypothesis components and the distinction between inductive and deductive reasoning.	K	1,2,4
2.	Understand the significance of creativity in scientific research and explore diverse sources and methods for generating research ideas.	U	1,2,3
3.	Apply skills in hypothesis formulation, reasoning, and testing to construct and assess research hypotheses	A	2,3
4.	Analyze the structure of scientific reports, recognizing the significance of each section and understanding the rationale behind visual elements.	An	1,2,3
5.	Synthesize knowledge to prepare a synopsis, comprehend various forms of scientific writing, and apply ethical considerations in biomedical research.	E	1,2,3

	Additionally, evaluate the peer review process and demonstrate ethical decision-making through practical exercises and real-world case studies		
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction, Structure and Processes of Scientific report	1.1	Introduction to Professional Scientific Communication.	2	1
	1.2	Discussion of creativity, research ideas and where to find them.	2	1
	1.3	Inductive reasoning versus deductive reasoning.	2	1
	1.4	Hypothesis, reasoning and testing-specify the hypothesis.	2	1
	1.5	Structure of a scientific report, Synopsis preparation.	3	2
	1.6	Structure of a Research article: Title, abstract, methods, results, and discussion, Schematic diagrams, figures, tables and flow charts -rationale and usage	4	2
	1.7	Peer review process, Different forms of writing: scientific report, proposal, and reviews.	4	5
	1.8	Presentations-thumb rules and good practice. Ethics in research	3	5
2 Overview of Major Indexing Databases	2.1	Understand the Importance of Scientific Publication Indexing: Explore the role of indexing databases in scholarly communication.	2	3
	2.2	Recognize the impact of indexing on visibility, credibility, and dissemination of research.	2	3
	2.3	Introduction to Major Indexing Databases: Overview of prominent scientific publication indexing databases (e.g., PubMed, Scopus, Web of Science, UGC care list, etc).	3	3
	2.4	Evaluating and Selecting Journals: Understand the criteria for selecting reputable journals for publication. Explore the	3	4

		use of journal metrics and impact factors.		
	2.5	Citation Analysis and Metrics: Introduction to citation analysis as a measure of research impact. Interpretation of citation metrics and their significance.	3	4
	2.6	Open Access Databases and Repositories: Explore open access indexing databases and repositories. Understand the benefits and challenges of open access publishing.	3	5
3 Ethical Considerations in Publications	3.1	Ethical Considerations in Publication: Discuss ethical issues related to scientific publishing. Understand plagiarism, authorship, and publication ethics.	2	5
	3.2	Practical Exercises and Case Studies: Hands-on sessions to navigate and search in popular indexing databases. Analyze real-world case studies related to publication and database usage.	5	5
4		Teacher specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	B. End Semester examination – 1.5 hrs. Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References:

1. C.R. Kothari , Gaurav Garg (2019) Research Methodology, New Age International (P) Ltd. ISBN-10 : 9386649225 ISBN-13 : 978-9386649225
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11. Council of Science Editors. (2014). Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers. Council of Science Editors.

SEMESTER VI

Mahatma Gandhi University
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<table>
<tr><td>Programme</td><td colspan="5">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="5">Plant physiology and biochemistry</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="5">MG6DSCBBT300</td></tr>
<tr><td>Course Level</td><td colspan="5">300</td></tr>
<tr><td>Course Summary</td><td colspan="5">The course aims at introducing the physiology of plant systems and indulges the student in finding out various processes that function within the plant body. The course also deals with various biomolecules.</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Concept of a plant cell and cell components, Basic chemistry of compounds</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Enlist various biomolecules in the living system.	K	PO1
2	Summarize the physiology of different plant life processes.	U	PO1
3	Categorize the factors affecting physiological processes	An	PO1
4	Investigate the presence of biomolecules in a given system	E	PO2
5	Investigate the role of biotic and abiotic components in plant stress	E	PO2
6	Design experiments in plant physiology	C	PO1
7	Appraise intricacies of protein structure and diversity	Ap	PO1 PO2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1		**Plant water relations (7 Hours)**		
	1.1	Plant water relations :Diffusion, imbibition, osmosis; Absorption of water - active and passive, apoplastic and symplastic pathways.	2	2
	1.2	Ascent of sap: Cohesion-tension theory, embolism; Transpiration- types, mechanism and significance; anti-transpirants. Guttation.	2	2,3
	1.3	Major and minor elements in plant nutrition, mineral uptake - passive (ion exchange) and active (carrier concept).	3	2
2		**Photosynthesis and respiration (30 Hours)**		
	2.1	Photosynthesis:Pigments, Photosystems; Light Reactions - cyclic and non-cyclic photophosphorylation. Dark reactions - C3, C2, C4 pathway, CAM. Factors affecting photosynthesis.	8	2,3
	2.2	Translocation of solutes: Phloem loading and unloading, polymer trapping (brief account); Mechanism - mass flow hypothesis.	2	2
	2.3	Respiration:Anaerobic and Aerobic; Glycolysis, Kreb's cycle, Mitochondrial Electron Transport system, ATP synthesis - chemi-osmotic hypothesis, Factors affecting respiration.	8	2,4
	2.4	Carbohydrates: Classification: mono (glucose and fructose), di (sucrose) and polysaccharides (starch); general structure (Haworth Projection) and functions. Lipids:General features, roles and types of lipids (Simple and Compound, structural and storage lipids). Proteins:General account of proteins - amino acid, peptide bond. Structural levels of proteins - primary, secondary, tertiary, and quaternary; General functions of proteins Enzymes:classification and nomenclature, mechanism of action (Lock and Key Hypothesis, Induced fit theory). Enzyme inhibition and Factors affecting enzyme action.	12	1, 7

3	**Plant hormones and stress physiology (8 Hours)**			
	3.1	Plant hormones : Physiological effect and practical applications - Auxins, Gibberellins, Cytokinins, ABA, and Ethylene.	2	2
	3.2	Stress Physiology: Abiotic (water and salt), Biotic (pathogens) stress, Role of phenolics and compatible solutes.	4	2,5,6
	3.3	Physiology of flowering : Phytochromes, Photoperiodism, Vernalization	2	2
4	**Practical (30 Hours)**			
	4.1	**Plant Physiology (20 Hours)** Core Experiments (any 3): ● Separation of plant pigments by TLC/Paper/ Column chromatography. ● Estimation of plant pigments by colorimetry. ● Estimation of Proline in plant tissue under abiotic stress. ● Estimation of Phenol in plant tissues under biotic stress. ● Calculation of stomatal index in mesophytes and xerophytes ● Estimation of rate of photosynthesis Demonstration experiments: (ANY 4) ● Demonstration of plasmolysis. ● Demonstration of tissue tension. ● Demonstration of osmosis using osmoscope. ● Demonstration of Oxygen evolution during Photosynthesis. ● Measurement of transpiration rate using Ganong's potometer/Farmer's potometer ● Measurement of leaf conductance using leaf porometer.	20	4,5,6,7
	4.2	**Biochemistry (10 Hours)** ● General test for carbohydrates – Molisch's test, Benedict's tests / Fehling's test. ● Colour test for starch - iodine test. ● Colour tests for proteins in solution – Million's test ● Quantitative estimation of protein using a colorimeter.	10	5,7

	4.3	**Activity** (Any one) ● Design and perform an experiment related to plant physiology. Prepare and submit a report with geotagged photos. ● Prepare and submit a report with your views and conclusions on the latest research in physiology / biochemistry based on journal publications on any topic mentioned in the syllabus (A copy of the original publication has to be submitted with the report. ● Design models representing physiological or biochemical processes taking place in plants and submit them for evaluation. ● Prepare a review article in a selected research area in Physiology and biochemistry and submit for evaluation. ● Retrieve 5 research articles on any selected topic in Physiology/ biochemistry and submit them for evaluation.		
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.

Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. **End Semester Evaluation (ESE)** **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

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Mahatma Gandhi University Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Genetics and evolutionary biology**
Type of Course	**DSE A**
Course Code	**MG6DSEBBT300**
Course Level	**300**
Course Summary	This course provides a comprehensive exploration of the fundamental principles underlying genetics and evolutionary biology. Students will delve into the molecular basis of inheritance, the mechanisms of evolution, and the interconnectedness of these fields. Through theoretical discussions, practical applications, and case studies, participants will gain a deep understanding of how genetic processes drive evolutionary change.

Semester	VI	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60

Pre-requisites, if any	History of genetics and contributions of Gregor Johann Mendel. Concept of gene and chromosome.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the basic principles of classical genetics and genetic interactions	U	PO1, PO4, PO6, PO7, PO10
2	Discuss the non-mendelian patterns seen in nature	U	PO1, PO2
3	Estimate the linkage based genetic mapping in eukaryotes	E	PO1, PO2,
4	Explain the types of sex determination mechanisms in higher organisms	U	PO1, PO2, PO7, PO10
5	Summarize the basics ofpopulation genetics	U	PO1, PO2, PO7, PO10
6	Transfer the concept of evolution in social inclusivity	A	PO1, PO2, PO6, PO7, PO10

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

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
	Introduction to Genetics, Gene Interactions and Non-mendelian Inheritance (30 hours)			
	1.1	a) Terms & Concepts – chromosome, gene, allele- dominant and recessive, locus, genotype & phenotype, chromosome theory of inheritance, cross-monohybrid & dihybrid, testcross, backcross b) Principles of Mendelian Inheritance- Dominance, Segregation, and Independent Assortment. c) Model genetic organisms- *Neurospora crassa*, *Saccharomyces cerevisisae*, *Arabidopsis thaliana*, *Zeamays* (mention only their importance in genetic study)	8	1
1	1.2	Modifications of Mendelian ratios a) Incomplete dominance: Example - flower colour in *Mirabilis jalapa.* b) Co-dominance: Example - MN blood type in humans. c) Lethal genes: Example - pigmentation in Snapdragon. d) Epistasis: - Dominant epistasis: Example - fruit colour in summer squashes; Recessive epistasis – coat colour in mice e) Complementary gene interaction: Example - flower colour in *Lathyrus odoratus*. f) Multiple alleles: definition, example –Blood grouping in human ABO, Self-sterility in *Nicotiana tabaccum*.	10	1

	1.3	a) Linkage – chromosome theory of linkage; complete and incomplete linkage. b) Crossing Over –mechanism of crossing over; types of crossing over – single, double and multiple; recombinant & non-recombinant gametes c) Linkage mapping: -two-point testcross & calculation of distance between genes; recombination frequency & map units; interference & co-incidence *d)* Extra chromosomal inheritance- cytoplasmic inheritance- Example: - leaf variegation in *Mirabilis jalapa* e) Quantitative inheritance: - polygenic; continuous traits. Example: ear size in maize; Quantitative trait Loci **Learning activity:** ● Workout Problems related to monohybrid cross, dihybrid cross, modified Mendelian ratios. ● Calculation of distance between genes by using two-point test crosses and linkage map construction.	12	1,2, 3
2	**Sex Determination (10 hours)**			
	2.1	a) Chromosomal mechanism of sex-determination: XX-XY, XX-XO, ZZ-ZW, Haplo-Diplo system,genic balance system. b) Environmental Sex Determination: Sex determination in slipper limpet and reptiles c) X-linked inheritance - Haemophilia in man; Y-linked inheritance – SRY gene d) Sex-limited Inheritance – Example-feathering pattern in Fowl; Sex-influenced Inheritance - Example – Baldness in humans e) Mechanisms of sex determination in plants-*Melandrium* (emphasis on Epigenetic inheritance)	10	4
3	**Population genetics (10 hours)**			

	3.1	Concept of Population, Allelic frequency, genotypic frequency; Hardy- Weinberg Equilibrium and the factors affecting the equilibrium. **<u>Learning activity:</u>** Problems based on Hardy- Weinberg equation	10	5
4	**Evolution (10 hours)**			
	4.1	a.) Origin of life- biochemical origin of life (Miller's Experiment). Theories of evolution -Darwin's theory and modern synthetic theory. Evidences for evolution- (brief study) b.) Character evolution; Microevolution and macroevolution; Convergent, divergent, and parallel- evolution- (definition with examples) c.) Biological Species concept; speciation - genetic divergences and isolating mechanisms- geographical isolation & reproductive isolation (prezygotic and postzygotic- isolation mechanisms)- (brief study) d.) Patterns of speciation- allopatric, sympatric, quantum and parapatric speciation- (brief study)	10	6
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 30 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks ● Very Short Answer (10 out of 12) : 2 x 10=20 Marks ● Short Answer (8 out of 10) : 8 x 5= 40 Marks ● Essay (1 out of 2): 1x 10= 10marks

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Research methodology and biometrics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG6DSEBBT301</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course discusses various aspects of research – like how to find a research problem, the major sources of literature for research, the major steps in research, methods of report writing, use of ICT and statistics in research.</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No.
1	Discuss the basic concepts of research.	U	PO 1 PO 2 PO 3
2	Identify and compile the various sources of literature for research.	U	PO 3 PO 9
3	Outline a research problem in Biology and design a project based on it.	An	PO 1 PO 2 PO 3
4	Write a research report in an accepted format.	A	PO 4
5	Familiarize various available operating systems.	A	PO 3
6	Operate various tools in MS office/Libre Office to generate and present research reports.	A	PO 3

7	Evaluate the data using various statistical tools and interpret the results.	E	PO 1 PO 2 PO 3 PO4
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Major Steps in research (15 hours)**			
	1.1	Objectives of research. Types of research - pure and applied. Identification of research problem, formulation of hypothesis – Null hypothesis and alternate hypothesis.	2	1
	1.2	Major steps, purpose, literature sources, names of reputed National and International journals in life science (Minimum 2 international & 3 national); reprint acquisition – INFLIBNET, PubMed, NCBI.	5	2
	1.3	Definition of the problem; Identification of the objective(s); literature review (brief account only), introducing working hypothesis, design of the study – basic principles and significance; sampling for data – methods, Identification and collection of data, types of data – Primary and Secondary; Collection of primary data – observation method, interview method, questionnaire method, through schedules; analysis and interpretation of data, Report writing (Brief account).	5	3
	1.4	Preparation of dissertation - IMRAD system - Preliminary pages – Title pages – Certificate, Declaration, Acknowledgement, Table of contents, Abstract; Main text - Introduction and review of literature, Materials and methods, Results, Discussion, Conclusion; End matter – Bibliography and Appendix.	3	4
2	**Use of ICT in Research (10 hours)**			
	2.1	Basic components of a computer – concept of Hardware and Software, Major Operating Systems: Proprietary: Windows, Macintosh and Open source: Linux. Application suit – M.S Office (Brief introduction).	1	5

	2.2	MS WORD - Word Processing - creating a new document, saving a document, exporting to pdf, opening an existing document, basic text editing; Editing tools – cut, copy, paste, find, and replace, undo and redo; Formatting tools – font formatting, paragraph formatting, bullets and numbering, styles, page formatting.	2	6
	2.3	MS EXCEL - creating worksheet, data entry, sorting data. Statistical tools (SUM, AVERAGE, MEDIAN and MODE.SNGL). Preparation of graphs and diagrams (Bar diagram, Pie chart, Line chart, Histogram).	2	6
	2.4	MS-POWERPOINT: Steps of preparation of presentation based on a topic from biology, which includes Tables, Charts, and Images. Ideal characteristics of a presentation slide set for scientific purposes using a model template.	2	6
	2.5	LibreOffice – Writer, Calc, Impress; Open Office (brief study).	1	6
	2.6	Search engines: Google.com; meta-search engine – Metacrawler; academic search - Google scholar. Educational sites related to biological science – Scitable, DNAi.	2	2
3	**Biometrics (20 hours)**			
	3.1	Statistical terms, and symbols (Brief study only). Sampling: concept of sample, sampling methods - random and non-random sampling.	3	7
	3.2	Diagrammatic and graphic representation - line diagram, bar diagram, pie diagram, histogram, frequency curve.	2	7
	3.3	Measures of central tendency: mean, median, mode, (discrete and continuous series). Measures of dispersion: standard deviation. Probability and distribution patterns: normal distribution, binomial distribution. Tests of significance (Z – test, t–test and Chi-square test).	15	7
4	**Practicals (30 hrs)**			

		1.Preparation of a list of references (not less than 10) on a given topic of biological science Preparation of Review on a given topic using online and print resources **2.**Collect information on a topic related to biological science using the internet and make a report based on the collected information (Using M.S WORD / Libre Office Writer) **3.** Collect a compound leaf with at least 25 leaflets of varying sizes from a plant, measure the length of each leaflet, and conduct the following works using M.S Excel/ Libre Office Calc and record: (a) Prepare data table/frequency table in M.S Excel / Libre Office Calc (b) Prepare bar diagram (c) Prepare Line chart (d) Prepare a Pie chart (e) Prepare Histogram **4.** Collect data on a particular topic using online or print questionnaires and perform the following activities in M.S Excel / LibreOffice Calc and record. (a) Calculate the average of variables (b) Calculate the median of variables (c)Calculate the mode (mode.sngl) of variables. **5.** Prepare a worksheet using a set of data collected and find out the SUM. **6.**Preparation of PowerPoint presentation using M.S PowerPoint / LibreOffice – Impress, based on a given topic. **7.**Problems related to a. Measures of central tendency b. Measures of dispersion c. Probability d. Test of significance (Z – test, t – test, Chi-square test)		
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. **End Semester Evaluation (ESE)** **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks Record: 5 marks

