Est. in 1921

UNION CHRISTIAN COLLEGE (AUTONOMOUS) ALUVA

Affiliated to Mahatma Gandhi University, Kottayam, India
NAAC Accredited with A++ Grade in Vth cycle
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DEPARTMENT OF BOTANY

UG SYLLABUS 2025

UNDERGRADUATE (HONOURS) PROGRAMMES {UCC UGP (HONOURS)}

Adopted from THE MAHATMA GANDHI UNIVERSITY
UNDER GRADUATE PROGRAMMES
(HONOURS) SYLLABUS
MGU-UGP (Honours)
(2024 Admission Onwards)

UNION CHRISTIAN COLLEGE, ALUVA (Autonomous)

UNDERGRADUATE PROGRAMMES (HONOURS) SYLLABUS

UCU-UGP (Honours)

(2025 Admission Onwards)

Faculty: Science

BoS: Botany

Subject: Bachelor of Science (Honours) Botany

Contents

PREFACE

With great enthusiasm and a strong sense of responsibility, we, the Board of Studies in Botany at Union Christian College, Aluva (Autonomous), present this preface to the meticulously crafted curriculum and syllabus, adopted from the Board of Studies in Botany, Mahatma Gandhi University, for the Four-Year Undergraduate Program (FYUGP) in Botany at our institution. We sincerely acknowledge and thank the Board of Studies in Botany, Mahatma Gandhi University, for the excellent syllabus they have developed.

The introduction of the Four-Year Undergraduate Program marks a significant transformation in the landscape of higher education in Kerala. The Department of Higher Education, Government of Kerala, is leading this progressive initiative, which is set to be implemented from the academic year 2024–25. In alignment with this vision, Mahatma Gandhi University has undertaken a thorough and thoughtful curriculum design process, adhering closely to the directives laid down by the Department.

Botany, as a scientific discipline, offers an exciting and in-depth exploration of the plant world. It encompasses the study of plant origin, diversity, structure, physiology, and the intricate relationships plants share with other organisms and their environment. With its roots tracing back nearly 3.5 billion years to fossilized primitive cells, the field of Botany continues to unravel the wonders of the plant kingdom—from microscopic organisms to colossal trees—across levels ranging from the cellular to the ecosystem.

The core objective of this Four-Year Undergraduate Program is to impart a comprehensive and profound understanding of plant science. The curriculum aims to equip students with the knowledge and practical skills necessary to navigate and appreciate the complexities of plant life. Serving as a guiding framework, the syllabus offers a holistic journey—from the microscopic architecture of cells to the study of vast and dynamic ecosystems.

Throughout the four years, students will engage in a vibrant blend of theoretical instruction, hands-on experiences, field studies, and case-based learning. This integrated approach ensures students remain attuned to the latest advancements in plant science, while also encouraging exploration and the pursuit of research interests. The curriculum is intentionally structured to cultivate critical thinking, scientific curiosity, and a deep appreciation for the pivotal role of plants in sustaining life on Earth.

In conclusion, we look forward with great anticipation to accompanying students on this enriching journey through the diverse realms of Botany. We hope this syllabus serves as a gateway to a transformative academic experience—laying a solid foundation for lifelong learning and meaningful contributions to the scientific community.

Chairperson
UG Board of Studies in Botany

Board of Studies

SL NO.	NAME	POSITION
01	**Dr. Justin R Nayagam**, Assistant Professor & Head Department of Botany, Union Christian College, Aluva – 683102	**Chairperson**
02	**Dr. Manju M George,** Associate Professor Department of Botany, Union Christian College, Aluva – 683102	**Member**
03	**Dr. Anumol Jose,** Assistant Professor Department of Botany, Union Christian College, Aluva – 683102	**Member**
04	**Dr. Reju J,** Assistant Professor Department of Botany, Union Christian College, Aluva – 683102	**Member**
05	**Dr. Reshmi G R,** Assistant Professor Department of Botany, Union Christian College, Aluva – 683102	**Member**
06	**Dr. E A Siril**, Professor & Head Department of Botany University of Kerala, Kariavattom, Trivandrum 695 581	**Member**
07	**Dr. Dennis Thomas T**, Professor & Head, Department of Plant Science, Central University, Kasargode.	**Member**
08	**Dr. Binoy T. Thomas**, Professor, Department of Botany, Catholicate College, Pathanamthitta,.	**Member**
09	**Dr. Sarala Samuel**, Vice President, R&D, Kerala Ayurveda Ltd, Athani Aluva, Ernakulam District, Kerala.	**Member**
10	**Dr. Jaya Kuruvila**, Head, Department of Botany, St. Xaviers College, Aluva.	**Member**

Syllabus Index

Name of the Major: **Botany**

Syllabus Index

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
UC1DSCBOT100	Fascinating World of Plant Sciences	DSC A	4	5	3		2	
UC1MDCBOT100	Ecotourism	MDC	3	4	2		2	

Semester: 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
UC2DSCBOT100	Plant resources and Ventures in Botany	DSC A	4	5	3		2	
UC2MDCBOT100	Gardening and landscaping	MDC	3	4	2		2	

Semester: 3

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
UC3DSCBOT200	Microbiology and Phycology	DSC A	4	5	3		2	
UC3DSCBOT201	Mycology and Plant Pathology	DSC A	4	5	3		2	
UC3DSEBOT200	Ethnobotany and Intellectual Property Rights	DSE	4	4	4			
UC3DSEBOT201	Herbal Technology							
UC3DSCBOT202	Thallophytes and Archegoniates (Minor for others)	DSC B	4	5	3		2	
UC3MDCBOT200	Agri based Micro Enterprises	MDC	3	3	3			
UC3VACBOT200	Bioethics and IPR	VAC	3	3	3			