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Plant ecology, conservation and sustainable development**					
Type of Course	**DSE A**					
Course Code	**MG6DSEBBT302**					
Course Level	**300**					
Course Summary	This course introduces ecology as a scientific discipline. By the end of the course, students should be familiar with ecological principles related to how plant populations & communities interact with their environments at local, regional, & global scales.					
Semester	VI	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Explain the basic concepts of plant ecology	U	PO1, PO4
2.	Describe the adaptations of different plants	U	PO1, PO4
3.	Outline the structure and functions of community	An	PO1, PO2
4.	Illustrate conservation strategies	A	PO1, PO2, PO10
5.	Critically assess the sustainable uses of resources	E	PO1, PO2, PO4, PO6, PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Plant Ecology (12 hours)**			
	1.1	Definition and scope of plant ecology, branches of ecology, ecological hierarchy-individual, population, community, ecosystem.	4	1
	1.2	Types of ecosystems- Terrestrial (Grassland, desert and forest), Aquatic (freshwater and marine).	4	1
	1.3	Adaptations of plants- hydrophytes, xerophytes, epiphytes, halophytes with special reference to Mangroves (Morphological, anatomical and physiological).	4	1
2	**Autecology & Synecology (15 hours)**			
	2.1	Study of plant populations, population characteristics-size, density, dispersion, natality, mortality, survivorship curve, immigration and emigration, population growth, Environmental resistance, biotic potential, carrying capacity.	6	2
	2.2	Community structure and organization- Key concepts: species interactions, species richness, species diversity, habitat, niche,	5	2

		ecological indicators, ecotone and edge effect, Foundation species, keystone species, Umbrella species.		
	2.3	Ecological Succession: types, processes and impacts of Hydrosere& Xerosere.	4	2
3	**Conservation Ecology and Sustainable Development (18 hours)**			
	3.1	Definitions: Genetic, Species and Ecosystem/Community diversity (Alpha, beta and gamma diversity), biosphere, hotspots, megadiversity. Threats to biodiversity: habitat loss and fragmentation- landslides, landslip, cloud burst, dam issues, Quarry issues, Ecologically Fragile Lands (EFL), man-wildlife conflicts, climate change.	5	3
	3.2	Organizations, movements and contributors of environmental studies and conservation: organizations - WWF, Chipko; contributors - Salim Ali, Sunder Lal Bahuguna, Madhav Gadgil, Tulsi Gowda, Lakshmikutty Amma.	2	3
	3.3	Conservation strategies- Definition and goals. *In-situ* and *ex-situ* conservation. IUCN, red data book, RET plant species. Technological Approach to Assessment and Conservation- Environmental Impact Assessment (EIA) brief account only. Application of Remote Sensing and GIS (brief account only) Conservation strategies and efforts in India, wetland conservation-Ramsar sites in Kerala.	5	3
	3.4	Sustainable development-definition, principles. The three pillars of sustainability. Global Responses to Sustainable Development (Paris Convention-goals of Sustainable development). Indicators of sustainable development, a brief introduction to green technology.	4	4
		Sustainable development-Kerala model, Rainwater harvesting and responsible tourism.	2	4

	Practical (30 hours)			
4	4.1	Conduct a two days field trip to any of the wild life sanctuaries, NPs, Ramsar sites and prepare a report categorizing major plant groups with geotagged photographs	10	1
	4.2	Ecological adaptations: Morphology and anatomy of hydrophytes, xerophytes, epiphytes, and mangroves	4	1
	4.3	Familiarize with different sampling methods (Quadrat/ Transect) Assessment of diversity, abundance, and frequency of plant species by quadrate method	10	2
	4.4	Estimation of CO2, Cl, and alkalinity of water samples (Titrimetry)	6	2
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.

Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty

	B. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks Record: 5 marks

References

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SUGGESTED READINGS

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Programme	BSc (Hons) Botany and Biotechnology (Double Major Programme)					
Course Name	Plant and Animal Biotechnology					
Type of Course	DSC B					
Course Code	MG6DSCBBT301					
Course Level	300-399					
Course Summary	The coursework covers plant tissue culture, including principles, techniques like micropropagation, and applications such as somatic hybridization. It also delves into animal cell culture, covering laboratory prerequisites, media types, and applications like stem cell utilization, providing students with a comprehensive understanding of tissue culture principles and applications.					
Semester	6	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Need to complete 200 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon completion of this course in Plant biotechnology, students should be able to:		
1	Recognize the historical evolution of plant biotechnology	K	1, 2, 4
2	Apply precise techniques for media preparation, sterilization, and propagation of plants through various plant tissue cultures techniques.	A	2, 3
3	Understand the principles and significance of germplasm conservation.	U	1, 2, 3,

4	Describe the historical development and milestones in animal cell culture, demonstrate knowledge of basic requirements for successful animal cell culture, including laboratory setup and equipment	K	1, 2, 4
5	Analyse the composition of culture media, Maintenance of established/continuous cell lines and apply advanced cell culture techniques	An	1, 2, 3
6	Apply animal cell culture techniques in stem cell and cancer research	A	2, 3
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to plant tissue culture	1.1	Historical development of plant Biotechnology	2	1
	1.2	Basic requirements and setting up of a plant tissue culture.	3	2
	1.3	Media preparation, Sterilization technique in plant tissue culture	3	3
	1.4	Totipotency, Stages of Micropropagation	2	3
	1.5	Regeneration of plantlets-organogenesis and somatic embryogenesis	3	4
2 Types of plant tissue culture, and Transgenic plants	2.1	Types of culture-Callus, Suspension and Single cell culture,	2	4
	2.2	Meristem culture. Haploid production- Ovary, Ovule, Anther and Pollen culture.	3	4
	2.3	Artificial seeds. Somaclonal variation	3	4
	2.4	Plant protoplast–isolation, culture and Somatic hybridization- Hybrids &Cybrids	4	6
	2.5	Maintenance and storage of plant cell, Applications of plant cell culture ,Transgenic Plants	5	6
3	3.1	History, Laboratory prerequisites for aseptic animal cell culture, Types of culture media: natural and synthetic, , Preparation and sterilization of media	5	6

Introduction to animal cell culture	3.2	Culture Types: Anchorage-dependent and anchorage-independent cells	2	6
	3.3	Transformed Animal Cells, Established/ Continuous cell lines, Common Cell lines and maintenance	2	6
	3.4	Basic Techniques of mammalian cell culture	3	6
	3.4	Stem cells and their applications	3	5
4 Practicals	4.1	Preparation of MS media for plant tissue culture.	5	1
	4.2	Surface sterilization of explants	5	3
	4.3	Callus culture, Meristem culture.	8	4
	4.4	Embryo rescue technique, Invitro germination of recalcitrant seeds (Orchid)	7	4
	4.5	Composition of animal tissue culture media, Preparation serum containing media, Preparation of serum free media. – Demo (Virtual lab) Submission of report.	5	5
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

Practical-35 marks **5 hrs.**	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Entrepreneurial botany**					
Type of Course	**SEC**					
Course Code	**MG6SECBBT300**					
Course Level	**300**					
Course Summary	The course aims to prepare the students for an entrepreneurial journey by giving an overview of entrepreneurship. The course discusses the process of developing and independent idea into ventures. Different areas of opportunity					
Semester	VI	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	-	-	45
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate knowledge of diverse botanical entrepreneurship and develop business acumen for botanical ventures	U, S	PO2, PO5, P07
2	Analyze and evaluate real world success stories of entrepreneurs from government initiatives and support schemes	A, S, E	PO2, PO5, PO7
3	Propose entrepreneurial ideas based on plant and plant-based product conducting preliminary research	C, A, S, Ap	PO1, PO2, PO5, PO8
4	Evaluate the success stories in entrepreneurship	C, A, S, E, Ap	PO2, PO5, PO6, PO7, PO8
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	Fundamentals of Botanical Entrepreneurship **(15 hours)**			
	1.1	Introduction to Entrepreneurship (5 hours) Types and Characterization of Botanical Entrepreneurship Explore various types: agribusiness, bio ventures, aesthetics Characterize ventures based on botanical products Analyze socio-economic factors driving entrepreneurial endeavors in botany	8	1, 4
	1.2	Entrepreneurship as Innovation, Risk Assessment, and Solutions; Examine the role of innovation in botanical entrepreneurship; Assess risks specific to botanical ventures and propose strategic solutions	7	2, 4

2	**Bio Ventures, Business Planning, and Government Initiatives (15 hours)**			
	2.1	Overview of Key Botanical Industries in Kerala Explore Spirulina, mushroom, drumstick, and coconut industries. Case studies on successful ventures - Jackfruit 360 and Vegro Biotech startups and support mechanisms (KDISC, Bio 360, BioNest) Aesthetics in Kerala Botanical Entrepreneurship Explore the market for ornamental plants and flowers in Kerala Identify opportunities and challenges in the aesthetics industry	8	1, 4
	2.2	Fruit and Vegetable-Based Products Production of juices, squashes, and other fruit-based products considering Kerala's agricultural landscape Bamboo and Cane-Based Products, Nutraceuticals, and Oils Herbal medicines and cosmetics Government Initiatives and Support Scheme - Kerala Startup Mission and Start Up India - MUDHRA Yojan and Stand Up India - SC/ST Hub Initiative	7	2, 4
3	Integrating Government Initiatives and entrepreneurial ventures (**15 Hrs**)			
	3.1	Navigating Government Support Practical guidance on how entrepreneurs can navigate and access the above-mentioned government schemes Develop a comprehensive business plan integrating one or more government schemes and do presentations.	5	
	3.2	Success Stories and Case Studies Analysing real world success stories of entrepreneurs who have benefited from the mentioned government initiatives: BIRAC schemes, YIP, Atal innovation missions Extracting key lessons and best practices. Each student presents an analysis of a chosen success story related to government support schemes.	5	

	3.3	. Entrepreneurial Impact Assessment : Evaluating the impact of government schemes on entrepreneurial ventures Discussing challenges faced and proposing solutions for improvement. Make an audio-visual document of an interview with an entrepreneur.	5	
4		**Teacher specific course components**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, Group discussions, Problem-based learning, Flipped classroom, Discussion-based Learning, Case-based Learning, Experiential Learning, Inquiry-Based Learning, Game-Based Learning, Socratic Method, Peer Teaching, Simulations, Online Learning, Blended Learning, and other innovative approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 25 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12) : 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10

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SUGGESTED READINGS

1. Kerala startup mission handbook 2021

Mahatma Gandhi University

Kottayam

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Environmental science and human rights</td></tr>
<tr><td>Type of Course</td><td colspan="6">VAC</td></tr>
<tr><td>Course Code</td><td colspan="6">MG6VACBBT300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course provides an in-depth exploration of key topics in environmental sciences and an understanding of various forms of pollution, their sources, impacts on human health and the environment, and mitigation strategies. It will cover principles and practices of conservation biology, including the importance of biodiversity, ecosystem services, and the impacts of habitat destruction, invasive species, and climate change. Students will learn about conservation strategies and will examine environmental policies and laws. The course will explore the intersection of environmental sciences and human rights, including the right to a healthy environment, environmental justice, and the disproportionate impacts of environmental degradation. By fostering critical thinking and interdisciplinary approaches, students will be empowered to advocate for environmental justice and contribute to a more sustainable and equitable world.</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">No pre-requisites for this course.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Distinguish the multidisciplinary nature of environmental science.	E	PO3
2	Evaluate the principles of ecology, ecosystem structure and function, and the importance of biodiversity.	An	PO1, PO2
3	Evaluate sustainable practices for the utilization of natural resources	An	PO6, PO7, PO8, PO10
4	Prioritize the control measures for air, water, and soil pollution by examining the environmental laws in India	An	PO6, PO7
5	Collaborate strategies and solutions aimed at biodiversity conservation froma global perspective.	C	PO3, PO7
6	Develop the relevance of human rights in real-world scenarios to make responsible citizens.	A	PO6, PO7, PO8, PO10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Environmental Science & Environmental Pollution (15 hours)**			
	1.1	Introduction to Environmental Science: a) Definition, scope & significance, multidisciplinary nature of environmental studies b) Principles of ecology, ecosystem structure and function, biodiversity and its importance	3	1, 2
	1.2	Natural Resources: a) Concept of resource b) Classification of natural resources (renewable and non–renewable)	4	3

		c) Sustainable practices for resource utilization		
	1.3	Overview of Environmental Pollution: Definition and types of pollution. Overview of air, water, soil, noise, and light pollution.	1	4
		Air pollution: Air pollutants, types, sources, effect of air pollution on plants and humans, control measures	2	4
	1.4	Water pollution: Common pollutants, sources, impact, control measures; water quality standards - DO and BOD; eutrophication.	2	4
	1.5	Soil Pollution: Causes, sources, solid waste, biodegradable, non-biodegradable, management of solid waste, composting, e–waste, waste management and recycling.	3	4
2	**Climate Change and Environmental Legislation and Laws (15 hours)**			
	2.1	Environmental issues: a) Global warming, greenhouse effect, causes and consequences of climate change, ozone layer depletion. b) Carbon sequestration. c) Carbon foot prints-Indian carbon footprint	3	5
	2.2	Global Conservation: a) Definition, importance, overview of threats to biodiversity b) International Conservation Organizations: Role of NGOs in Conservation (eg. WWF, Conservation International), United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN)-categories **c)** Overview of Key International Treaties (e.g., Kyoto Protocol, Paris Agreement)	7	5
	2.3	a) Environment (Protection) Act 1986 and Environment (Protection) Amendment Rules, (2023) b) Wildlife (Protection) Act, 1972, amended in 2022, c) Forest (Conservation) Act, 1980, Forest (Conservation) Amendment Bill 2023 Biological Diversity (Amendment) Act, 2023 [brief account only].	5	5

		d) Corporate Environmental Responsibility [brief account only]		
3	**Human Rights (15 hours)**			
	3.1	An Introduction to Human Rights, history of Human Rights, Generations of Human Rights, Universality of Human Rights, Basic International Human Rights Documents - UDHR, ICCPR, ICESCR. -Value dimensions of Human Rights.	5	6
	3.2	Human Rights and United Nations: Human Rights coordination within the UN system, Role of UN secretariat, Economic and Social Council, Commission of Human Rights, Security Council and Human Rights, Committee on the Elimination of Racial Discrimination, Committee on the Elimination of Discrimination Against Women, Committee on Economic, Social and Cultural Rights, The Human Rights Committee, Critical Appraisal of UN Human Rights Regime.	5	6
	3.3	Human Rights National Perspective: Human Rights in Indian Constitution, Fundamental Rights, Directive Principles of State Policy and Human Rights- Human Rights of Women-Children -Minorities-Prisoners, Science Technology and Human Rights- National Human Rights Commission- State Human Rights Commission- Human rights awareness in education.	5	6
4	**Teacher-Specific Course Components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● **Lectures** ● **Invited talks:**Invite guest speakers from environmental organizations, human rights NGOs, and academia to share practical insights and experiences. ● **Seminars** ● **Debate:** Facilitate discussions and debates on ethical dilemmas related to environmental science and human rights. ● **Technology Integration:** Utilize technology for virtual field trips, data analysis, and collaboration on global environmental and human rights issues. ● **Case Study:**Learner has to present a case study of environmental issues.

<table>
<tr><td></td><td>

The learner has to identify the issue
Distinguish the cause(s)
Investigate the effects
Evaluate the responses
Educe/Propose solutions to mitigate the issue

Project-Based Learning, Experiential Learning, Peer Teaching, group discussions, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches
</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>
MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory/Hands on Work- 25 Marks

Involvement and responses in class room transactions
Home Assignments
Oral presentation/ Viva/Quiz/Open book test
Field study, Group discussion on a recent research or review article(<5 years) related to the course
Any other method as may be required for specific course / student by the course faculty

</td></tr>
<tr><td>
B. End Semester Evaluation (ESE)

Theory: 50 marks
Short answer (10 out of 12) : 10 x 1=10
Short Essay (6 out of 8) : 6 x 5= 30
Essay (1 out of 2) : 1x 10= 10
</td></tr>
</table>

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2. Kumar U, M Asija, 2006. *Biodiversity: Principles and conservation*. Agrobios India.
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Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Biotechnology for Nourishing Health**					
Type of Course	**VAC**					
Course Code	**MG6VACBBT301**					
Course Level	**200**					
Course Summary	This course equips learners with a holistic understanding of biotechnology's evolution, its role in food production and medicine, and its contributions to human welfare while navigating ethical considerations in this rapidly advancing field.					
Semester	3	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Curiosity to know the applications of Biotechnology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To identify and define the scope and concepts of Biotechnology.	K	3,10
2	To understand the Basic Concepts and tools in Biotechnology.	U	3,10
3	To explain the principle of BT crops and GM foods and analyse the benefits of Biofortification in foods.	An	1,2,6
4	To understand the importance of Probiotics in gut health.	U	2,3,10

5	To apply the knowledge gained about the GM products and probiotics in improving health	A	1,2,10
6	To compare GM foods from Normal Foods based on its properties.	An	1,3,10
7	To compare the GM foods with normal foods and it's health benefits.	E	4,6,10
8	To understand the importance Environmental Biotechnology and define the role of Biofuels in sustainable development.	U	2,10
9	Understand and Apply Ethical and Legal aspects of Biotechnology.	A	1,2,6,
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 **Overview of Biotechnology**	1.1	Biotechnology: History and milestones	3	1
	1.2	Scope of Biotechnology	3	1,2
	1.3	Tools in Biotechnology: Overview	4	5
2 **Biotechnology and Food**	2.1	Basics of rDNA technology	4	1,2
	2.2	GM Crops: Merits and Demerits.	3	3,7
	2.3	Biofortification of foods and it's Benefits. Fermented foods Probiotics and Gut Health,	6	3
3 **Applications of**	3.1	Importance of Biotechnology in Medicine:	3	1
	3.2	Production of Medicine by Biotechnology An overview. Gene Therapy, Stem cell Technology.	4	2
	3.3	Introduction to Gene Editing, Personalized Medicine. Molecular Diagnostics.	6	2

Biotechnology	3.4	Environmental Biotechnology for healthy planet. Biofuel and its advantages.	5	8
	3.5	Biotech Trends in Health & Medicine: Synthetic Biology & 3D printing.	2	6
	3.6	Ethical & Legal aspects of Biotechnology	2	9
4		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	B. End Semester examination – 1.5 hrs. Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References

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2. Dr. U. Satyanarayana & Dr. U. Chakrapani Biotechnology First Published: 2005 Reprints: 15: ISBN: 81-87134-90-9 –.

3. Sandy B. Primrose and 1 more Principles of Gene Manipulation and Genomics 7th Edition7th Edition ISBN-13: 978-1405135443.
4. Reinhard Renneberg, Viola Berkling Vanya Loroch Biotechnology for Beginners, Second Edition, ISBN: 978-0-12-801224-6 Academic Press.
5. Industrial Biotechnology: Products and Processes Editor(s):Christoph Wittmann, James C. Liao First published:25 November 2016 Print ISBN:9783527341818

Suggested Readings

1. Fundamentals of Food Biotechnology Author(s):Byong H. Lee First published:12 December 2014 Print ISBN:9781118384954
2. S. C. Bhatia Food Biotechnology 1st Edition: WPI Publishing eBook ISBN9781315156491.

SEMESTER VII

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Research methodology and biostatistics**					
Type of Course	**DCC A**					
Course Code	**MG7DCCBBT400**					
Course Level	**400**					
Course Summary	This course equips the students to conduct research in the field of their interest. Course discuss various aspects of research like - identification of research problems, formulation of hypothesis, collection of literature, analysis and interpretation of data, hypothesis testing, preparation of research reports, project proposal, and use of statistics in research. The course also discusses various ethical concerns related to research.					
Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No.
1	Discuss the basics of research	U	PO 1 PO 2 PO 3
2	Conduct comprehensive literature reviews by utilizing physical and digital databases.	A	PO 1 PO 3 PO 9
3	Identify, explain, compare, and compose the fundamental components of a research proposal/report or presentation.	U	PO 4 PO 6
4	Capable of referencing literature using MLA, APA, Chicago, and Harvard citation styles and publishing an article in a journal.	A	PO 3, PO4, PO6, PO 10

5	Practice the preparation of proposals for research funding	A	PO 4 PO 6
6	Choose different ethical concerns within research for an ideal experimental design	A	PO 1 PO 2 PO 3 PO 8
7	Perform different quantitative data collection methods and processing methods in research using various statistical significance tests and statistical analysis methods.	A	PO 1 PO 2 PO 3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to research methodology and review of literature (10 hours)**			
	1.1	Need for research, objectives of research, types of research; Stages of research – generation of a research problem, review of literature, formulation of hypothesis, preparation of research design, execution of work, recording of observations, Analysis of data, interpretation and conclusions, preparation of report.	5	1
	1.2	Features of a Scientific Library, Journals (Current and Back-volumes), Books. Computerized catalogue; Journals: indexing journals, abstracting journals, research journals, review journals, e-journals. **<u>Learning Activity:</u>** Visit a scientific library or documentation centre and submit a report.	3	2
	1.3	Online and Open access Initiative – Google Scholar, NCBI, PubMed, Medline, INFLIBNET, N-list and Shodhganga, Acquisition of Reprints and filing.	2	2
2	**Academic communication (20 hours)**			
	2.1	Writing Dissertation/Thesis: General Format (IMRAD-System) and General principles in writing: Front matter - title page, certificate, acknowledgements, and contents page. Body of the Dissertation/Thesis: introduction, review of literature, material(s) and method(s), heading(s), result(s): table(s) and illustration(s), marginal indicator(s), caption(s), camera-ready	5	3

		copy; discussion, summary and conclusion; references, abstract(s) and appendix.		
	2.2	Reference styles – APA, MLA, Harvard, Chicago. Bibliography Management system: Mendeley, Zotero (Brief Account), Endnote. **Learning Activity:** Preparation of at least 20 references on a given topic in APA reference style using any reference management system (Mendeley/Zotero/Endnote).	5	4
	2.3	(i) Formats for preparation of Research paper and short communications – title, author name and affiliations, Abstract, Keywords, Introduction, methods, results, discussion, conclusion, acknowledgement, references. (ii) Preparation of review articles. (iii) Proofreading-standard abbreviations for proof correction. (iv) Presentation of Research findings in Seminars and Workshops. **Learning Activity:** Submit a review paper to the instructor based on a topic of choice.	6	3
	2.4	Selection of Appropriate Journal for publishing, Method for submitting research papers to journals (Elsevier/Springer). Peer review process, Responding to comments by reviewers. Authorship: Corresponding Author, Co-authorship. Indices for Assessment of Journals and Authors: Impact factor of journals; author citation and citation indices: h – index, i – index.	4	4
3	**Preparation of Research proposals for funding and Ethics in Research (10hours)**			
	3.1	Title, introduction, literature review and abstract; aim and scope; present status; location of experiments; materials and methods; justification; expected outcome; date of commencement; estimated date of completion; estimated cost; references; funding agencies. **Learning activity:** Prepare a project proposal to submit a funding agency.	6	5
	3.2	Introduction, important concepts and terms, Intellectual property rights, Patent, Trademark, Geographical indication, Copyright and related rights, royalty, Plagiarism and tools to detect plagiarism (Urkund).	4	6

4	**Statistics in research (20 hours)**			
	4.1	Principles - Replication, Randomization and Local Control. Common designs in biological experiments: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), and Factorial Design (FD).	5	6
	4.2	Data collection, Primary and Secondary data. Tools for data collection and presentation. Measures of central tendency and dispersion. Probability - Definition, mutually exclusive and independent events. Binomial and Normal distribution. Linear Regression and Correlation (*Simple and Multiple*).	5	7
	4.3	Statistical Inference-Estimation-Testing of Hypothesis: - t-Test, Chi-square Test (Goodness of fit, Independence or Association, Detection of Linkages), F-test, ANOVA. Statistical data analysis using any of the following Software – *SPSS* / *R* / Past. **Learning activity:** 1. Test the significance of a given data using the t-Test, Chi square -test. 2. Analysis of a set of data for Correlation / Regression (Scatter diagram). 3. Determine the probability of different types of events. 4. Perform statistical data analysis using a given data in SPSS/ R /Past software.	10	7
5	**Teacher-specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.

<table>
<tr>
<td rowspan="2">Assessment Types</td>
<td>MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory/Hands on Work- 30 Marks

● Involvement and responses in class room transactions
● Home Assignments
● Oral presentation/ Viva/Quiz/Open book test
● Field study, Group discussion on a recent research or review article(<5 years) related to the course
● Any other method as may be required for specific course / student by the course faculty</td>
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<tr>
<td>B. End Semester Evaluation (ESE)- 70 marks
● Very Short Answer (10 out of 12) : 2 x 10=20 Marks
● Short Answer (8 out of 10) : 8 x 5= 40 Marks
● Essay (1 out of 2): 1x 10= 10marks</td>
</tr>
</table>

References

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Advances and applications in plant science – Thallophytes**
Type of Course	**DCC A**
Course Code	**MG7DCCBBT401**
Course Level	**400**
Course Summary	This course will enable the students to identify, and compare the characteristics of the major groups of thallophytes and to classify them within a phylogenetic framework. Students will be able to use the evidence of comparative biology to correlate the evolutionary trends to the diversity of plant life on earth. Knowledge about the interactions and associations of lower plants will provide better insights on the adaptive strategies of plants. Awareness in the thrust areas of research will generate interest in students to pursue the same.

Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explore the course of evolution of algae and land plants	U	PO1, PO2
2	Analyze the diversity of thallus forms in algae and its adaptive strategies to diverse environments.	AN	PO1, PO2, PO3
3	Review the affinities of fungi with other groups and differentiate morphological forms within the group.	U	PO1, PO2, PO3
4	Analyse different fungal associations and its ecological impact	AN	PO1, PO2, PO3
5	Evaluate the various applications of thallophytes in different fields	E	PO1, PO2, PO3
6	Generate interest in recent research trends in Thallophyta.	I	PO3, PO6, PO9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1		**Introduction to Algae and Evolution of Land Plants (15 hours)**		
	1.1	The range of thallus diversity in the algae. Polyphyletic origin of algae and its evolution, with emphasis on endosymbiosis	3	1,2
	1.2	Algae and the fossil record; Gene sequencing (18SrRNA, HTS) in algal systematics.	2	1,2
	1.3	Algal pigments involved in photosynthesis Evolution and structural variations of Chloroplast in algae Algal responses to light- phototaxis, photophobia, and gliding.	4	1,2
	1.4	Adaptation strategies of algae to different environmental conditions-Resting spores, Allelopathy in algae, UV Sunscreens	2	1,2

	1.5	Algal symbiosis-extracellular (lichens, association of cyanobacteria with *Azolla*, Coralloid roots) and intracellular associations. Nitrogen fixation by blue-green algae.	4	1,2
2	**Introduction to Fungi and Fungal Associations (15 hours)**			
	2.1	General features of fungi. Affinities with plants and animals; Modern trends in fungal classification; Molecular phylogeny of fungi with emphasis on 18srRNA sequencing.	1	3
	2.2	Architecture of the fungal cell wall.	2	3
	2.3	Morphological diversity of fungi- an overview (Slime molds, Mycelial and non-mycelial fungi)	1	3
	2.4	Types of Fungal spores and its dispersal mechanisms (Ballistic dispersal, Dispersal by gravity, wind, water, insects and animals)	4	3
	2.5	Lichens– Ecological role, Nature of associations of algal and fungal partners with emphasis on its nutritional relation, Establishment of a lichen thallus-the process. Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance. Phosphate solubilisation	4	4
	2.6	Fungus-insect mutualism- Fungal farming by ants Parasites - Common fungal parasites of plants, humans, insects and nematodes (Brief account only). Saprophytes - Fungal decomposition of organic matter, coprophilous fungi, cellulolytic fungi, lignolytic fungi (Brief account only).	3	4
	Applied Aspects of Algae and Fungi (15 hours)			
	3.1	Brief Account on the following applications of algae.Algae as the source of food and fodder. Algal polysaccharides-its commercial utilization.Algae as the source of diatomaceous earth, pigments,	4	5,6

3		fatty acids and pharmaceuticals. Production of biofuel, biogas and bioplastics from algae.Algae as pollution indicator, algae-based wastewater treatment for biodiesel production, phycoremediation and biodegradation of plastics. Algae in soil fertility: Soil algae and cyanobacteria		
	3.2	Algal blooms: Beneficial, harmful and toxic bloom. Common cultivated algal species in India. Algal research stations in India Algal culture: scope and a brief account on isolation and culturing techniques (Axenic, Clonal, Unialgal, Enrichment, Maintenance, Batch, Continuous and Immobilized Culture) Molecular genetic techniques for algal bioengineering (Brief Account only), phylogenomics in algal research (Brief Account only) - current trends.	4	5,6
	3.3	Brief Account on the following applications of fungi.Fungi in the food industry-Flavour& texture, Fermentation, Baking. Application of fungi in agriculture-Mycoherbicides, Mycoinsecticides, Myconematicides. Fungi as a biofertilizer Fungi as the source of Mycotoxins-Aflatoxins, Amatoxin, Ergot, Fusarin	4	5,6
	3.4	Commercial production of Organic acids, Enzymes, Planthormones Mycoproteins, and alcohol from fungi.Antibiotics from fungi- penicillin, cephalosporin, Griseofulvin, Volatile organic compounds production by fungi.Fungi as plant and animal pathogen. Fungi as a model organism in genetic experiments- *Neurospora*, *Saccharomyces*. Recent research trends in fungi- Zombie ant fungi, Adaptive cognitive behavior and learning in slime molds.	3	5,6
	Practical (30 hours)			

4	4.1	Study of the thallus morphology of the following algal genera; Cyanophyceae: *Lyngbya, Oscillatoria, Scytonema* Chlorophyceae: *Chlorella, Zygnema, Mougeotia,Pithophora, Nitella*, *Caulerpa, Ulva, Halimeda* Bacillariophyceae: *Navicula, Odontella* Phaeophyceae:*Ectocarpus, Turbinaria, Padina, Dictyota* Rhodophyceae: *Batrachospermum,Gracilaria,Gelidium, Kappaphycus* **Activity:** Conduct a field visit to familiarize algal habitats, especially seaweeds; and study algal diversity of a location and submit a report	15	2,5,6
	4.2	Morphological study of the following types by preparing suitable micro preparations of the following fungi *Albugo, Rhizopus, Mucor, Aspergillus, Pilobolous, Xylaria, Peziza, Pleurotus, Auricularia, Lycoperdon, Fusarium.* Lichen-*Usnea* Isolation of fungi from rotten vegetables and culturing the same on PDA; Staining and observing VAM Fungal spore staining using lactophenol cotton blue.Conduct field visit to study on fungal diversity of a location. Lichen identification- morphological and chemical methods	15	3,5,6
5	**Teacher specific course content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)

Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory: 25 marks
·Involvement and responses in class room transactions
·Home Assignments/preparedness
·Oral presentation/Viva/Quiz/Open book test/written test
Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course
·Any other method as may be required for specific course / student by the course faculty
Practical: 15 marks
·Lab involvement and practical skills
·Record/Any other method as may be required for specific course / student by the course faculty</td></tr>
<tr><td>B. End Semester Evaluation (ESE)
Theory: 50 marks
Short answer (10 out of 12): 10 x 1=10
Short Essay (6 out of 8) : 6 x 5= 30
Essay (1 out of 2) : 1x 10= 10
Practical: 35 marks
·Practical based assessments: 30 marks
Record: 5 marks</td></tr>
</table>

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SUGGESTED READINGS

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3. https://www.cell.com/current-biology/pdf/S0960-9822(19)31164-9.pdf

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Advances and applications in plant science - Archegoniates</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCC A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG7DCCBBT402</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course is designed to make students aware of advances and applications in archegoniates. After completion of the course, the students will be able to
● Recognize the habitat variation, morphological diversity and reproductive behavior of archegoniates.
● Describe the economic significance of archegoniates.
● Summarize the diversity and distributions of prehistoric archegoniate flora.
● Classify archegoniates based on morphological and evolutionary characters.
● Compare the evolutionary trends and ecological significance of archegoniates.
● Investigate the diversity of archegoniates.
● Construct artificial ecosystems for conservation of archegoniates.</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recognize the habitat variation, morphological diversity, and reproductive behaviour of bryophytes, pteridophytes, and gymnosperms	U	PO1
2	Describe the economic significance of bryophytes, pteridophytes, and gymnosperms	U	PO1
3	Summarize the diversity and distributions of prehistoric archegoniate flora	U	PO2
4	Classify archegoniates based on morphological and evolutionary characters	A	PO2 PO3
5	Compare the evolutionary trends and ecological significance of archegoniates	AN	PO3
6	Investigate the diversity of archegoniate	E	PO2 PO4
7	Construct artificial ecosystems for the conservation of archegoniates.	C	PO2 PO6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Bryology (19 hours)**			
	1.1	Introduction- Salient features, classification by Goffinet *et al.* 2008	1	4, 5
	1.2	Comparative account of gametophyte, sporophyte, their inter relationship and spore dispersal mechanisms of the following phylum Marchantiophyta (*Riccia, Marchantia, Porella*), Bryophyta (*Pogonatum)* andAnthocerotophyta (*Anthoceros*).	5	1, 6
	1.3	Origin and evolution of sporophyte and gametophyte in bryophytes.	2	5
	1.4	Ecologic roles, economic importance, and conservation of bryophytes.	1	2, 7
Practicum		**1.** Detailed study of the structure of gametophytes and sporophytes of the following genera of bryophytes by suitable micropreparation:*Targionia, Cyathodium, Marchantia, Lunularia, Dumortiera, Reboulia, Pallavicinia, Fossombronia, Porella, Anthoceros, Notothylas, Pogonatum*. **2.** Conduct a field study and submit a report with geo-tagged photos related to diversity of bryophytes in your locality.	10	1, 6
2	**Pteridology (22 hours)**			
	2.1	Introduction, general characters, Trends, and concepts in classification of pteridophytes with emphasis on PPG 1. (brief study)	4	4, 6