Semester: 4

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
UC4DSCBOT200	Archegoniates	DSC A	4	5	3		2	
UC4DSCBOT201	Plant Anatomy and Reproductive Botany	DSC A	4	5	3		2	
UC4DSEBOT200	Food science and Quality Control	DSE	4	4	4			
UC4DSEBOT201	Horticulture and Post harvest technology							
UC4DSCBOT202	Introduction to flowering plants and their economic importance (Minor for others)	DSC B	4	5	3		2	
UC4SECBOT200	Biofertilizers and Bio-control Agents	SEC	3	3	3			
UC4VACBOT200	Conservation biology and Sustainable Development	VAC	3	3	3			

Internship

UC4INTBOT200	Internship	INT	2					

Semester: 5

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
UC5DSCBOT300	Angiosperm Systematics and Economic Botany	DSC A	4	5	3		2	
UC5DSCBOT301	Plant Cell and Molecular Biology	DSC A	4	5	3		2	
UC5DSEBOT300	Plant breeding and plant Genetic Resources	DSE	4	4	4			
UC5DSEBOT301	Phytogeography, Forestry and Ecotourism							
UC5DSEBOT302	Plant Biotechnology	DSE	4	4	4			
UC5DSEBOT303	Green technology and Sustainable Development							
UC5DSEBOT304	Analytical techniques in Plant Sciences	DSE	4	4	4			
UC5DSEBOT305	Climate change and disaster management-Botanical Perspective							
UC5SECBOT300	Mushroom Production and Value Addition	SEC	3	3	3			

Semester: 6

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the Course</th><th rowspan="2">Type of the Course DSC, MDC, SEC etc.</th><th rowspan="2">Credit</th><th rowspan="2">Hours/ week</th><th colspan="4">Hour Distribution /week</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>O</th></tr>
<tr><td>UC6DSCBOT300</td><td>Plant Physiology and Biochemistry</td><td>DSC A</td><td>4</td><td>5</td><td>3</td><td></td><td>2</td><td></td></tr>
<tr><td>UC6DSCBOT301</td><td>Genetics and Evolutionary Biology</td><td>DSC A</td><td>4</td><td>4</td><td>4</td><td></td><td></td><td></td></tr>
<tr><td>UC6DSEBOT300</td><td>Bioinformatics in Plant Science</td><td rowspan="2">DSE</td><td rowspan="2">4</td><td rowspan="2">5</td><td rowspan="2">3</td><td rowspan="2"></td><td rowspan="2">2</td><td rowspan="2"></td></tr>
<tr><td>UC6DSEBOT301</td><td>Plant Chemical Ecology</td></tr>
<tr><td>UC6DSEBOT302</td><td>Research Methodology and Biometrics</td><td rowspan="2">DSE</td><td rowspan="2">4</td><td rowspan="2">5</td><td rowspan="2">3</td><td rowspan="2"></td><td rowspan="2">2</td><td rowspan="2"></td></tr>
<tr><td>UC6DSEBOT303</td><td>Plant Ecology, Conservation and Sustainable Development</td></tr>
<tr><td>UC6SECBOT300</td><td>Entrepreneurial Botany</td><td>SEC</td><td>3</td><td>3</td><td>3</td><td></td><td></td><td></td></tr>
<tr><td>UC6VACBOT300</td><td>Environmental Science and Human Rights</td><td>VAC</td><td>3</td><td>3</td><td>3</td><td></td><td></td><td></td></tr>
</table>

Semester: 7

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
UC7DCCBOT400	Research Methodology and Biostatistics	DCC	4	4	4			
UC7DCCBOT401	Advances and Applications in Plant Science - Thallophytes	DCC	4	5	3		2	
UC7DCCBOT402	Advances and Applications in Plant Science – Archegoniates	DCC	4	4	4			
UC7DCEBOT400	Agronomy, Horticulture and Agroforestry	DCE	4	4	4			
UC7DCEBOT401	Plant Genomics							
UC7DCEBOT402	Seed Technology							
UC7DSEBOT400	Ecology and Ecotourism	DSE (For students opting Botany as Minor)	4	4	4			
UC7DSEBOT401	Biological approaches and evolutionary trends in plants							
UC7DSEBOT402	Biotechniques							

Semester: 8

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
UC8DCCBOT400	Plant Metabolism	DCC	4	5	3		2	
UC8DCCBOT401	Plant Breeding and Plant Propagation Techniques	DCC	4	5	3		2	
UC8DCEBOT400	Phytochemistry and Pharmacognosy	DCE (Any Two)	4	5	3		2	
UC8DCEBOT401	Omics in Plant sciences							
UC8DCEBOT402	Modern Trends in Plant Systematics							
UC8DCEBOT403	Agroecology							
UC8DCEBOT404	Forest Botany	DCE (Any One)	4	5	3		2	
UC8DCEBOT405	Aquatic Botany							
UC8DCEBOT406	Plant Bio-analytics and Advanced Instrumentation.							
UC8PRJBOT400	Project	PRJ	12					

SEMESTER I

<table>
<tr><td></td><td colspan="6">UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</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">UC1DSCBOT100</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 familiarized with 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)**			

MODULE	UNITS	COURSE DESCRIPTION	Hrs.	CO NO.
	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	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)			