	2.2	Stelar and soral evolution in pteridophytes. Structural organization of sporophyte and gametophyte (development of sex organs not necessary) of the following type with special reference to stelar structure, heterospory and seed habit. **Lycophytes (Lycopodiopsida)** ● *Palhinhaeacernua*(syn - *Lycopodiellacernua*) ● *Selaginella* **Ferns (Polypodiopsida)** ● *Equisetum* ● *Psilotum* ● *Marsilea*	6	1, 5
	2.3	● Economic importance of pteridophytes. ● Endemic pteridophytes, and conservation.	2	1, 2, 7
Practicum		**1.** Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera: *Palhinhaeacernua, Selaginella, Equisetum, Angiopteris, Marsilea, Azolla, Lygodium, Acrostichum, Adiantum,* **2.** Study of two fossil pteridophytes with the help of specimens or permanent slides. **3.** Conduct a survey and submit a report with geo-tagged photos of pteridophyte flora in your locality / Submit a survey report with geo-tagged photos of ornamental pteridophytes.	10	1, 2, 6
3	**Gymnosperms (15 hours)**			
	3.1	Introduction, general characters, evolutionary significance. Origin of seed plants: -Evolution of pollen and seed -the key reproductive evolutionary mechanisms for Life on Land. Relationships among gymnosperms - molecular phylogeny	2	4, 5

	3.2	Study the Morphological and Applied Aspects of gymnosperms Cycadales - Ginkgoalesclade (general account on morphology) Coniferales clade -Pinaceae, Cupressaceae, Taxaceae, Podocarpaceae, Araucariaceae (general account on morphology) Gnetales: *Gnetum*(general account on morphology). Brief study of habit, morphology and reproductive characters of *Welwitschia mirabilis* Pollination strategies in gymnosperms Vascular system of gymnosperms (give emphasis to wood architecture) The ecological and economic importance of gymnosperms. Conservation of gymnosperms	7	1, 2, 5, 6, 7
Practicum		**1.** Study of the morphology and anatomy of vegetative and reproductive parts of *Zamia, Cupressus, Podocarpus, Agathis, Araucaria* and*Gnetum* (reproductive structure only). Conduct a field survey of gymnosperms in your locality and submit a report with geo-tagged photos. / Conduct a case study to summarize the reasons for the fast extinction of gymnosperms and submit a report based on your findings.	6	1, 5, 6
4	**Paleobotany: (4 hours)**			
	4.1	• Introduction, fossil types & technique of study. Indian contribution to paleobotany **Fossil plants** Study of the following types; • Fossil bryophytes:*Naiadita lanceolata* • Fossil pteridophyte: *Rhynia* • Fossil gymnosperms: *Williamsonia*	4	3
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 30 Marks** • Involvement and responses in class room transactions • Home Assignments • Oral presentation/ Viva/Quiz/Open book test • Field study, Group discussion on a recent research or review article(<5 years) related to the course • Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks • Very Short Answer (10 out of 12) : 2 x 10=20 Marks • Short Answer (8 out of 10) : 8 x 5= 40 Marks • Essay (1 out of 2): 1x 10= 10marks

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http://www.bryoecol.mtu.edu/
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http://www.home.aone.net.au/~byzantium/ferns/
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http://www.mygarden.ws/fernlinks.htm
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http://www.gymnosperms.org/
http://www.plantapalm.com/vce/toc.htm

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Agronomy horticulture and agroforestry**					
Type of Course	**DCE A**					
Course Code	**MG7DCEBBT400**					
Course Level	**400**					
Course Summary	Agronomy, Horticulture, and Agroforestry is an interdisciplinary course that examines the management and optimization of crop production, the science of garden cultivation, and the integration of trees and agriculture in sustainable land management. It explores the principles, techniques, and applications of these fields in the context of modern agricultural practices. Learners will acquire practical knowledge in horticulture and different entrepreneurial skills, which have potential career opportunities in industries and start-ups.					
Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60
Pre-requisites, if any	A basic understanding of biological sciences would be beneficial.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Identify the different methods of crop propagation, crop management and cropping patterns in agronomy	R	PO1, PO2 PO4
2.	Describe the role of manures and fertilizers in crop management	U	PO5, PO6 PO8
3.	Explain different plant propagation methods in Horticulture and the importance of organic farming	A	PO7, PO9, PO10
4.	Evaluate the role of Hi-Tech farming in modern agriculture and institutions giving financial assistance for agriculture	An	PO3, PO6
5.	Appraise the applications of agroforestry	E	PO3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Principles of Agronomy (18 hours)**			
	1.1	Introduction: Meaning, definition and scope of agronomy. Crop Growth- factors affecting growth.	1	1
	1.2	Crop propagation: Seed – characteristics of good quality seeds. Factors affecting seed quality, Seed viability testing-Seed germination test and Tetrazolium test. Seed Dormancy-Primary and Secondary. Vegetative propagation- Bulbs, Tubers, Corms, Rhizomes, Rootstock, runners, Offsets and suckers.	4	1, 3

	1.3	Methods of sowing/planting: Planting geometry and its effect on growth and yield.	1	1
	1.4	Soil and Soil Profile: Physical, chemical and biological properties of soil. Soil fertility and Soil productivity.	2	1, 3
	1.5	Tillage: definition- objectives, types of tillage, tillage implements. Learning activity: Identification of different tillage implements.	2	1, 3
	1.6	Crop nutrition: Micro and Macro nutrients (role & deficiency symptoms), Nutrient sources- organic manures, fertilizers, biofertilizers; Integrated Nutrient Management.	2	1, 2
	1.7	Cropping Patterns: Multiple cropping, Intercropping, sequential cropping and crop rotation. Mixed farming.	2	1, 3
	1.8	Irrigation and water management:Irrigation: definition and objectives. Types and methods- surface irrigation, subsurface and micro irrigations including sprinkler and drip irrigation. Learning activity: Visit a field showing different types of irrigation methods.	4	1,3
2.	**Horticulture (12 hours)**			
	2.1	Introduction to Horticulture: Definition and objectives of Horticulture; branches of Horticulture- Pomology, Olericulture, Landscape Gardening, Nursery management.	2	1,3
	2.2	Plant propagation methods: Propagation by seeds; Vegetative propagation- Natural, Artificial- Budding ('T' and patch budding), Grafting (approach and wedge Grafting) and layering (Air Layering). Learning activity: Demonstration of budding/grafting techniques	5	1,3

	2.3	Manures and Fertilizers: Manures: Farm Yard Manure (FYM), neem cake, green manure, organic manures, vermicompost. Fertilizers: NPK; Biofertilizers (Bacterial, Fungal and Algal). Organic Farming: Definition andScope. Learning activity: Identification of plants as green manure – *Glyricidia*sp., *Vigna unguiculata, Leucaena* sp.	5	1,2,3
3.	**Plant Protection (15 hours)**			
	3.1	Diseases: General account of Plant diseases (viruses, bacteria, mycoplasma, fungi, nematodes and parasitic plants). Case study-Bunchy top of Banana. Pests on horticultural crops- General account on Aphids, beetles, stem borer, caterpillars and rats.	4	1, 3
	3.2	Weed Management: Introduction, harmful and beneficial effects of weeds, crop weed association, crop weed competition and allelopathy. Methods of weed control: physical, chemical and biological methods. Integrated Weed Management (IWM). **Learning activity:** 1. Prepare a report on the diversity of weeds in your locality with suitable geotagged photos. 2. Preparation of a list of commonly available herbicides in the market.	6	1,3
	3.3	Methods of Pest Control: Pest management, Integrated Pest Management (IPM). **Learning activity:** Bordeaux mixture preparation	5	1,3, 5
4	**Gardening, and Principles of Agroforestry (15 hours)**			

	4.1	Establishing a Garden: Selection of site, Preparation of land for vegetable garden-Mulching; Sowing; Transplanting.	2	3
	4.2	Landscape Gardening: Principles of landscaping & garden design. Indoor gardens; Terrarium/Bottle Garden, Hydroponics Garden Components: Hedges & Edges, Lawn, Flowerbeds, Arches & Pergolas, Fencing, Water bodies. **Learning activity:** Prepare and submit a Bottle Garden / Terrarium.	4	3, 4
	4.3	High –Tech farming: Brief overview on Greenhouse technology, Polyhouse, and Precision farming. Procuring financial assistance from different funding agencies-National Horticulture Mission (NHM), State Horticulture Mission (SHM), MSME.	4	4,5
	4.4	Agroforestry: Definition and scope. Agroforestry in the farming system in the different parts of the farm, Climate farming system (Climate Smart Agriculture- CSA) Practical application of Agroforestry-As live fences, hedgerow barriers, windbreaks and shelterbelts Silviculture, Agri-silviculture, Agri-horticulture, Alley cropping, Taungya cultivation and social forestry (Brief study only).	5	4,5
5	**Teacher Specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive Lectures, PowerPoint presentations, Group discussions, Hands-on training, Field trip flipped classroom, Project-Based Learning, Experiential Learning, Peer Teaching, invited lectures, group discussions, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 30 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks ● Very Short Answer (10 out of 12) : 2 x 10=20 Marks ● Short Answer (8 out of 10) : 8 x 5= 40 Marks ● Essay (1 out of 2): 1x 10= 10marks

References

1. Balasubramaniyan, P and Palaniappan, S.P. 2005. *Principles and Practices of Agronomy*. AgroBios (India) Ltd., Jodhpur.
2. Brady, N.C. and Well, R.R. 2002. *The Nature and Properties of Soils* (13th ed.). Pearson Education, Delhi.
3. Chadha, K.L. 2001. *Handbook of Horticulture*. ICAR, New Delhi.
4. Ed Verheij. 2003. *Agroforestry*. AgromisaFoundation, The Netherlands.
5. Franciso J. Villalobos and Elias Fereres.2017. *Principles of Agronomy for Sustainable Agriculture*. Springer Cham.
6. Gupta, O.P. 2000. *Weed Management - Principles and Practices*. Agrobios (India) Ltd., Jodhpur.
7. Hazra, P. and Som, M. G. 2009. *Technology for vegetable Production and Improvement*. Naya Prokash, Calcutta.
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11. Swarup, V. 1993. *Indoor Gardening*. ICAR, New Delhi Trivedi
12. Yellamanda Reddy T and Sankara Reddy G.H. 2023.*Principles of Agronomy*, Kalyani Publications, 6th revised edition.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Plant genomics**					
Type of Course	**DCE A**					
Course Code	**MG7DCEBBT401**					
Course Level	**400**					
Course Summary	The Plant Genomics course offers a comprehensive examination of the molecular intricacies governing plant life, emphasizing genomic principles. Students delve into the structural nuances of plant genomes, exploring chromosomal organization, gene structure, and the role of repetitive DNA elements. Functional genomics techniques, such as transcriptomics and proteomics, are explored alongside an in-depth look at cutting-edge tools like next-generation sequencing. Comparative genomics sheds light on the evolutionary aspects of plant genomics, while mapping and sequencing techniques provide insights into genome structure. The course equips students with the emerging trends in plant genomics research, ensuring students are prepared for careers at the intersection of genomics and plant biology.					
Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60
Pre-requisites, if any	Basics of molecular biology and genetics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the basics of genome organization	U	PO2, PO6
2	Illustrate the processes in genome mapping	An	PO2, PO6, PO8
3	Distinguish various sequencing technologies and its applications in plant science	An	PO1, PO2, PO3, PO5, PO6, PO7, PO8, PO9, PO10
4	Consider various functional genomics aspects in plant science research	E	PO1, PO2, PO3, PO9, PO10
5	Choose comparative genomic tools in evolutionary studies	E	PO1, PO2, PO3, PO4, PO6, PO7, PO8, PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Structural genomics (15 hours)**			
	1.1	Introduction to genomics	1	1
	1.2	Brief overview of prokaryotic and eukaryotic genome organization	2	1
	1.3	Extra-chromosomal DNA: Mitochondrial and chloroplast genomes	2	1
	1.4	Genetic mapping and physical mapping.	2	1, 2
	1.5	Construction of linkage maps using molecular markers – RFLP, RAPD, AFLP, SSLP, SNP	5	1, 2
	1.6	Physical mapping – restriction mapping, STS mapping, EST	3	1, 2
2	**Genome sequencing (20 hours)**			
	2.1	Sanger's DNA sequencing method; Genome sequencing strategies-Whole genome, clone-by-clone and hybrid approaches.	5	3
	2.2	Next generation sequencing technologies- • Pyrosequencing, • Reversible terminator sequencing, • ion torrent method, • PacBio long range sequencing, • nanopore sequencing. Applications of NGS in modern world (Any five applications)	10	3
	2.3	Sequence assembly – methods used. (Reference and *de novo*)	1	3
	2.4	Genome Annotation, Gene Ontology (GO)	2	3

	2.5	Important findings of the completed genome projects: Arabidopsis genome project, Tomato genome project and Banana Genome project.	2	3
3	**Functional Genomics (15 hours)**			
	3.1	Transcriptome/RNA seq, Exome sequencing	2	4
	3.2	Expression profiling using Real time quantitative PCR (RT-qPCR).	2	4
	3.3	Methyl sequencing	1	4
	3.4	Gene expression analysis using dot blotting and microarrays.	2	4
	3.5	Chromatin immunoprecipitation sequencing (ChIP Seq) and its applications.	2	4
	3.6	Gene editing using CRISPR-Cas9 technology, its applications	1	4
Experiential Session: Provide the students a captivating day-long laboratory excursion, offering an exclusive visit to a state-of-the-art sequencing facility.			5	4
4	**Comparative genomics (10 hours)**			
	4.1	Gene identification by comparative genomics	1	5
	4.2	Comparative genomics as a tool in evolutionary studies (molecular phylogeny): Orthologous, Analogous, Paralogous and Xenologous genes	2	5
	4.3	Metagenomics. (A brief account with its applications)	2	5
Experiential Session: Phylogenetic analysis using genomic tools (MEGA or Phylip)			5	5
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, Group discussions, Problem-based learning, Flipped classroom, Discussion-based Learning, Case-based Learning, Experiential Learning, Inquiry-Based Learning, Game-Based Learning, Socratic Method, Peer Teaching, Simulations, Online Learning, Blended Learning, and other innovative approaches.	
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory/Hands on Work- 30 Marks** • Involvement and responses in class room transactions • Home Assignments • Oral presentation/ Viva/Quiz/Open book test • Field study, Group discussion on a recent research or review article(<5 years) related to the course • Any other method as may be required for specific course / student by the course faculty	
	B. End Semester Evaluation (ESE)- 70 marks • Very Short Answer (10 out of 12) : 2 x 10=20 Marks • Short Answer (8 out of 10) : 8 x 5= 40 Marks • Essay (1 out of 2): 1x 10= 10marks	

References

1. Brown, T. A. (2023). Genomes 5.CRC Press; 5th edition
2. Farrell Jr, R. E. (2009). *RNA Methodologies: laboratory guide for isolation and characterization*. Academic Press.
3. S B Primrose, R M Twyman (2006). Principles of gene manipulation and genomics (VII Edn). Blackwell publishing.
4. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant*
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6. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics: From genes to genomes* (II Edn). McGraw Hill.
7. David P Clark (2010). *Molecular biology*. Elsevier.
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9. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
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11. C W Sensen (2002). *Genomics and Bioinformatics*. Wiley – VCH.
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13. Robert K Murray, David A Bender, Kathleen M Botham, Peter J Kennelly, Victor W Rodwell, P Anthony Weil (2009). *Harper's Illustrated Biochemistry* (XXVIII Edn). McGraw Hill.
14. S R Pennington, M J Dunn (Edts) (2002). *Proteomics: From protein sequence to function*. Viva Books Private Limited.
15. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principles and applications of recombinant DNA*. ASM press.
16. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
17. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X* . Jones and Bartlett Publishers.