COURSE CONTENT

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

REFERENCES

1. Ames, O., & Ames, B. (1937). *Pollination of Orchids through Pseudocopulation*. Botanical Museum Leaflets, Harvard University, 5(1), 1–xix.
2. Bajpai, P. K., (2010). *Biological instrumentation and methodology*. S Chand & co Ltd.
3. Barthlott, W., &Neinhuis, C., (1997). *Purity of the sacred lotus, or escape from contamination in biological surfaces*. Planta 202, 1–8.
4. Beerling D., (2007).*The Emerald Planet: How plants changed Earth's history*. Oxford University Press, New York.
5. Berg L. R., (2008). *Introductory Botany: Plants, People, and the Environment, Second Edition*. Thomson Brooks/Cole.,Thomson Higher Education, 10 Davis Drive, Belmont, CA 94002-3098, USA.
6. Cotteril, R., (2002). *Biophysics- an Introduction*. John Wiley and Sons.
7. Gangulee, S.C., Das, K.S., Dutta, C.D., & Kar, A.K., (1968). *College Botany Vol. I, II and III*. Central Education Enterprises.
8. Krishnamurthy, K. V., (2004). *An Advanced Text Book on Biodiversity Principles and practice*. Oxford and IBH Publishing Co. Pvt. Ltd.
9. Kumar, N., Yamaç, S.S., & Velmurugan, A., (2015). *Applications of Remote Sensing and GIS in Natural Resource Management*. Journal of the Andaman Science Association Vol. 20(1):1-6.
10. Misra, A., & Agrawal, P. R., (1978). *Lichens*. Oxford and IBH, NewDelhi.
11. National Research Council (U.S.). Committee on an Examination of Plant Science Research Programs in the United States. (1992) *Plant biology research and training for the 21st century*. Washington, D.C. : National Academy Press.
12. Nita, B., (2002). *Hand book on Mushrooms*. Oxford & IBH Publishing C. Pvt.
13. Rodriguez, E., & Wrangham, R.W., (1993). *Zoopharmacognosy: the use of medicinal plants by animals.* Recent Advances in Phytochemistry. Vol. 27
14. Sambamurty A. V. S. S., (2006). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*. I.K. International publication, New Delhi.
15. Saranya, T., Deisy, C., Sridevi, S., & Sonai M. A., (2023). *A comparative study of deep learning and Internet of Things for precision agriculture*. Engineering Applications of Artificial Intelligence. 122 (C).
16. Sharma, A., Ashutosh, S., Alexey, T., Alexander, B., Tanupriya, C., Madani, A. A., & Manuel S., (2023). *Artificial intelligence and internet of things oriented sustainable precision farming: Towards modern agriculture*. Open Life Sciences. 18 (1)
17. Sharma, V.K., (1991). *Techniques in microscopy and cell biology*. Tata McGraw-Hill, New Delhi.
18. Starr, C., (2007). *Biology : concepts and applications. VI edn*. Thomson Press.

SUGGESTED READINGS

1. Akkem, Y., Saroj K. B., & Aruna V., (2023). *Smart farming using artificial intelligence: A review*. Engineering Applications of Artificial Intelligence. Vol. 120, 105899.
2. Arber, Agnes (1986) [1912; 2nd ed. 1938]. Stearn, William T. (ed.). *Herbals: their origin and evolution. A chapter in the history of botany*, 1470-1670 (3rd ed.). Cambridge: Cambridge University Press. ISBN 9780521338790.
3. Arya Vaidya Sala Kottakkal (1994- 1997). *Indian Medicinal Plants Vol I-V*. Orient Longmann
4. Bendra, A., & Ashok, K., (1980). Economic botany. Rastogi publications, Meerut.
5. Chandel, N., Chakraborty, S., Rajwade, Y., Dubey, K., Tiwari, M. K., & Jat, D., (2021). *Identifying crop water stress using deep learning models.* Neural Computing and Applications. 33. 10.1007/s00521-020-05325-4.
6. Dayna, B., Benyus, J.M., Dwyer, J., Ritter, S., &Tocke, R., (2011). *Biomimicry - resource handbook*. A seed bank of best practices-Create Space
7. Dicks, H., (2023) - *The Biomimicry Revolution-Learning from Nature How to Inhabit the Earth*. Columbia University Press.
8. Durai, S. K. S., & Mary, D. S., (2022). *Smart farming using Machine Learning and Deep Learning techniques*. Decision Analytics Journal. Vol, 3, 100041.
9. Gifford, E. M., & Foster, A.S., (1988). *Morphology and Evolution of Vascular Plants*, W.H. Freeman & Company, New York.
10. Gifford, E.M., & Foster, A.S., (1988). Morphology and Evolution of Vascular Plants. W.H. Freeman & Company, New York.
11. https://biomimicry.net/what-is-biomimicry/
12. https://biomimicry.org/
13. https://biomimicry.org/what-is-biomimicry/
14. Janine M. B., (2009). *Biomimicry - innovation inspired by nature*. HarperCollins e-books
15. Jeffery, C., (1968). An Introduction to Plant Taxonomy. J and A Churchill, London.
16. Majumdar, G. P., (1982). "*Studies in History of Science in India*". In Chattopadhyaya, Debiprasad (ed.). *The history of botany and allied sciences in India* (c. 2000 B.C. to 100 A.D.). Asha Jyoti, New Delhi: Editorial Enterprise.
17. Pandey, B.P., (2005). Collage Botany : Vol I, 5th edn. S.Chand &Company LTD. New Delhi.
18. Pawlyn, M., (2019). *Biomimicry in Architecture*. RIBA Publishing.
19. Raven, P.H., Evert, R.F., & Eichhorn, S.E., (2013). Biology of plants. VIIIth Ed. W.H. Freeman Publishers.
20. Sambamurthy, A.V.S.S., & Subrahmanyam, N.S., (1989). *A Text Book of Economic Botany.*

Wiley Eastern Ltd.

21. Sharma, V.K., (1991). *Techniques in microscopy and cell biology*. Tata McGraw-Hill, New Delhi.

22. Singh, N. C., Subir, K.C., Yogesh, A. R., Kumkum, D., Mukesh, K. T., & Dilip, J., (2020). *Identifying crop water stress using deep learning models*. Neural Computing and Applications.
23. Singh, V., Pandey, P.C., & Jain, D.K., (2017). *Anatomy of Angiosperms*. Rastogi Publication, Meerut
24. Singh, V., Pandey, P.C., & Jain, D.K., (2017). Anatomy of Angiosperms. Rastogi Publication, Meerut.
25. Sivarajan, V. V., (1991). Introduction to the Principles of Plant taxonomy. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
26. Varantha, P., & Gautham, N., (2005). Biophysics. Norosa Publishing House New Delhi.
27. Vij, A., Singh, V., Abhishek, J., Shivam, B., Aashima, B., & Aarushi, S., (2020). *IoT and Machine Learning Approaches for Automation of Farm Irrigation System*. Procedia Computer Science. Vol.167, 1250-1257

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</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">UC1MDCBOT100</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
2	**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
	2.4	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

SEMESTER II

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Plant resources and ventures in botany**					
Type of Course	DSC A					
Course Code	UC2DSCBOT100					
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 **<u>Activity 1 (Optional):</u>** 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)		
		❖ 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)		
		❖ Make collections of plant products specified in the syllabus and submit	3	1
		❖ Polybag cultivation of mushroom	2	3
		❖ Demonstrate Air layering, T-budding and patch budding	2	3
		❖ Select any start up initiative and prepare a report or present a mock up idea for an plant based entrepreneurship	2	4
		❖ Culturing of *Spirulina*.	2	3
		❖ Demonstration of tissue culture techniques: culture media, surface sterilization and inoculation of explants.	3	3

		❖ Flower arrangement – fresh and dry	4	3
		❖ Sample synopsis	2	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

REFERENCES

1. Arya Vaidya Sala Kottakkal (1994- 1997). *Indian Medicinal Plants., Vol I-V*. Orient Longmann
2. Arya, H., & Bhatt, T. K., (2021). *Introduction of intellectual property rights. In The Design & Development of Novel Drugs and Vaccines*. Academic Press. (pp. 275-281).
3. Aydara, E. F., Sena, T., & Beraat, O., (2020). *Plant-based milk substitutes: Bioactive compounds, conventional and novel processes, bioavailability studies, and health effects*. Journal of Functional Foods. 103975. 1-15.
4. Chrispeels, M. J., &Sadava, D. E., (1994). *Plants, Genes and Agriculture*. Jones & Bartlett Publishers.
5. Cruses, W.V., & Fellows, P. J., (2000). *Commercial fruits and vegetable processing*. CRC press, United
6. Edmond, J. B., Musser, A. M., & Andrews, F. S., (1957). *Fundamentals of Horticulture*. McGraw Hill Book Co., New Delhi.
7. Hill, A. F., (1952). *Economic Botany: A Textbook of Useful Plants and Plant Products*. McGraw Hill Publishing Company Ltd., New Delhi.
8. https://botany.org/home/careers-jobs/careers-in-botany/requirements-for-a-career-in-botany.html
9. Kalian Kumar De, 1996. *Plant Tissue Culture*. New Central Book Agency (P) Ltd.
10. Mohanty, S. K. (2005). *Fundamentals of entrepreneurship*. PHI Learning Private Limited, Rimjhim House, 111, Patparganj Industrial Estate, Delhi-110092. ISBN-978-81-203-28679
11. Narayana, P. S., Varalakshmi, D., & Pullaiah, T., (2021). *Research Methodology in Plant Science 2nd Edition*. Scientific(R) Publishers. Jodhpur , Rajasthan, India.
12. Sambamurthy, A. V. S. S., & Subrahmanyam, N. S., (1989). *A Text Book of Economic Botany*. Wiley Eastern, New Delhi. ISBN: 9780852268803, 0852268807
13. Sandhu, M. K., (1989). *Plant Propagation*. Wiley Eastern Ltd., Bangalore.
14. Simpson, B. B., & Conner-Ogorzaly, M., (1986). *Economic Botany - Plants in Our World*. McGraw Hill, New York.
15. Smith, V. A., (1903). *The Indian Civil Service as a profession (1 ed.)*. Dublin: Hodges, Figgis, & Co., Ltd.
16. Stagg B. C., & Justin, D., (2023). *Plants, education and sustainability: rethinking the teaching of botany in school science*. Journal of Biological Education. 57 (5), 941-943
17. States. ISBN: 9780849308871.
18. www.bsi.gov.in
19. Zheng, B., Hualu, Z., & David, J. M., (2021). *Nutraceutical-fortified plant-based milk analogs: Bioaccessibility of curcumin-loaded almond, cashew, coconut, and oat milks*. LWT - Food Science and Technology. Vol, 147, 111517