<table>
<tr><td colspan="2"></td><td colspan="5">Mahatma Gandhi University
Kottayam</td></tr>
<tr><td colspan="2">Programme</td><td colspan="5">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td colspan="2">Course Name</td><td colspan="5">Seed technology</td></tr>
<tr><td colspan="2">Type of Course</td><td colspan="5">DCE A</td></tr>
<tr><td colspan="2">Course Code</td><td colspan="5">MG7DCEBBT402</td></tr>
<tr><td colspan="2">Course Level</td><td colspan="5">400</td></tr>
<tr><td colspan="2">Course Summary</td><td colspan="5">This course is a comprehensive study of principles and application of seed science and technology. The course provides an understanding of the vital role in seed plays in agriculture, plant biology and sustainable development.</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No	Expected Course Outcome	Learning Domains *	PO No
1	Explain the basics of seed biology and seed quality	Understand	PO2, PO4
2	Evaluate the quality of seeds using seed testing method	Evaluate	PO2, PO9
3	Outline the steps in seed processing and seed certification	Remember	PO2,PO9
4	Apply the role of biotechnology in seed development	Apply	PO2,PO9, PO3
5	Analyze seed marketing and trade	Analyse	PO2,PO9, PO1,PO3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to seed technology (15 Hours)**			
	1.1	Definition of seed science and technology, scope; Heritage of seed technology and contribution of seed technologists towards the holistic development of modern science(interactive sessions)-	1	1
	1.2	Morphology and seed development: Seed Biology-Study of floral biology of monocots and dicots external and internal structures of monocot and dicot seeds; seed coat structure, different types of embryos, endosperm and cotyledons Seed development Physiology-Physiology of seed development and maturation; chemical composition, synthesis and accumulation of seed reserves, induction of desiccation tolerance, hormonal regulation of seed development	9	1

		Dormancy- definition, types, mechanisms, advantage, disadvantage, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy Seed deterioration- causes and factors affecting seed deterioration, Physiological, cytological and biochemical changes during seed storage and its implication in seed quality, methods to reduce seed deterioration **Activity:** Preparation of seed albums and identification		
	1.3	Seed ripening and maturation process, Factors affecting seed setting. Seed germination -Seed germination; factors affecting germination; role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination; seed respiration, breakdown of stored reserves in seeds, mobilization and interconversion pathways.	5	1
2	**Seed quality and vigour (17 Hours)**			
	2.1	Seed viability and longevity, pre and post-harvest factors affecting seed viability ; seed aging ; physiology of seed deterioration; lipid peroxidation and other viability theories; means to prolong seed viability; mechanism of desiccation sensitivity and recalcitrance with respect to seed. Varietal Seed vigour and its concept, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield. Seed invigoration and its physiological and molecular control Methods to prolong seed viability, Procedures involved in seed testing, (Sampling, physical purity, germination, seed moisture, viability, health, vigour and determination of genuineness), Devices and tools used in seed testing. ISTA, AOSA and its role in seed testing. **Activity:** ● Seed viability testing method (Tetrazolium),	7	2

		• Seed germination test (Between paper/Top of paper method) • Visit to seed production Unit		
	2.2	Seed storage: general principles, Seed drying and storage; drying methods-importance and factors affecting it, changes during storage, concepts and significance of moisture equilibrium, methods of maintaining safe seed moisture content. Methods to minimize the loss of seed vigour and viability; factors influencing storage losses. Methods of seed storage – modified atmospheric storage – ultra dry storage – vacuum storage – cryopreservation – germplasm storage – gene banks – NBPGR, IPGRI and National seed storage laboratory, Measures for pest and disease control during storage, Seed Bank Seed treatments-methods of seed treatment, seed treating formulations and equipments, Biological seed treatments, seed disinfestations, identification of treated seeds; Packaging: principles, practices and materials; bagging and labeling	10	3
3	**Seed production and enhancement (20 Hours)**			

	3.1	Seed production through crop improvement and breeding, hybrid seeds (Maize, Sunflower), Causes of varietal deterioration and maintenance of genetic purity during seed production Seed quality control – Definition of seed and its quality-concept and objectives; regulatory mechanisms – Seed Act (1966) – Seed Rules (1968), statutory bodies– Central Seed Committee – Central Seed Certification Board, DUS test. Detection of genetically modified seeds. Identification through Grow Out Test and Electrophoresis. Seed certification –objectives; general and specific crop standards, field and seed standards; seed certification agency – role of certification agencies, phases of seed certification; Brief account on role and working of CSTL. Seed processing technologies(seed cleaning and equipment in seed processing)	10	3
	3.2	Seed quality enhancement Seed priming: types of priming technology, biochemical and molecular changes associated, pre-germination, film coating and pelleting, seed tapes, seed mats, seed colouring, biopriming Seed marketing: structure and organization, sales generation activities, promotional media.; Factors affecting seed marketing. Seed trade regulations, IPR in seed technology	10	3,5
4	**Biotechnology in seed improvement (8 Hours)**			
	4.1	Impact of genetic engineering , Genetic purity analysis of seeds, Use of Molecular markers, GMOs in seed production, Detection of genetically modified crops,; Transgene contamination in non-GM crops; GM crops and organic seed production.; Application	8	4

		of tissue culture in genetic conservation-Embryo culture, Embryo rescue, pollen and anther culture		
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 30 Marks** ● Involvement and responses in class room transactions ● Home Assignments ● Oral presentation/ Viva/Quiz/Open book test ● Field study, Group discussion on a recent research or review article(<5 years) related to the course ● Any other method as may be required for specific course / student by the course faculty
	B. End Semester Evaluation (ESE)- 70 marks • Very Short Answer (10 out of 12) : 2 x 10=20 Marks • Short Answer (8 out of 10) : 8 x 5= 40 Marks • Essay (1 out of 2): 1x 10= 10marks

References

1. Agrawal RL. 2019. Seed Technology. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi.
2. Joshi AK and Singh BD. 2004. Seed Science and Technology. Kalyani Publishers, New Delhi.
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9. Chakrabarthi SK. 2010. Seed Production and Quality Control. Kalyani Publishers,New Delhi.

Suggested Readings

1. Mishra DK, Khare D, Bhale MS and Koutu GK. 2011. Handbook of Seed Certification. Agrobios, Jodhpur, Rajasthan
2. Sharma P. 2008. Seed Legislation. Gene-tech Book Publishers, New Delhi.
3. Chakrabarthi SK. 2010. Seed Production and Quality Control. Kalyani Publishers. New Delhi.
4. Chalam GV Singh A and Douglas JE. 1967. Seed Testing Manual. ICAR and United States Agency for International Development, New Delhi

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Agricultural Biotechnology**
Type of Course	**DCE B**
Course Code	**MG7DCEBBT403**
Course Level	**400-499**
Course Summary	The course covers Agricultural Biotechnology, spanning from its introduction and significance in modern farming to historical perspectives and milestones. Ethical considerations and regulatory frameworks are explored alongside an introduction to plant genetic engineering and genetically modified techniques in crops. Transgenic plants and genome editing technologies like CRISPR/Cas9 are discussed. Microbial Biotechnology's role in soil health, biofertilizers, and plant-microbe interactions for improved crop yield are examined. The course also addresses plant stress, crop management applications, and strategies for increased crop yield through modern agronomic practices and biotechnology-enhanced breeding techniques.

<table>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Need to complete difficulty level 300-399 courses</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify the impact of biotic and abiotic factors on agricultural practices.	U	1, 2, 3, 6
2	Evaluate ethical considerations associated with agricultural biotechnology.	E	1, 2, 3, 7
3	Analyse the applications and implication of transgenic plant.	An	1, 2, 3, 9
4	Understand the fundamentals of Genome editing in agriculture.	U	1, 2, 9, 10

5	Formulate bio fertilizers.	C	1, 2, 9, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Agriculture Biotechnology	1.1	Overview Of Agricultural Biotechnology: Introduction to agricultural biotechnology and it's significance in modern farming. Key concepts, principles and techniques in agricultural biotechnology. Application of biotechnology in crop improvement, pest control and disease resistant	4	1
	1.2	Historical Perspectives And Milestones: Evaluation of agriculture Biotechnology from traditional breeding to modern technological approaches. Land mark achievement and discoveries in the field. Contributions of notable scientists and researchers.	4	2
	1.3	Ethical Considerations: Exploration of ethical issues, impact of biotechnological interventions, ethical consideration in genetic modification and gene editing in crops.	4	3
	1.4	Regulatory Framework: Overview of national and international regulation, role of governmental and non-governmental organizations in biotechnological practices	3	4
2 Plant Genetic Engineering	2.1	Introduction To Plant Genetic Engineering: Overview of genetic engineering principles, historical development, importance of genetic modification in agriculture	4	3,4
	2.2	Genetically Modified Techniques In Crops: Various methods of genetic modification in crops, comparison of traditional breeding and genetic engineering, regulatory framework governing GM crops.	4	3,4
	2.3	Transgenic Plants: Concepts And Development: Definition and characteristics of transgenic plants, techniques for introducing foreign genes into the plants Examples of successful transgenic crops.	4	3,4
	2.4	Genome Editing Technology In Agriculture (Crisper/Cas9): Introduction to genome editing and crisper cas9, mechanism and composition of crisper cas9 system.	3	3,4

3 Microbial Biotechnogy in Agriculture	3.1	Introduction To Microbial Biotechnology: Definition and scope, historical context and development of microbial application in farming, significance of microorganisms in sustainable agriculture.	3	5
	3.2	Role Of Microorganism In Soil : Importance of soil microorganisms for nutrient cycling, microbial diversity in soil ecosystems, impact of microorganism on soil structure and fertility	3	5
	3.3	Biofertilizers And Their Applications: Definition and types of bio fertilizers, microorganisms used in biofertilizer production, benefits and challenges of using biofertilizers in agriculture.	3	5
	3.4	Plant - Microbe Interaction For Improved Crop Yield: Mutualistic relationship between plant and beneficial microbes, mechanisms of plant growth – promoting Rhizobacteria (PGPR), enhanced nutrient uptake and disease resistance through microbial interactions.	3	2
	3.5	Applications In Crop Management: Microbial solutions for pest and disease control, bioremediation using microorganisms.	3	2
4 Advanced Crop Improvement Techniques	4.1	Introduction To Plant Stress: Biotic stress and abiotic stress in plants, impact on plant growth and development, physiological responses to biotic and abiotic stress.	5	1
	4.2	Strategies For Increased Crop Yield: Factors influencing crop yield, modern agronomic practices - sustainable farming techniques, precision agriculture and its impact on yield, molecular tools in crop breeding. Marker-assisted breeding its principles and applications, genomic selection in crop improvement.	5	3
	4.3	Biotechnology For Crop Enhancement: Transgenic crops for pest and disease resistant, genetic modification for enhanced nutritional content.	5	3
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.

<table>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT
A. Continuous Comprehensive Assessment (CCA)
Assignment, Oral Presentations, Quiz, Group Discussions
Evaluation:
CCA : 30 marks</td></tr>
<tr><td>B. End Semester Examination – 2.0 hrs.
Total marks: 70 marks.</td></tr>
<tr><td>Pattern of questions:</td><td>Total marks : 70 marks (2.0 hrs)
One word answer question(1 mark):10 out of 10 10x1= 10 marks
Short answer questions (3 marks) :5 out of 7 5x3= 15 marks
Short essay (6 marks) :5 out of 7 5x6= 30 marks
Essay (15 marks) :1 out of 2 1x15= 15 marks</td></tr>
</table>

References:

1. Doe, J. (1987) Principles of Agricultural Biotechnology. National Research Council
2. Smith, J. et al.(1996). Genetic Engineering of Crops. Nature biotechnology,
3. Johnson, R. et al. (2004) Microbial Applications in Agriculture. Springer
4. Chawala, H. S. (2011) Biotechnology in Crop Improvement. CRC Press.
5. Gupta, P. K. (2010) Elements of Biotechnology. Rasthogi Publications

Mahatma Gandhi University
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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Proteomics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE B</td></tr>
<tr><td>Course Code</td><td colspan="6">MG7DCEBBT404</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Summary</td><td colspan="6">The Proteomics course covers diverse protein analysis techniques and applications. It explores protein isolation, structure analysis, and methods like 2-DE gels, MALDI-TOF mass spectrometry, and NMR spectroscopy. Students learn protein identification strategies such as sequencing, peptide mass fingerprinting, and quantification through isotope labeling and MS. Post-translational modifications analysis and protein interaction assessment methods are also discussed. The course emphasizes proteome databases like UniProt, NCBI Protein, and STRING, alongside proteomic analysis software and quantitative techniques such as i-TRAQ and SILAC. Through case studies and insights from the Human Proteome Atlas, students understand proteomics' significance in clinical research, drug discovery, biomarker identification, and agriculture.</td></tr>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Need to complete difficulty level 300-399 courses</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Discuss the concept of proteomics	U	1,2,10
2	Apply the methods available for the identification of unknown gene expression products in a high-through-put manner	E	2,3
3	Evaluate the use of the protein structural analytical tools	E	1,2,4
4	Formulate a stepwise workflow for identifying novel protein using Insilco studies	C	1,2
5	Explain the applications in Biomedical research, agricultural research, environmental studies.	U	1,2,10

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Proteomics	1.1	Introduction and scope of proteomics; Types of proteomics-quantitative proteomics; functional proteomics, structural proteomics.	4	1
	1.2	Protein isolation & structure analysis: detection and quantitation of proteins, Preprocessing, Protein Identification and Quantification, Interpretation and Visualization	4	1
	1.3	Analysis of proteomes: Sample Preparation, Solubilization, Reduction, Resolution	2	2
	1.4	Reproducibility of 2-DE Gels Two-dimensional polyacrylamide gel electrophoresis.	3	2
	1.5	Isoelectric focusing (IEF), protein microarrays, MALDI-TOF mass spectrometry, NMR spectroscopy, x-ray crystallography	5	2
2 Strategies for protein identification	2.1	Protein sequencing, peptide mass fingerprinting.	4	3
	2.2	Protein quantification based on isotope labeling and MS. Analysis of post-translational modifications.	4	3
	2.3	Analysis of protein interactions using affinity chromatography; DNA-Protein interaction: EMSA, Chromatin Immunoprecipitation (ChIP)	3	3
	2.4	Protein - Protein interaction: Chemically induced dimerization, Y2H methodology and protein microarrays.	4	3
3 Proteome databases and Servers	3.1	Proteome database: Chip-seq,	3	4
	3.2	Amino acid sequencing Protein Databases: UniProt, NCBI Protein Protein Data Bank (PDB), InterPro, STRING, PhosphoSitePlus, PRIDE	4	4
	3.3	Proteomic analysis software (protein pilot, Mascot)	4	4
	3.4	Introduction to quantitative proteomics and techniques. (i-TRAQ and SILAC).	4	4
4 Potentials of proteomics in biotechnology	4.1	Case studies related to Clinical and biomedical application of proteomics; drug discovery and personalized medicine,	3	5
	4.2	Target identification and validation, Biomarker discovery in drug development, Stem Cell Research, Protein Engineering,	4	5

	4.3	Monitoring Agricultural Contaminants, Bio indication and Biotic Response	3	5
	4.4	Metaproteomics. Human Proteome Atlas	2	5
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. End Semester Examination – 2.0 hrs. Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Twyman R (2013). Principles of Proteomics. Garland Science, Taylor & Francis Group, LLC, New York, USA.
2. Liebler DC (2002). Introduction to Proteomics- Humana Press, New York, USA.
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Suggested Readings

1. Reiner Westermeier, Tom Naven, Proteomics in Practice, Wiley-VCH, May 2002.
2. D. Hochstrasser, Concepts in Proteomics
3. Wilkins, M. R., Williams, K. L., & Appel, R. D. (Eds.). (1997). Proteome Research: New Frontiers in Functional Genomics (2nd ed.). Springer.
4. Kussmann, M., & Roepstorff, P. (2005). Mass Spectrometry in Systems Biology: An Introduction. Wiley-VCH.
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Mahatma Gandhi University
Kottayam

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Genetic Engineering</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE B</td></tr>
<tr><td>Course Code</td><td colspan="6">MG7DCEBBT405</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course provides a comprehensive understanding of the tools used to manipulate DNA, the methods of gene cloning, and the practical applications of rDNA technology.</td></tr>
<tr><td>Semester</td><td>7</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Need to complete difficulty level 300-399 courses</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Understand the fundamental principles and history of genetic engineering	U	1,2, 3
2.	Apply various techniques and tools used in gene cloning and manipulation	A	2,3,8
3.	Analyze the role of genetic engineering in medicine, agriculture, and industry	An	1, 2, 3, 8
4.	Evaluate the ethical, legal, and social implications of genetic engineering	E	1, 2, 3, 6, 8
5.	Create innovative solutions to biological problems using advanced genetic engineering techniques.	C	1, 2, 3, 6, 8,9

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to genetic engineering	1.1	Introduction to genetic engineering. History and Scope of Genetic Engineering, Birth of rDNA Technology: Paul Berg's development of DNA techniques.	3	2
	1.2	Isolation of genetic material:DNA,RNA,Plasmid. Gene Libraries: Genomic and cDNA Libraries.	3	5
	1.3	PCR and Its Applications. Gene Cloning Strategies: Restriction Enzyme, Gateway, TOPO, Gibson assembly, Type IIS , Ligation Independent Cloning, Oligo Stitching **Activity**: DNA sequencing - Sanger or Maxam Gilbert (Demo)	5	3
	1.4	Steps in genetic engineering: Isolating the DNA, Cutting the DNA at specific site, Preparing the suitable vector, Ligation, Transformation, Screening and Selection, Harvesting and Analyzing. Adapters, Linkers, Homopolymer tail.	4	3
2 Tools and techniques of Genetic engineering	2.1	Enzymes in genetic engineering: DNA Ligases, Polymerase enzymes -DNA polymerase, Klenow fragment, Taq polymerase, Reverse transcriptase; Nucleases - exonucleases: Bal31, exonucleases III, lambda exonuclease, S1 nucleases, RNase H; Restriction endonucleases; Alkaline Phosphatase, Polynucleotide Kinase, Terminal transferase;	5	5
	2.2	Vectors in Genetic engineering: Classification of Vectors: Plasmids - pSC 101, pBR322, pUC; Bacteriophage vectors: M13, and Lambda; Cosmids, Phasmid, Shuttle vectors: YACs, & BACs. Plant and Animal vectors.	5	5
	2,3	Techniques of Gene Transfer: CaCl2 mediated Transformation, Transfection, Electroporation, Lipofection, Microinjection, and Biolistic method. Agrobacterium mediated gene transfer. **Activity**: Cloning and transformation of gene.	5	5
3 Screening methods and applications of Genetic	3.1	Screening methods: Blue White screening, Insertional inactivation, Marker genes, reporter genes, colony hybridization. Molecular Techniques: RFLP, RAPD.	5	5
	3.2	Blotting Techniques: Southern, Western, Northern **Activity**: Production of recombinant protein/enzyme.(Demo)	5	5

engineering	3.3	Application of genetic engineering: Production of GMOs: Transgenic plants, animals; Protection of recombinant Insulin, vaccines, antibiotics, Superbugs, Gene therapy, Biofuels, Molecular pharming; Risk of GMOs	5	4
4 Cutting-Edge Techniques and Future Perspectives	4.1	Genome Editing Technologies: CRISPR-Cas9, TALENs, and ZFNs	3	6
	4.2	Synthetic Biology: Design and Construction of Novel Biological Pathways and Organisms	3	6
	4,3	RNA Technologies: RNA Interference, RNAi Therapeutics, and Gene Silencing	3	6
	4.4	High-Throughput Sequencing Technologies and Applications in Functional Genomics	3	6
	4.5	Future Directions and Challenges in Genetic Engineering.	3	6
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

Reference:

1. Brown, T. A. (2007). Genomes 3. Garland Science.
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13. Nicholl, D. S. T. (2008). An Introduction to Genetic Engineering. Cambridge University Press.

SEMESTER VIII

<table>
<tr><td></td><td colspan="6">Mahatma Gandhi University
Kottayam</td></tr>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Plant metabolism</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCC A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG8DCCBBT400</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course is designed to make students aware of advances and applications in Plant Metabolism. After completion of the course, the students would be able to; Recall and articulate key concepts related to plant metabolism, including the pathways involved in energy production, biosynthesis of essential compounds, and regulatory mechanisms governing metabolic processes in plants.Grasp the fundamental principles underlying plant metabolism, including the biochemical pathways, enzyme kinetics, and metabolic regulation that drive cellular processes in plants.Equipped to apply their knowledge of molecular and cellular processes to understand how plants assimilate nutrients, synthesize biomolecules, and respond to environmental stimuli at the molecular level.Gain insight into the diverse range of plant responses to internal and external stimuli, as well as the regulatory mechanisms that govern these responses, including signal transduction pathways and gene regulation.Evaluate energy conversion processes in plants, including photosynthesis and respiration, and understand how these processes contribute to the overall metabolism and growth of plants.Synthesize information from various cellular processes in plants, integrating knowledge of metabolism, cellular signaling, gene expression, and physiological responses to gain a holistic understanding of plant metabolism</td></tr>
<tr><td>Semester</td><td>VIII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Introduction to plant cells, cell interaction, cytoskeleton, nucleic acids
Knowledge about light reaction and dark reaction</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall the concepts of plant metabolism	K	PO1
2	Comprehend the fundamental Principles of Plant metabolism	U	PO2
3	Apply Molecular and Cellular Processes in Plants	A	PO3
4	Analyze Plant Responses and Regulatory Mechanisms	An	PO1
5	Evaluate Energy Conversion and Metabolic Processes	E	PO2, PO3
6	Synthesize various Cellular Processes in Plants	C	PO1
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Biological membranes, Cell cycle and Plant Genome (12 hours)**			
	1.1	Biological membranes: Fluid-mosaic model, membrane Lipids, carbohydrates and proteins. Endomembrane system and membrane trafficking (brief study only). Cell cycle checkpoints: Cyclins and CDKs, regulation-G1/S and G2/M regulation, and spindle checkpoint.	6	1,2,3,5,6
	1.2	Nuclear Genome: Genome organization: Chromatin loops, 250 nm fibre and chromosome. Chromatin and the epigenetic regulation of gene expression. Plant Cytoplasmic Genomes: Mitochondria and Plastid genome: The endosymbiotic theory.	6	1,2,3,4,5,6
2	**Plant Physiology and Development (25 hours)**			
	2.1	Photosynthesis: The Light Reactions: PSI and PSII structure and composition, Mechanisms of Electron Transport, Proton Transport and ATP Synthesis in the Chloroplast. The Carbon Reactions: Rubisco-structure and function, The Calvin–Benson Cycle. Biosynthesis of starch and sucrose. The C_2 Oxidative Photosynthetic Carbon Cycle and its role. Brief account of adaptive mechanisms to overcome the oxidative property of Rubisco.	8	1,2,3,4,5,6
	2.2	Respiration: Substrate level phosphorylation (Brief study) Plant Mitochondrial electron transport, and ATP synthesis – organization of electron transfer complexes (complex I – V). Inhibitors of oxidative phosphorylation. Cyanide-Resistant Respiration ATP synthase, Binding change mechanism of ATP synthesis (Oxidative phosphorylation). Comparison of mitochondrial and chloroplast electron transport	8	1,2,3,4,5,6

	2.3	Signals and Signal Transduction -Plant signaling molecules and receptors (GPCR, Ion channel). Second messengers and signal transduction- MAPK cascades. Two-component signaling systems in plants : Cytokinin signal transduction. Structure and function of plant photoreceptors: phytochromes, cryptochromes, and phototropins. Floral induction and development (ABC Model).	5	1,2,3,4,5,6
	2.4	Plant Senescence and Cell Death- Leaf Abscission and Whole Plant Senescence (Brief account only). Types of cell death, PCD in plants (Brief account only), Leaf Senescence and its regulatory mechanism, Positive and Negative Senescence Regulators. Protein degradation in cells. (Brief account only)	4	1,2,3,4,5,6
3	**Biochemistry (8 hours)**			
	3.1	Overview of: Nitrate Assimilation, Ammonium Assimilation, Amino acid biosynthesis in plants: research and prospects, Symbiotic Nitrogen Fixation	4	1,2,3,4,5,6
	3.2	Lipid Metabolism -Fatty acid biosynthesis- an overview, Lipid metabolism in oil seeds – oxidation of fatty acids, glyoxylate cycle, gluconeogenesis.	4	1,2,3,4,5,6
4	**Practical (30 hours)**			
	4.1	Estimation of Free amino acids in senescing leaves/ Ripening fruits.	30	3,2
	4.2	Separation of photosynthetic pigments by TLC/column chromatography and calculate the Rf value.		
	4.3	Estimation of amylase activity in germinating seeds		
	4.4	Estimation of total chlorophyll in various leaf samples		
	4.5	Extraction and estimation of leg-hemoglobin from root nodules		
	4.6	Study of meiosis by smear preparation of PMCs.		
	4.7	Visit a molecular biology lab and submit a report		
	4.8	Isolation of DNA from plant samples.		

	4.9	**Activity (any one)** Write a report on latest advances in plant metabolism (a copy of the original paper to be submitted along with the document. Design and perform an experiment related to plant metabolism. Prepare and submit a report with geo-tagged photos. Prepare and submit an innovative project proposal based on plant metabolism. Presentation and submission of a report on a research paper related to recent advances in plant metabolism. Present and submit a report on emerging trends and technologies in plant metabolism. Prepare and submit an animated video/ audio visual documentary, explaining any plant metabolic process.		
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.

Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. **End Semester Evaluation (ESE)** **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

References

1. Buchanan, B. B., Gruissem, W., and Jones, R. L. (2015). *Biochemistry and molecular biology of plants*. 2nd ed. Wiley-Blackwell.
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4. Taiz, L., Moller, I. M., Murphy, A., and Zeiger, E. (2023). *Plant Physiology and Development*. 7th ed. USA: Sinauer Associates Inc. Publishers.

SUGGESTED READINGS

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11. Verma, V. (2007). Textbook of Plant Physiology. Ane Books India, New Delhi.
12. Taiz, L., Zeiger, E. (2002). Plant Physiolgy (III Edn). Panima publishing Corporation, New Delhi.

<table>
<tr><td></td><td colspan="6">Mahatma Gandhi University
Kottayam</td></tr>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Plant breeding and plant propagation techniques</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCC A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG8DCCBBT401</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course Plant breeding and Plant propagation techniques deals with plant and crop improvement techniques.</td></tr>
<tr><td>Semester</td><td>VIII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Outline divisions and components of Horticulture.	U	PO1
2	Describe the role of breeding methods in producing improved varieties of crop plants.	U	PO2
3	Illustrate how different plant growing structures are employed in Horticulture	A	PO2
4	Examine how cell differentiation occur in callus	An	PO1
5	Design aquaponics, hydroponics and aeroponics based irrigation systems for improved crop yield	A	PO1, PO2, PO3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Plant breeding (15 hours)**			
	1.1	Introduction to Plant Breeding: Objectives and achievements, Domestication and centres of origin of cultivated plants. Plant introduction - Primary and Secondary	4	1
	1.2	Breeding for resistance - Biotic (disease)- Vertical and horizontal Abiotic (drought) stresses.	4	2
	1.3	Mutation breeding: Achievements and limitations, Physical and chemical mutagens, Spontaneous and induced mutations, effects of mutation. Gamma gardens- Structure, Principles and working.	7	2
2	**Horticulture (15 hours)**			
	2.1	Introduction to Horticulture: Nature and scope. Objectives of horticulture. Divisions of horticulture, Fruit and vegetable zones of India. Career opportunities in horticulture. NHM, AHM, VFPCK, IRRI	3	1
	2.2	Basic components of Horticulture a. Soils: Types, Physical characteristics b. Climate: – Light, temperature, photoperiod, relative humidity, rainfall, altitude c. Common garden implements and tools d. Manures, Fertilizers: chemical fertilizers and organic fertilizers methods of application. e. Irrigation and water management: system of irrigation, surface irrigation, sub soil irrigation, overhead system of irrigation. Artificial propagation of plants (brief account)-	8	1
	2.3	Plant growing structures Greenhouse, Polyhouses, Mist chambers, Hot beds. Modern trends in horticulture-Aquaponics, Hydroponics, Aeroponics, Nutrient Film Technique. Horticulture therapy.	4	5
	Tissue culture (15 hours)			

	3.1	Important milestones in plant tissue culture. Types of cultures: organised structures - meristem, shoot tip, node, embryo, root cultures (Brief study); unorganised structures - callus, suspension and protoplast cultures (Brief study)	4	4
	3.2	Techniques and stages of micropropagation Advantages, disadvantages an of micropropagation	2	2
3	3.3	Differentiation of cells in callus - tracheid formation, chloroplast differentiation. Factors influencing vascular differentiation. Organogenic differentiation: factors influencing shoot bud differentiation, induction of organogenic differentiation. Advances and applications of tissue culture	9	4
4	**Practical (30 hours)**			

	4.1	**Students are expected to do minimum 5 practicals** 1. Identification of soil types based on particle size 2. Preparation of bio fertilizer and field application (Trichoderma culture and application). 3. Preparation and application of growth regulators (Coconut milk and root hormones). 4. Students are expected to submit any artificially propagated plants done by him (Cutting/Budding / Grafting/ Layering). 5. Identify and submit a layout of suitable irrigation techniques applicable in our local area. 6. Submit a photographic report on novel plant propagation tools. 7. Prepare aquaponics/ Hydroponics/ Aeroponics/ Nutrient Film 8. Hybridization techniques in self and cross pollinated plants 9. Visit a plant breeding station to familiarize with breeding programmes. Submit a report of the visit. 10. Preparation of MS medium from stock solutions. 11. Isolation, preparation, sterilization and inoculation of different explants like shoot tip, node, anther, embryo and cambium. **12.** Production of mutated cells/tissues/plants	30	2, 3, 4, 5
5	**Teacher specific course components**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)

Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory: 25 marks
·Involvement and responses in class room transactions
·Home Assignments/preparedness
·Oral presentation/Viva/Quiz/Open book test/written test
Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course
·Any other method as may be required for specific course / student by the course faculty
Practical: 15 marks
·Lab involvement and practical skills
·Record/Any other method as may be required for specific course / student by the course faculty</td></tr>
<tr><td>B. End Semester Evaluation (ESE)
Theory: 50 marks
Short answer (10 out of 12): 10 x 1=10
Short Essay (6 out of 8) : 6 x 5= 30
Essay (1 out of 2) : 1x 10= 10
Practical: 35 marks
·Practical based assessments: 30 marks
·Record: 5 marks</td></tr>
</table>

References

1. Adams, C. R., Early, M. P., & Bamford, K. M. (2008). Principles of horticulture. Butterworth-Heinemann.
2. Long, Bob. (2012). The EZ Guide to Gardening without Soil. Bonjour Limited Holdings LLC.
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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Phytochemistry and pharmacognosy</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG8DCEBBT400</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">Phytochemistry is the study of the chemicals produced by plants, particularly the secondary metabolites which are synthesized as a measure for self-defense, and its medicinal, industrial, and commercial applications. The proper understanding of phytochemicals is essential for drug discovery and for the development of novel therapeutic agents against major diseases. Pharmacognosy is the study and science of medicine from natural sources. Natural medicines have been used for many thousands of years to enhance human health and treat diseases, and modern pharmaceutical medicine is largely dependent on drugs originally discovered in and isolated from natural sources. Pharmacognosy remains a central feature in traditional medicine and pharmacology, with the former remaining the primary source of medicine in developing countries and emerging economies. This course introduces phytochemistry, discusses the relationship of phytochemistry with other sciences and the importance of pharmacognosy.</td></tr>
<tr><td>Semester</td><td>VIII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PO No
1	The student will be able to describe the importance of phytochemicals and pharmaceutical drugs.	U	PO1
2	The student will be able to explain the principle involved in the extraction and isolation techniques.	U	PO1
3	The student will be able to classify the different phytochemicals and pharmaceutical drugs.	A	PO2
4	The student will be able to carry out various phytochemical tests and procedures using different laboratory equipments.	An	PO3
5	The student will be able to evaluate various drugs and estimate the presence of phytochemicals. The student will be able to investigate the various adulterants present in pharmaceutical drugs	E	PO1, PO2, PO3, PO6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT				
MODULE	**UNITS**	**COURSE DESCRIPTION**	**Hrs.**	**CO NO.**
1	**Phytochemistry: Introduction to Phytochemistry,Plant Secondary Metabolites (15 Hours)**			
	1.1	A Definition, history and scope of Phytochemistry.	3	1,2
	1.2	Recent advances in the field of chemotaxonomy.	3	1,2
	1.3	Phytochemical approach to economic botany	2	1,2
	1.4	Classification, occurrence, structure and function of medicinally important plant products: glycosides, tannins, alkaloids, phenolic compounds, saponins, terpenoids, steroids, flavonoids, gums and mucilage.	7	1,2
2	**Extraction and characterization of phytochemicals (15 Hours)**			
	2.1	Solvents- Petroleum ether, Chloroform, Ethanol, Acetone, Water	3	2
	2.2	Extraction techniques- Cold extraction, Hot extraction, Soxhlet- Clavenger apparatus	3	2
	2.3	Separation techniques- TLC, Column Chromatography, HPLC; Characterization techniques- GC-MS, LC-MS/MS, UV-VIS Spectrometry, IR Spectrometry, N M R	9	2
3	**Pharmacognosy-Introduction, classification and evaluation of drugs, sources, and techniques of drug production (15 Hours)**			
	3.1	Definition, history, scope, and development	1	1.2.3,6
	3.2	Plants in Medicine: Indigenous traditional drugs, traditional system of medicine, herbal medicine, folk medicine, unani, siddha, ayurveda, homoeopathy and Chinese medicine (Brief) Ethnopharmacology	4	
	3.3	Therapeutic classification of crude drugs, Morphological, microscopical and organoleptic evaluation of crude drugs; Drug preparation and storage. Collection and preparation of crude drugs for the market. Quality control of drugs- Adulteration of drugs, tools for identification.	4	
	3.4	Plant kingdom as source of drugs- plant secondary metabolites as drugs	2	

	3.5	Techniques for production of drugs– purification, filtration, adsorption, solubilization, absorption, suspension and emulsification. Histochemical localization of starch grains- rice, potato	4	
4	**Practical (30 hours)**			
	4.1	Histochemical analysis of plant components: Starch grains in rice and potato.	15	1.2.3,6
	4.2	Estimation of water content, dry matter and ash content. Qualitative analysis of tannins, phenolics, flavonoids and alkaloids. TLC and column chromatography (Demonstration).	10	1.2.3,6
	4.3	Visit a phytochemical industry and learn the industrial process of phytochemical isolation and drug manufacturing. Interaction with subject expert in the field of Ayurvedic medicine for industrial exposure	5	1.2.3,6
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.