SUGGESTED READINGS

1. Acquaah, G., (2019). *Horticulture: Principles and Practices (4th edition)*. India: Pearson India Education Services Pvt. Ltd.
2. Agrawal, P. K., (1993). *Hand Book of Seed Technology*. Department of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
3. Amprazis, A., & Papadopoulou, P., (2018). *"Primary School Curriculum Contributing to Plant Blindness: Assessment Through the Biodiversity Perspective*". Advances in Ecological and Environmental Research 3 (11): 238–256.
4. Armstrong, E. M., Larson, E. R., Harper, H. C., Webb, R., Dohleman, F., Araya, Y., & Grierson, C. S., (2023). *"One Hundred Important Questions Facing Plant Science: An International Perspective."* New Phytologist 238 (2): 470–481.
5. Bailey, L. H., (2009). *Manual of Gardening*. Srishti Book Distributors, New Delhi.
6. Bassett, M. J., (1986). *Breeding Vegetable Crops*. Westport, Conn.: AVI Publishing.
7. Beasley, K., Lee-Hammond, L., & Hesterman, S., (2021). "A Framework for Supporting the Development of Botanical Literacies in Early Childhood Education". International Journal of Early Childhood 53 (2): 119–137.
8. Biles, R. E., (2003). *The Complete Book of Gardening*. Biotech Books, Delhi.
9. Billings, S., & Collingwood, S., (2013). *The Big book of home remedies*. Lulu.com publisher.
10. Bonney, R., Cooper, C.B., Dickinson, J., & Steve, K., (2009). Citizen science: a developing tool for expanding science knowledge and scientific literacy. Bioscience 59, 977e984.
11. Borlaug, N., (1970). "The Green Revolution, Peace, and Humanity". Nobel Lecture. Available at http://www. nobel.se.
12. Bose, T. K., & Mukherjee, D., (1972). *Gardening in India*. Oxford & IBH Publishing Co., New Delhi.
13. Buckley, C., (2020). *Plant Magic: Herbalism in Real Life*. Roost Books Publishers, New York.
14. Chen, G., &Weibang, S., (2018). *The role of botanical gardens in scientific research, conservation, and citizen science*. Plant Diversity. 40 (4) P. 181-188
15. Chen, X., Lu, X., Shu, N., Wang, S., Wang, J., Wang, D., Guo, L., & Ye, W., (2017).

Targeted mutagenesis in cotton (Gossypium hirsutum L.) using the CRISPR/Cas9 system. Scientific Reports. 7, 44304

16. Clough, D. R., Fang, T. P., Vissa, B., & Wu, A., (2019). *Turning lead into gold: How do entrepreneurs mobilize resources to exploit opportunities?*. Academy of Management Annals, 13(1), 240-271.
17. Cohn, J.P., 2008. *Citizen science: can volunteers do real research*? Bioscience 58, 192e197.
18. Conrad, C.C., & Hilchey, K.G., (2011). *A review of citizen science and community-based environmental monitoring: issues and opportunities*. Environ. Monit. Assess. 176, 273e291.
19. Courtier, J., & Clarke, G., (1997). *Indoor plants: The Essential Guide to Choosing and Caring for Houseplants*. Reader's Digest, New York.

20. Dawe, D., (1998). *"Re-Energizing the Green Revolution in Rice."* American Journal of Agricultural Economics. 80: 948–953.
21. Fuller, K. W., & Gallon, J. A., (1985). *Plant Products and New Technology*. Clarendon Press, Oxford, New York.
22. Gately, D., (2001). *"Backgrounder: The Past 25 Years: Successes, Failures, and Lessons Learned in Feeding the World."* International Food Policy Research Institute, Washington, D.C.
23. Gopichandran, V., & Satish, K., Ch., (2012). *"Mainstreaming AYUSH: an ethical analysis"*. Indian Journal of Medical Ethics. 9 (4): 272–277.
24. Hershey, D. R., (1996). *"A Historical Perspective on Problems in Botany Teaching."* The American Biology Teacher 58 (6): 340–347.
25. Janick, J., (1979). *Horticultural Science (3rd edition)*. W.H. Freeman & Co., San Francisco, USA.
26. Kletečki, N., Hruševar, D., Mitić, B., &Šorgo, A., (2023). *"Plants are Not Boring, School Botany is."* Education Sciences 13 (5): 489.
27. Kochhar, S. L., (2012). *Economic Botany in the Tropics*. MacMillan India Ltd., New Delhi.
28. Kollmuss, A., & Agyeman, J., (2002). *"Mind the Gap: Why Do People Act Environmentally and What are the Barriers to Pro-Environmental Behavior?"* Environmental Education Research 8 (3): 239–260.
29. Kumar, N., (1997). *Introduction to Horticulture*. Rajalakshmi Publications, Nagercoil.
30. Lal, G., Siddhapa, G. S. & Tandon, G. L., (1988). Preservation of fruits and vegetables. Indian Council of Agricultural Research (ICAR). ISSN: 0101-2061.
31. Leaf, M. J., (1984). *Song of Hope: The Green Revolution in a Punjab Village*. New Brunswick, NJ: Rutgers University Press.
32. New Delhi.
33. Nieuwenhuizen, C., (2004). *Basics of entrepreneurship. Juta Legal And Academic Publishers*. ISBN-13: 978-0-7021-8859-6, ISBN: 0-7021-8859-X
34. Pahuja, D. A., & Sanjiv, R., (2015). Introduction to entrepreneurship. Small Entrpresises Journal, 2(3), 45-62.
35. Perkins, J. H., (1997). Geopolitics and the Green Revolution: Wheat, Genes, and the Cold War. New York: Oxford University Press.
36. Poehlman, J. M., (1986). *Breeding Field Crops. 3d ed*. Westport, Conn.: AVI Publishing.
37. Purohit, S. S., & Vyas, S. P., (2008). *Medicinal Plant Cultivation: A Scientific Approach*. Agrobios, India.
38. Randhawa, G. S., & Mukhopadhyay, A., (1986). *Floriculture in India*. Allied Publishers Limited, New Delhi.
39. Ranganna, S., (2001). *Hand book of analysis and quality control of fruits and vegetable products, Second edition*. Tata mcgraw hill, New Delhi. ISBN: 9780074518519.
40. Rao, K. M., (2005). Textbook of Horticulture (2nd edition). MacMillan India Limited,
41. Rao, P. S., (2016). *Vegetable Crops Production*. Sonali Publications, New Delhi.
42. Raven, P. H., Johnson, G. B., Losos, J. B., & Singer, S.R., (2005). *Biotechnology in*