<table>
<tr><td>Assessment Types</td><td>MODE OF ASSESSMENT
A. Continuous Comprehensive Assessment (CCA)
Theory: 25 marks
·Involvement and responses in class room transactions
·Home Assignments/preparedness
·Oral presentation/Viva/Quiz/Open book test/written test
Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course
·Any other method as may be required for specific course / student by the course faculty
Practical: 15 marks
·Lab involvement and practical skills
·Record/Any other method as may be required for specific course / student by the course faculty</td></tr>
<tr><td></td><td>B. End Semester Evaluation (ESE)
Theory: 50 marks
Short answer (10 out of 12): 10 x 1=10
Short Essay (6 out of 8) : 6 x 5= 30
Essay (1 out of 2) : 1x 10= 10
Practical: 35 marks
·Practical based assessments: 30 marks
·Record: 5 marks</td></tr>
</table>

References

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SUGGESTED READINGS

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3. Trease G E and Evans W C (2002) Pharmacognosy. Collis Macmillan Publishers, Madras.

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Omics in plant sciences</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG8DCEBBT401</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course will provide a comprehensive overview of data resources, tools and techniques that have revolutionized Plant Science research especially in the fields of genome editing, high throughput sequencing, metabolomics etc. There will be sessions on genomics, transcriptomics, proteomics and metabolomics with emphasis on dealing with large-scale dataset production and challenges in high-throughput data handling and analysis. The goal of this course is to broadly review molecular and omics technologies applied in Plant science research.</td></tr>
<tr><td>Semester</td><td>VIII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Basic understanding of molecular biology tools used in Bioinformatics</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Compare key technologies used to generate omics data	U	PO1, PO2
2	Implement and use methods for detection and annotation of genomic variants	A	PO1
3	Outline methods for sequence mapping and assembly of genomes and transcriptomes	An	PO3
4	Recommend a omics experiments to address the biological question	E	PO1, PO2
5	Design an omics-based experiment to address a certain biological question - and take a lead role in analyzing resulting data	C	PO2, PO3

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

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1		**Introduction to omics, Genomics-Structural and Functional (15 hours)**		
	1.1	Introduction to Omics, Historical development in Biological Research, Genomics, Proteomics, Transcriptomics, Metabolomics-Applications in Plant science (overview)	3	1
	1.2	Structural genomics- Genome organization, genome mapping: (Principle and Application) SSR, ISSR, AFLP, SNP, Physical and genetic maps (An overview with special reference to crop improvement). Role of Genome sequencing techniques in structural genomics: Sanger's dideoxy sequencing, whole genome shotgun sequencing, Pyrosequencing. Genome annotation.	8	2,3
	1.3	Functional genomics- mRNA profiling, Gene expression analysis using RT-PCR, Applications of Functional genomics	4	4
2		**Transcriptomics and proteomics (15 hours)**		
	2.1	Transcriptomics- insights of transcriptomics (mRNA regulation). Types and function of RNA Transcriptome analysis: Role of Q-PCR, Microarray. EST- Expressed Sequence Tags, EST database and EST web tools SAGE -Serial Analysis of gene expression, Role of SAGE in Gene Discovery,	5	3,4,5
	2.2	Proteomics-Introduction to proteomics, Types (Quantitative, Functional- Brief account)	1	3
	2.3	Structural Proteomics: Primary, Secondary, Super Secondary, tertiary and Quaternary Structure Ramachandran Map, Protein Folding	4	3,4
	2.4	Protein identification-Western Blotting, Mass Spectroscopy (Brief Account only) Peptide sequencing (Edman Degradation) Protein structure elucidation- X-ray crystallography,	4	3,4,5

	2.5	Functional proteomics - protein-protein interaction (GFP tagging, reporter assay)	1	3,4,5
3	**Metabolomics (15 hours)**			
	3.1	Metabolomics: Introduction to metabolomics: Metabolome, Metabonomics (Terms and Concepts). Application of metabolomics analysis in medicinal plant science.	3	4,5
	3.2	Metabolomes Databases- PmDB, Metabolite profiling, Metabolome fingerprinting.	7	4,5
	3.3	Role of Biomarkers in metabolomics, Tools of metabolome studies: NMR, MS, GC, LC, IR	5	4,5
	Practicals (30hrs)			
4	4.1	Submit a comparative account on the different genome sequencing strategies with special reference to Arabidopsis thaliana / Rice genome projects.	5	
	4.2	Prepare a report on any of the above genome projects and submit for evaluation	5	
	4.3	Extract protein from plant tissues using suitable methods	5	
	4.4	Predicting protein structure from sequences from NCBI and predict their three-Dimensional structure	5	
	4.5	Extract metabolites from plants using suitable solvent and use simple colorimetric assays to identify them.	5	
	4.6	Use computational tools to predict protein secondary and tertiary structures and analyze Ramachandran plots	5	
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. **End Semester Evaluation (ESE)** **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Modern trends in plant systematics**
Type of Course	**DCE A**
Course Code	**MG8DCEBBT402**
Course Level	**400**
Course Summary	The morphological characters alone should not be considered in systematic classification of plants. Modern trends help plant taxonomists to look for more precise techniques in order to understand the relation between the genera and families. Complete knowledge of taxonomy is possible with the principles of various disciplines like cytology, palynology, phenology, biochemistry and numerical taxonomy. These have been found to be useful in solving some of the taxonomical problems by providing additional characters.

Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the conceptual basis of plant classification and the concept of family, genus and species and the taxonomic diversity within species	U	1,2
2	Develop working skills in modern techniques in plant systematics	A	2,9
3	Choose appropriate tools of modern systematics for plant identification	A	10

4	Determine evolutionary relationship between a group of species using molecular taxonomic tools and techniques	A	2
5	Construct phylogenetic trees based on molecular systematic data	C	1, 2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1		**Conceptual basis of plant systematics (16)**		
	1.1	Definition, Concepts and theories of classification and biosystematics. History and theories of classification – Theophrastus, Linnaean and post Linnaean era- Phylogenetic classification - Angiosperm Phylogeny Group (APG)- Detailed Account.	7	1
	1.2	Hierarchy in classification. Concept of Family, Genera, Species, Subspecies and other infra-specific categories. Species concepts: Typological, Nominalistic and Biological species concepts (in plant perceptive).	6	1
	1.3	The new global taxonomy initiatives: Systematic Agenda-2020- Missions.	3	3
2		**Interdisciplinary approaches in plant systematics (14)**		
	2.1	Chemotaxonomy- Classification based on phytochemicals- phenolics, alkaloids, terpenoids and nonprotein amino acids. Serology and Taxonomy. Scope and limitations..	5	3
	2.2	Cytotaxonomy – chromosome number, chromosome size, chromosome banding and behaviour of chromosomes during division	5	3
	2.3	Palynotaxonomy- Pollen morphological characters and their significance in taxonomy and evolution- Polarity,	4	3

		symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern. PollenAtlas		
3	**Ultrastructural and Numerical systematics (15 hours)**			
	3.1	Stereo Microscopes, Scanning Electron Microscopy, Transmission Electron Microscopy, Microphotography (Image analyser software) for micromorphological studies - Trichomes and seed morphology	5	2,3
	3.2	Numerical Taxonomy (Phenetics): Theory and principles- Operational Taxonomic Unit (OTU) Cluster analysis; UPGMA Methods; NTSYS, Applications, Merits and Demerits, Cluster analysis, Dendrogram.	4	4,5
	3.3	Molecular taxonomy - concepts, scope and limitations, Plant DNA barcoding- Molecular markers- isozymes, AFLP, Internal Transcribed Spacer (ITS), rbcL, matK. NCBI, Similarity search tools- BLAST, FASTA,Cladistics (Monophyletic, polyphyletic and paraphyletic groups), Phylogenetic tree construction, methods and tools- MEGA, PHYLIP. Interpreting data. Detailed study.	6	4,5
4	**Practicals (30 hours)**			
	4.1	Students should submit a review on plant classification- past to present.	3	1
	4.2	Students should refer to research articles and find out some cases where chemotaxonomic markers helped to establish their taxonomic identity	3	3
	4.3	Students should familiarise themselves with the application of chemical data fromTLC/ HPTLC/ HPLC/GC for taxonomy.	4	3
	4.4	Semipermanent pollen preparations by acetolysis method /any other alternative methods and study of different pollen morphotypes.	5	3
	4.5	**:**Study of plant surface attributes (trichomes/spines/etc.) / pollen characters with the help of Stereo Microscope /SEM.	5	3

	4.6	Practical based on numerical taxonomy- Construct OTU tables examining morphological characters of selected plants.	5	4,5
	4.7	Construct phylogenetic trees using MEGA/PHYLIP or Sequence similarity searching through NCBI BLAST	5	4.5
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. **End Semester Evaluation (ESE)** **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

References

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SUGGESTED READINGS

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Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Agroecology**					
Type of Course	**DCE A**					
Course Code	**MG8DCEBBT403**					
Course Level	**400**					
Course Summary	This course provides a comprehensive exploration of the principles and applications of agroecology, offering undergraduate botany students a foundational understanding of how ecological processes can be strategically applied to agricultural systems. As the global agricultural landscape evolves, agroecology emerges as a transformative approach that integrates ecological principles with sustainable farming practices.					
Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1		75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recognize the foundations of Agroecology	U	PO1
2	Apply Agroecological principles to Agriculture	A	PO1, PO2
3	Implement sustainable soil and crop management practices	A	PO2, PO3
4	Apply both cognitive understanding and practical skills in integrated livestock and pest management for sustainable agriculture	A	PO2, PO5
5	Analyze and promote sustainable agricultural practices	An	PO1, PO6, PO7, PO8
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Fundamentals of Agroecology: Principles and Applications (15 hours)			
1.	1.1	Introduction to Agroecology- Definition and scope, historical development and evolution of agroecology, Distinctive features of agroecology as a discipline, ecological, Social and economic benefits, Sustainability in agriculture	4	1,5
	1.2	Basic principles and concepts- Agroecological Principles and elements and their implications in Agricultural systems.	4	2
	1.3	Soil Management for Sustainable Agriculture- Soil health and sustainability, Importance of soil as a living ecosystem, Soil structure,	5	3

		texture and composition, Erosion control methods, cover cropping and mulching, contour plowing and terracing.		
	1.4	Crop Diversity and Rotation- Types and benefits of cover crops, incorporating cover crops in rotation, improving soil health and structure, Benefits of crop rotation.	2	2,3,5
2	**Sustainable Farming Practices and livestock integrations (18 hours)**			
	2.1	Agroforestry- Introduction to Agroforestry, Principles of agroforestry, Alley cropping, wind breaks and integrating trees and crops for mutual benefits, Biodiversity enhancement, carbon sequestration and climate resilient farming, Economic and social benefits	5	2,5
	2.2	Water Management in Agriculture- Importance of water in agriculture, Role of water in plant growth and development. Efficient Irrigation techniques- Drip irrigation, sprinkler and furrow irrigation, Water conservation practices in irrigation. Rain water harvesting techniques, sustainable use of water resources	6	2,3,5
	2.3	Livestock Integration in Agroecosystems- Silvio pasture and agroforestry systems with livestock, Grazing and mixed farming practices, grazing management for optimal land use	4	4,5
	2.4	Balancing crop and livestock systems, Inter dependence between crops and livestocks, Nutirentcycyling and Waste utilisation	3	4,5
	Food Systems and Security (12 hours)			

3.	3.1	Environmental impact assessment of agricultural practices, mitigation strategies for minimizing negative effects	3	5
	3.2	Ensuring food security- understanding the ecological footprints of different farming systems	3	1,5
	3.3	Social and economic aspects of sustainable agriculture- Socioeconomic impact of agricultural practices, community engagement and involvement of communities in sustainable agriculture.	4	5
	3.4	Ethical values and practices involved in agriculture	2	5
4.	**Practical (30 hours)**			
	4.1	Soil texture and composition analysis using hydrometer and particle size distribution	2	3,5
	4.2	Field visit: Visit Designated Field areas with cover crop and discuss the benefits of over crop and mulching	10	2,5
	4.3	Field Visit: Visit field to study the impact of tree crop interaction and their impact on soil properties	10	2,5
	4.4	Analyse the water retention and distribution efficiency of different irrigation systems	3	3,5
	4.5	Analyse the nutrient content in soil in farms with and without livestock integration.	5	4,5
5	**Teacher specific module**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)

Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
<tr><td>Assessment Types</td><td>MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory: 25 marks
·Involvement and responses in class room transactions
·Home Assignments/preparedness
·Oral presentation/Viva/Quiz/Open book test/written test
Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course
·Any other method as may be required for specific course / student by the course faculty
Practical: 15 marks
·Lab involvement and practical skills
·Record/Any other method as may be required for specific course / student by the course faculty</td></tr>
<tr><td></td><td>B. End Semester Evaluation (ESE)
Theory: 50 marks
Short answer (10 out of 12): 10 x 1=10
Short Essay (6 out of 8) : 6 x 5= 30
Essay (1 out of 2) : 1x 10= 10
Practical: 35 marks
·Practical based assessments: 30 marks
·Record: 5 marks</td></tr>
</table>

References

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2. Agroecology: A transdisciplinary participatory and action oriented approach edited by Ernesto Mendez, Christopher M Bacon, Roseann Cohen.
3. Agroecology in Action: extending alternative agriculture through social
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1. Bruno Dorin (2022) Theory, Practice and Challenges of Agroecology inIndia, International JournalofAgricultural Sustainability, 20:2, 153-167, DOI: 10.1080/14735903.2021.1920760

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**					
Course Name	**Forest Botany**					
Type of Course	**DCE A**					
Course Code	**MG8DCEBBT404**					
Course Level	400					
Course Summary	This course will help develop a comprehensive understanding of plant science as applied to forest ecosystems. Covering taxonomy, morphology, physiology, ecology, genetics, and practical applications, the course equips students with the knowledge and skills necessary for sustainable forest management.					
Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Develop a comprehensive understanding of forest ecosystems, exploring tree morphology and recognizing diverse forest types with a focus on stratification and physiogamy.	U, A, An	PO2, PO6, PO10
2	Hone skills in plant identification, classification, and recognize the significance of endemic species, understanding their causes, threats, and consequences.	K, U, A, An	PO2, PO6, PO7
3	Explore forest ecology, ecological interactions, and recognize threats to biodiversity, while formulating effective conservation strategies and understanding genetic resource documentation	E, An, C, S	PO2, PO6, PO7
4	Apply theoretical knowledge practically, calculating biodiversity indices, examining leaf modifications, and gaining field experience through forest visits. Understand physiological adaptations of forest plants to environmental stress and their role in carbon sequestration.	A, An, S, I	PO2, PO4, PO5, PO6, PO10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to forest Botany (15 hours)**			
	1.1	Introduction to forest ecosystems, Morphology or trees,	5	1
	1.2	Importance of forest- Radiation, temperature, precipitation patterns and wind, forest products- Major and Minor	5	1,2

	1.3	Forest types- stratification and physiognomy	5	2
2	**Forest Plant Diversity (15 hours)**			
	2.1	Tree identification and classification based on morphology of stem and leaves and architecture	5	2,4
	2.2	Shrub and herbaceous plant diversity- adaptations, role, interactions. Shannon wiener index	5	2,3
	2.3	Endemic and rare species- causes, significance, Threats, Red data book, consequences of loss	5	2,3
3	**Forest conservation, management and physiology (15 hours)**			
	3.1	Forest succession, community- structure and dynamics. Forest productivity, ecological succession. Ecological interaction in forest- geographic and climatic factors, nutrient cycling, impact of abiotic factors. Mutualism, competition, predation, role of decomposers	5	3
	3.2	Adaptation in forest environment- Structure of leaves, stem wood , bark and roots in trees, adaptations with special reference to shade tolerance, leaf modifications, Root systems, seed dispersal mechanisms , epiphytic adaptations and mycorrhiza associations	5	3,4
	3.3	Threats to biodiversity- Climate change, Global warming and forests depletion. Deforestation, role of invasive species Conservation strategies for forest plants: Documentation and evaluation of forest genetical resources (FGR), in situ and ex situ conservation of gene resources.	5	3,4

		Application of remote sensing and biotechnological Approaches		
4	**Practicals (30 hours)**			
	4.1	Calculate Shannon Wiener index for biodiversity index for two distinct ecosystems.	5	4
	4.2	Examine leaf modification and their adaptive significance.	3	4
	4.3	Collect water samples and perform water quality analysis using titrimetric methods.	3	4
	4.4	Visit a local forest and explore different interactions, its stratifications.	10	4
	4.5	Collect soil samples from different forest ecosystems and analyse the soil properties.	9	4
5.	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** B. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course

	·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	C. End Semester Evaluation (ESE) **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

References

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2. Nageswara-Rao, M., Soneji, J. R., & Sudarshana, P. (2012). Structure, diversity, threats and conservation of Tropical Forests. *Tropical Forests*, *1*.
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25. Lorenz, K. (2010). *Carbon sequestration in forest ecosystems*.2). Carbon sequestration in forests and soils. *Annu. Rev. Resour. Econ.*, *4*(1), 127-144.