Producing a Scientific Revolution. Biology (7th edition). New York, NY: McGraw-Hill Companies, Inc.

43. Richardson, M., Passmore, H. A., Barbett, L., Lumber, R., Thomas, R., Hunt, A., & Fish, R., (2020). *“The Green Care Code: How Nature Connectedness and Simple Activities Help Explain Pro-Nature Conservation Behaviours.”* People & Nature 2 (3): 821–839.
44. Samal, J., &Dehury, R. K., (2016). "An Evaluation on Medical Education, Research and Development of AYUSH Systems of Medicine through Five Year Plans of India". Journal of Clinical and Diagnostic Research. 10 (5)
45. Stevenson, V., (1984). *Plants and Flowers in the Home*. Treasure Press, London.
46. Swarup, V., (1997). Ornamental Horticulture. MacMillan India Ltd., UK
47. Trivedi, P. P., (1987). *Home Gardening*. Indian Council of Agricultural Research, New Delhi.
48. Upadhyay, R., (2023). *Botany for B.Sc. students, Economic Botany, Ethnomedicine and phytochemistry/Commercial Botany and phytochemical Analysis*. S. Chand and Company Ltd. Publishers, India.
49. Vaver, D. (1997). *Intellectual Property Law: Copyright, Patents, Trade-Marks [First Edition]*. Concord, ON: Irwin Law. ISBN: 1552210073
50. Wickens, G. E., (2001). *Economic Botany: Principles & Practices*. Kluwer Academic Publishers, The Netherlands.
51. Zingare, A. K., (2013). A Manual of Gardening. Satyam Publishers & Distributors, Jaipur.

<table>
<tr><td>Est. in 1921</td><td colspan="6">UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Gardening and landscaping</td></tr>
<tr><td>Type of Course</td><td colspan="6">MDC</td></tr>
<tr><td>Course Code</td><td colspan="6">UC2MDCBOT100</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 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.</td></tr>
<tr><td>Semester</td><td>II</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">Basic understanding of Biology</td></tr>
</table>

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.		
	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	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**			

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
	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

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.
3. Peter, K. V. *Basics of Horticulture*. New India Publishing Agency, New Delhi.
4. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publishers.
5. Rajmohan,K., Soni,K.B., Gomathi, KS &Prakah,R. 2004. *Essentials of Plant Tissue Culture*. Kerala Agricultural University
6. Larson, R.A., 1980. *Introduction to Floriculture*. Academic Press, London
7. Sheela, V.L. 2011. *Horticulture*. MJP Publishers, Chennai.
8. Singh, J. 2002. *Basic Horticulture*, Kalyani Publishers.
9. Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping*. Naya Prokash.
10. De, L.C. 2012. *Handbook of Gardening*, Aavishkar Publishers, Jaipur
11. Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publishers.
12. Sabina GT & Peter KV. 2008. *Ornamental Plants. New India Publishing Agency*, New Delhi.
13. Sundaram,V. 2016. *Textbook on Commercial flowers and Ornamental Gardening.* Kalyani Publishers.
14. Syamal, M.M. 2014. *Commercial Floriculture*. Jaya Publishing House, New Delhi.
15. Nambisan, K.M.P.1992. *Design element of landscape gardening*, company, New Delhi

SEMESTER III

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Microbiology and phycology**					
Type of Course	DSC A					
Course Code	UC3DSCBOT200					
Course Level	200					
Course Summary	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.					
Semester	III	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Basic botanical learning and laboratory skills					

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	U	PO1, PO2, PO9

	research potential of algae		
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
2. Campbell,R.1987.PlantMicrobiology.ELBSEdwardArnold,London.
3. Dube, H.C. (2008). Fungi, Bacteria and Viruses. Agrobios
4. Fritsch, F.E. (Vol. I, II5). The structure and reproduction of Algae. Cambridge University Press.
5. Harnold C Bold, Michael J Wynne (1978). Introduction to Algae: Structure and reproduction. Prentice Hall.
6. Kim, S.K. (2011). Marine medicinal foods: Implications and Applications of micro and macroalgae. Academic Press, New York.
7. Lee, R. E (2008) Phycology,4th Edition, Cambridge University Press, New York, 2008, p. 645
8. Linda, E.G and Lee, W.W., (2000). Algae, Prentice Hall, New Jersy.
9. Moheimani, N.R., McHenry, N.P., de Boer, K. and Bahri, P.A . (2015). Biomass and Biofuels from Microalgae. Springer International Publishing Switzerland.
10. Pelczar, Chan and Krieg. Microbiology. (Indian edition)
11. Sahho, D and Seckback, J. (2015). The algae world. Springer Dordrecht Heidelberg New York.
12. Sharma, O.P (2011). Algae. Tata McGraw- Hill, New Delhi, p.419.
13. Smith, G.M. (1955). Cryptogamic Botany (Vol. 1): Algae and Fungi. Tata McGraw Hill, New York, p.546.