SUGGESTED READINGS

1. Bettinger, P., Boston, K., Siry, J. P., & Grebner, D. L. (2016). *Forest management and planning*. Academic press.SA, P. W. P., & Rica, C. (2016). Forest management.
2. Spittlehouse, D. L., & Stewart, R. B. (2003). Adaptation to climate change in forest management.

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<tr><td></td><td colspan="6">Mahatma Gandhi University
Kottayam</td></tr>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Aquatic Botany</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG8DCEBBT405</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">This syllabus aims to cover key aspects of aquatic botany, providing students with a comprehensive understanding of the diversity, ecology, and conservation of plants in aquatic environments.</td></tr>
<tr><td>Semester</td><td>VIII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td>-</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	The learner will acquire comprehensive understanding of aquatic ecosystems, including physiochemical properties, flora and biological productivity.	U,A,An	PO1, PO3, PO10
2	Acquire skills in identifying and classifying aquatic plants and their ecology	S, U, A	PO1, PO2, PO3, PO4, PO10
3	The learner will be able to proficiently analyse different types of water pollution, understand their sources and propose effective management and conservation strategies.	S, U, A	PO1, PO2, PO6, PO8
4	The learner will be able to acquire knowledge and develop and understanding of the physiology and adaptations in aquatic plants	U,A,An	PO1, PO2, PO3
5	The student will be able to recognize threats to aquatic plant biodiversity and implement conservation strategies considering factors like climate change, aquaculture and habitat degradation.	U, A, E, C	PO1, PO5 PO6, PO7 PO9
6	Demonstrate practical skills through activities such as setting up a natural aquarium, conducting water quality analysis and plan participate in mangrove restoration	S, A, C, I	PO2, PO4, PO5, PO6, PO7, PO9, PO10

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

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
	Introduction to Aquatic Botany (15 hours)			
1	1.1	Overview of Aquatic Ecosystems **Fresh water-** Lentic ecosystem and Lotic Ecosystem **Rivers and Ponds**: Physicochemical properties.	5	1,3

		Riparian flora, Biological productivity. Concept of watershed and watershed management **Swamps and marshes**: Types of swamps. Physicochemical conditions. Nutrient cycling. **Lakes and reservoirs**: Characteristics and stratification. **Marine**- definition, range of salinity, stratification **Mangroves** and **Estuaries**		
	1.2	Identification and Classification of Aquatic Plants Classification based on growth form--freshwater higher vascular plants-floating (rooted and free floating), submerged and emerged, sea weeds, sea grasses and mangroves, invasive aquatic plants. Classification based on morphology-amphiphyres, Helophytes, nymphaeids, Isoetids, neuston etc. Micro and Macro algae: distribution and importance. Seaweeds and Seagrasses: structure, types and economic importance	6	2,3
	1.3	Functions of aquatic ecosystems. Importance in nutrient cycling, impact of soil chemistry and role in soil chemistry.Dynamics of plant aquatic community, common aquarium plants	4	1,4
2	**Aquatic Pollution and Management (15 hours)**			
	2.1	Water pollution: types- Thermal pollution, Oil pollution, Radioactive pollution, Detergent pollution, interaction of pollutants and factors affecting toxicity Sources: Characteristics of effluent sewage, industrial and agricultural discharges. Emerging pollutants, heavy metals, pesticides, plastic and microplastics, oil spills, etc.	5	3,4
	2.2	Biological concern: Eutrophication (change in the plant diversity in aquatic systems, change in DO levels), algal blooms, bioaccumulation and biomagnification, change in water quality (BOD, COD, DO), monitoring and control of pollutants, effect of waste disposal on marine ecosystem.	6	3,4
	2.3	Sustainable Management of Aquatic Environments. Conservation of freshwater ecosystems. Restoration of	4	3,5

		freshwater wetlands. Ramsar convention, Ramsar sites, Role of Pollution Control Board (PCB) Conservation of Mangroves: need, Impact of human, role of institutions and NGO's in India		
	Conservation, physiology and Adaptations (15 hours)			
3	3.1	Threats to Aquatic Plant Biodiversity: Climate change, Harmful aspects related to aquaculture activities, introduction of exotic species, destruction of mangroves, Expanding hydropower etc	5	5,6
	3.2	Conservation Strategies for Aquatic Plants: Conservation of freshwater ecosystems, habitat restoration ecology, Habitat protection, wetland conservation, riparian buffer zones, invasive species management.	5	5,6
	3.3	Physiology and Adaptations in Aquatic plants. Fine structure and properties of algal plastids. Morphological and anatomical modifications in aquatic plants. Physiological adaptations in mangroves.	5	4,6
4	**Practicals (30 hours)**			
	4.1	Collect common aquatic plants- Identify and set up and natural aquarium	5	2,6
	4.2	Collect aquatic plants and plants form mangroves and conduct anatomical studies to understand anatomical adaptations	5	2,6
	4.3	Field visit to observe and identify aquatic ecosystems	10	1,5
	4.4	Conduct water quality analysis between different aquatic ecosystems using titrimetric methods	3	3,6
	4.5	Visit mangroves to understand the ecological significance and the need for restoration activities	7	5
5	**Teacher specific module**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)

Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching.</td></tr>
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References

1. Bolton, J. J. (2016). What is aquatic botany?—And why algae are plants: The importance of non-taxonomic terms for groups of organisms. *Aquatic Botany*, *132*, 1-4.
2. Barnes, R. S. K., & Mann, K. H. (Eds.). (2009). *Fundamentals of aquatic ecology*. John Wiley & Sons.
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Mahatma Gandhi University
Kottayam

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) Botany and Biotechnology (Double Major Programme)</td></tr>
<tr><td>Course Name</td><td colspan="6">Plant bioanalytics and advanced instrumentation</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE A</td></tr>
<tr><td>Course Code</td><td colspan="6">MG8DCEBBT406</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course equips the students with essential skills for molecular and cellular research like microscopy, centrifugation, radioisotope application, chromatography and mathematical concepts. The course prepares the students for roles in both research and professional settings.</td></tr>
<tr><td>Semester</td><td>VIII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td>-</td><td>1</td><td></td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">The student must have completed courses in cell biology, biochemistry and plant physiology.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Utilize the microscopy and imaging techniques	A	PO2, PO8
2	Apply the expertise in experimental techniques and specifically in chromatography and advanced imaging methods	A	PO2, PO5
3	Establish the basics of biochemical mathematics and acid-base chemistry, applying mathematical and statistical concepts in biological research	A	PO1, PO6
4	Demonstrate practical skills in applying biochemistry techniques, including plant pigment separation, and critically evaluate and interpret diverse micrographs.	A	PO2, PO10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Imaging techniques and Cell fractionation (15 hours)**			
	1.1	Principles of microscopy- Types of microscopes: Optical, electron, and fluorescence microscopes, Importance of resolution and magnification. Light Microscopy, Basics of light microscopy. Brightfield and phase contrast microscopy.	5	1
	1.2	Fluorescence Microscopy: Principles of fluorescence and fluorochromes. Applications in cell biology: Live cell imaging, immunofluorescence. Principles of Excitation emission and fluorophore selection. Commonly used fluorescent dyes. Confocal microscopy, FRET.	5	1
	1.3	Electron Microscopy: Transmission and scanning electron microscopy. Sample preparation techniques: Fixation, embedding, sectioning, Applications of Fluorescence Microscopy: Chromosome analysis: Banding techniques.	5	1

		Fluorescence in situ hybridization (FISH) Live cell imaging, super resolution microscopy		
2	**Centrifugation andbasic spectroscopy (20 hours)**			
	2.1	Centrifugation Basics, Principles of centrifugation. Different types of centrifuges: Fixed angle, swinging bucket. Factors influencing centrifugation.	5	2
	2.2	Differential and density gradient centrifugation: Techniques for separating cellular components. Sucrose density gradient and CsCl2 gradient centrifugation.	5	2
	2.3	Basics of Spectrophotometry-Principles of spectrophotometry. Applications in quantifying biomolecules. UV -Visible spectrophotometry and its limitations.	5	2
	2.4	Autoradiography and pulse chase experiment. Basic Principles and applications in studying cellular dynamics.	5	2
3	**Chromatography and Biochemical Methods (10 hours)**			
	3.1	Basics of chromatography. Principles: overview of chromatography principles. Types of chromatography: Gas, liquid, affinity, size exclusion.	3	2
	3.2	Paper chromatography and column chromatography: basics, techniques and applications	3	2
	3.3	Characterization Techniques- Mass spectrometry: Principles and applications.	2	2
	3.4	Introduction to Biochemical Mathematics: Basics of mathematical concepts applied in biochemistry.	2	2
4	**Practical (30 hours)**			
	4.1	Prepare and observe microscopic slides of different specimens of different types of plant cells	5	1
	4.2	Collect and evaluate micrographs from different types of microscopes	3	1
	4.3	Separate different cellular components from a given sample using centrifugation	4	2
	4.4	Estimate protein concentration using lowry's method	3	2

	4.5	Separate plant pigments using thin layer chromatography	5	2
	4.6	Lab visit: Visit a well-established lab with advanced bioinstrumentation facility	10	1,2,3, 4,
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Field based collection and interactions, Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** A. **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** ·Involvement and responses in class room transactions ·Home Assignments/preparedness ·Oral presentation/Viva/Quiz/Open book test/written test Field study report /Group discussion on a recent research or review article (≤ 5 years) related the course ·Any other method as may be required for specific course / student by the course faculty **Practical: 15 marks** ·Lab involvement and practical skills ·Record/Any other method as may be required for specific course / student by the course faculty
	B. **End Semester Evaluation (ESE)** **Theory: 50 marks** Short answer (10 out of 12): 10 x 1=10 Short Essay (6 out of 8) : 6 x 5= 30 Essay (1 out of 2) : 1x 10= 10 **Practical: 35 marks** ·Practical based assessments: 30 marks ·Record: 5 marks

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SUGGESTED READINGS

1. Farago, M. E., & Mehra, A. (1994). 9 Analytical Techniques for Plant Analysis. *Plants and the Chemical Elements: Biochemistry, Uptake, Tolerance and Toxicity*, *253*, 241.
2. Kalra, Y. P. (1998). Methods for plant analysis. *CRC, USA*, 85-88.
3. Garg, B. K. (2012). *Plant analysis: comprehensive methods and protocols*. Scientific Publishers.
4. Dhale, D. A. (2023). *Advanced Techniques in Plant Sciences*. Book Saga Publication.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Advanced Instrumentation Techniques**
Type of Course	**DCE B**
Course Code	**MG8DCEBBT407**
Course Level	**400**
Course Summary	This course describes different advanced techniques in proteomics, imaging techniques and genomics

Semester	8	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	**75**
Pre-requisites, if any	Need to complete difficulty level 300-399 level courses					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Students will be able to recall the working principles of advanced techniques used biological research	K	1, 10
2	Students will be able to classify the techniques required for specific application	An	1,2,3
3	Students will be able to implement different techniques used in biological research	A	1, 2,9
4	Students will be able to evaluate biological samples for the detection of specific proteins	E	I, 2, 10

5	Students will be able to select suitable tools for applying various techniques.	E	1,2.9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Techniques in proteomics	1.1	Protein purification- An overview,	4	1
	1.2	Techniques in protein purification- Cell lysis Methods, Precipitation Techniques, Dialysis, Chromatographic techniques (Ion exchange, Size exclusion, Affinity chromatography).	6	1,2
	1.3	Techniques used in protein analysis and characterization: SDS PAGE, Western Blotting, HPLC, NMR Spectroscopy- Proton NMR, C13 NMR, 2D NMR, MALDI - ToF Spectroscopy, Peptide Mass Fingerprinting, GC-MS.	5	1,2
2 Advanced Imaging Techniques	2.1	Microscopic Techniques:- Phase Contrast Microscopy, Fluorescent Microscopy, Confocal Microscopy, Flow cytometry.	5	1,2
	2.2	Electron Microscopy:- Scanning Electron Microscopy, Transmission Electron Microscopy, Cryo Electron Microscopy.	5	1,2
3.	3.1	Sequencing Techniques: -	7	1,2

Techniques in genomics		Next Generation Sequencing Techniques - Illumina, Nanopore Sequencing.		
	3.2	Sequence analysis tools	7	1,2
	3.3	Gene expression analysis: Relative gene expression Analysis using qPCR, DNA microarrays, Biosensors	6	1,2
4 **Practicals**	4.1	Protein purification	4	1,2,
	4.2	Ion exchange / Affinity chromatography	8	1,2
	4.3	SDS PAGE	8	1,2
	4.4	Western Blotting	6	1,2
	4.5	DNA sequencing (Demo)	4	1,2
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **G. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	H. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References

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PROJECT

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Botany and Biotechnology (Double Major Programme)**
Course Name	**Project**
Course Code	**MG8PRJBBT400**
Summary	The project undertaken in the 8th semester is a crucial element of an individual’s academic journey, providing hands-on experience and a deep dive into practical applications of their field of study. This project allows students to synthesize their knowledge, tackle real-world problems, and develop innovative solutions, enhancing their technical proficiency and research capabilities. Working closely with scientists, faculty members, researchers and industry experts, in a collaborative environment, students gain invaluable insights and professional skills. This culminating experience not only reinforces their academic learning but also prepares them for future careers or advanced studies, ensuring they are well-equipped to meet the demands of their chosen professions
Project with 12 credits (200 marks)	**A) Continous Comprehensive Assessment (CCA) :60 marks** (If the student is doing project in any institutions out side the college, internal marks may be obtained from the project supervisor of that institute) **a. Project Proposal (10 marks)** **Criteria:** • Clear definition of the project objectives and scope. • Feasibility and relevance of the project topic. • Detailed methodology and work plan. **b. Literature Review (10 marks)** **Criteria:** • Depth of literature review. • Critical analysis of existing research.

- Identification of Research gaps

c. **Methodology and experimental design(15marks)**
Criteria:

- Appropriateness of methodology
- Robustness of the chosen methodology
- Experimental Designs- Controls and variables

d. **Data collection and analysis (15 marks)**
Criteria:

- Quality of Data collection
- Data Analysis techniques
- Critical analysis and interpretation of data.

e. **Professionalism and Team work(5 marks)**
Criteria:

- Punctuality
- Ability to work independently and as part of a team
- Creativity and ethical conduct
- Adherence to work place rules

f. **Supervisor Evaluation (5 marks)**
Criteria:

- Feedback from the internship supervisor regarding the intern's performance, growth, and contributions.
- Supervisor's overall satisfaction with the intern's work and professionalism

(B) End Semester Evaluation (ESE) : 140 marks

a. **Introduction, novelty and relevance of the project. (20 marks)**
Criteria :

- Clarity and comprehensiveness of the project
- Novelty of the project.
- Relevance and depth of background information.

b. **Objective and Literature Review (10 marks)**
Criteria:

- **Clarity and relevance of the objectives**
- **Depth of literature review.**
- **Critical analysis of existing research.**

- **Identification of Research gaps**

c. **Methodology and Experimental Work (20 marks)**
Criteria:
- Clarity and description of methodology
- Depth of literature review.
- Critical analysis of existing research.
- Identification of Research gaps

d. **Data collection and presentation (15 marks)**
Criteria:
- Clarity and description of methodology
- Depth of literature review.
- Critical analysis of existing research.
- Identification of Research gaps

e. **Results (10 marks)**
- Clarity, accuracy and presentation of results

f. **Discussion (10 marks)**
- Depth and insightfulness of discussion
- Interpretation of results

g. **Conclusion and future prospects (10 marks)**
- Summary of findings
- Recommendation for future work

h. **References (10 marks)**
- Uniformity of style.

i. **Presentation (30 marks)**
- Clarity, logical structuring
- Formatting- grammar and spelling

j. **Viva Voce (5 marks)**
- Description, explanation, handling of questions and critical thinking, ability to communicate ideas clearly and coherently