<table>
<tr><td colspan="2"></td><td colspan="5">UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Mycology and plant pathology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">UC3DSCBOT201</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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 laboratory skills</td></tr>
</table>

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.
	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	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
	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	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.
3. Ainsworth, G.C. and Sussman, A.S. eds., 2013. *The fungal population: an advanced treatise*. Elsevier.
4. Alexopoulos, C.J., Mims, C.W. and Blackwell, M., 1996. *Introductory Mycology*. John Wiley & Sons. *Inc.*, *New York*, *868*.
5. Varma, A., Abbott, L., Werner, D. and Hampp, R. eds., 2007. *Plant surface microbiology*. Springer Science & Business Media.
6. Campbell, R., 1987. *Plant Microbiology*. ELBS Edward Arnold, London
7. Borkar, S.G., 2017. *History of Plant Pathology*. CRC Press.
8. Vasishta, B.R., Sinha, A. K., and Kumar, A., 2016. *Botany for Degree Students, Fungi*. S. Chand ang company Ltd, New Delhi.
9. Gupta, V. K. and Paul, T. S., 2004, *Fungi & Plant diseases*. Kalyani publishers, New Delhi
10. Deacon, J.W., 2013. *Fungal biology*. John Wiley & Sons.
11. Bush, J., 2019. *Genetics of Plant Diseases*. Scientific e-Resources.
12. Misra A and Agrawa P.R 1978 *Lichens*, New Delhi: Oxford and IBH.
13. Gogoi, R., Rathaiah, Y., Borah T. R., 1990, *Mushroom Cultivation Technology*. Scientific Publishers (India).
14. Nita Bahl 2002. *Hand book on Mushrooms*, Oxford & IBH Publishing C. Pvt. Ltd. New Delhi.
15. Sharma, P. D., 2004, *The Fungi*, 2nd Edition, Rasthogi publication

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<tr><td colspan="7">Est. in 1921 — UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Ethnobotany and intellectual property rights</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC3DSEBOT200</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course will deal with the origin, botany, utilization, cultivation, and uses of plants; important firewood and timber-yielding plants and non-wood forest products (NWFPs); traditional herbal medicine; endangered and rare useful plants of Kerala; strategies for conservation of medicinal, spice and other useful plants; research methods in ethnobotany; roles of ethnobotany in biodiversity conservation and socio-economic development, Intellectual Property Rights, and its importance.</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>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>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify socially, economically, and culturally useful plants	K	PO1,PO2, PO6
2	Describe ethnobotanical research methods;	U	PO1,PO2
3	Implement ethnobotanical knowledge in biodiversity conservation and socio-economic development.	A	PO1,PO2, PO6,PO7
4	Appreciate the need to conserve floristic and cultural diversity of the region.	Ap	PO2
5	Describe and document Ethnobotanicals for sustainable use of plant resources.	U	PO2,PO7
6	Explain the fundamental aspects of Intellectual property Rights	A	PO2
7	Recognize intellectual property rights and its benefit to people and society who share their knowledge.	AN	PO2,PO4
8	Develop the knowledge on IPR, patents, patent regime in India and abroad and registration	C	PO2,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	**Introduction, relevance, scope, and status (8 Hours)**			
	1.1	Introduction, concept, scope, and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context.	2	1
	1.2	Centers of Ethnobotanical studies in India. (FRLHT-Foundation for the Revitalization of Local Health Traditions, JNTBGRI).	3	2
	1.3	Contributions of J.W. Harshberger, E.K.Janakiammal, S.K.Jain&P.Pushpangadan	3	1
2	**Tribal/Folk communities of Kerala and plants of ethnobotanical significance(17 Hours)**			
	2.1	Tribal/Folk communities of Kerala state focusing on customs and beliefs related to Ethnobotany - Kani, Kurichiya, Cholanaikan, Malampandaram (brief study only).	6	1

	2.2	Significance of the following plants in ethnobotanical practices (brief study only) - *Cosciniumfenestratum*; *Dioscorea* sp.; *Vitex negundo*; *Gloriosa superba*; *Calamus rotang*; *Pongamia pinnata*; *Curcuma longa*; *Indigofera tinctoria*.	8	1, 4
	2.3	Role of ethnobotany in modern medicine with special reference to *Rauvolfia serpentina; Trichopuszeylanicus; Withaniasomnifera*	3	1, 4
3	**Methods and techniques used in Ethnobotany(16 Hours)**			
	3.1	Field level activities for data collection- Approach, Documentation (Audio, Video recording, Photographs, Interview – Methods, Questionnaire, and Data sheet), Consent forms, Forest productivity check by analysing the log books of Forest, EDC (Eco Development Committee), VSS (Vana Samarakshana Samithi), Authentication of plant species (Field Book, Herbarium).	10	5
	3.2	Peoples' Biodiversity Register (PBR); legal aspects Ethnobotany as a tool to protect interests of ethnic groups. Benefit sharing of wealth concept with few examples from Kerala (Jeevani).	6	1 2 3
4	**Intellectual Property Rights (IPR) and Patents(20 Hours)**			
	4.1	IPR Brief history, Types of Intellectual Properties, Role of undisclosed information and rationale of patents and licenses.	3	6
	4.2	Benefits of patents. IPR in India and the world. IPR and WTO	3	6
	4.3	Bioprospecting and Bio-Piracy; Geographical Indication (GI) – specific to Kerala	3	6, 7
	4.4	Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patent, Infringement, Industrial Application: Non-Patentable Subject Matter, Registration Procedure, Rights and duties of Patentees.	4	6, 7
	4.5	Protection of traditional knowledge - Objectives, Concept of traditional knowledge, Holders, Issues	4	7, 8
		concerning, Traditional Knowledge Digital Library (TKDL).		
	4.6	Plant varieties protection in India. Rights of farmers, breeders and researchers. National gene bank. Protection of Plant Varieties and Farmers' Rights Act, 2001	3	6

	Teacher Specific Content
Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Group discussion, Field trip and report, List out any 10 GI (Geographical Indication) and Traditional Knowledge Products. Identify and document plant parts used in preparation of crude drugs/herbal formulations
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. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
2. Cotton, C.M. (1996). Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England
3. Cunningham, A.B. (2001). Applied Ethnobotany: People, Wild Plant Uses and Conservation. Earthscan Publication Ltd., London.
4. Eldredge, N. (1992). Systematics, Ecology, and the Biodiversity Crisis. Columbia University Press., New York.
5. Faulks, P.J. (1958). An introduction to Ethnobotany, Moredale Publ. London
6. Harding, L.E. and Mccullum, E. (1994). Biodiversity in British Columbia: Our Changing Environment. Environment Canada, Canadian Wildlife Service, Canada.
7. Jain S.K.(1997). Contribution to Indian Ethnobotany, Sci. Publ. Jodhpur
8. Jain, S. K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi
9. Jain, S. K. (1989). Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow
10. Jain, S. K. (1995). A manual of Ethnobotany. Scientific Publishers, Jodhpur
11. Jain, S. K., Mudgal, V., Banerjee, D. K., Guha, A., Pal, D. C. and Das, D. (1984). Bibliography of Ethnobotany. Botanical Survey of India, Howrah
12. Jose Boban K. (1998). Tribal Ethnomedicine: Continuity and change. APH publishing corporation 5, Ansari Road, Darya Ganj, New Delhi
13. Martin, J.G. (2000). Ethnobotany: A Methods Manual. Chapman and Hall, USA.
14. Mathur, M. (2015). Ethnic Knowledge: Documentation and Their Interpretation, Agrobios India, Jodhpur
15. Mathur, P. R. G. (1977). Tribal situation in Kerala. Kerala Historical Society, Trivandrum
16. McMahon, M., Anton, M.K., and Vincent, R.E. (2001). Hartmann's Plant Science: Growth, Development, and Utilization of Cultivated Plants, 3rd ed. Prentice Hall Publication.
17. Nautiyal, S. and Kaul A.K. (2003). Non-Timber Forest Products of India. Jyoti Pub, Dehra Dun, India.
18. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in AndhraPradesh, India.Botanical Survey of India. Howrah.
19. Rath, A. K. and Mishra, S. R. (2017). Ethnobotany, Kalyani Publishers, New Delhi..
20. Shashi, S. S.(1995). Tribes of Kerala (Encyclopedia of Indian tribes Series-8). Ammol Publication Pvt. Ltd. Ansari Road, Daryagang, New Delhi
21. Sinha K. R. & Sinha S. (2001). Ethnobiology (Role of Indegenous and Ethnic Societies in Biodiversity Conservation, Human Health Protection and Sustainnable Development), Surabhi Publication, Jaipur
22. Sinha K. R. (1996). Ethnobotany The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers, Jaipur.
23. Snehalatha and Jain, S. K. (1998). Historical Archive in Ethnobotany. Institute of Ethnobotany, NBRI, Lucknow

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf

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/)

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Herbal technology**					
Type of Course	DSE					
Course Code	UC3DSEBOT201					
Course Level	200					
Course Summary	The present course focuses mainly on common herbal plants in our locality, their morphological peculiarities, nutritive and medicinal properties. This course also aims for the extraction of major principles of herbal plants in their crude form, also their cultivation, conservation practices and their applied aspects (Herbal Dyes, Organic pesticides, Biofuels).					
Semester	III	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60
Pre-requisites, if any	Maintenance of herbal garden under the guidance of Botany Department					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify the common herbal plants in our locality.	U	PO6, PO10
2	Familiarize the cultivation practices and conservation of the herbal plants and homely application against common diseases.	U	PO6, PO7, PO10
3	Examine the different herbal plants based on the medicinal and nutritive values.	An	PO1, PO3
4	Develop the skills for extracting the various phytochemicals in crude form.	C	PO2, PO9
5	Evaluate the major chemical components present in the selected herbal plants.	E	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	**Introduction to herbal technology (6 hours)**			
	1.1	Introduction to herbal technology: Definition, Branches of herbal technology,	3	1
	1.2	Need of herbal gardens in the present scenario (Home Garden, Educational institutions and Research centre), Significance of herbal technology.	3	1
2	**Herbal resources of practical significance (12 hours)**			
	2.1	A brief classification of medicinal plants based on their secondary metabolites and its uses	2	3, 5
	2.2	Definition, Extraction methods: Types 1. Solvent extraction- a) Alcohol b) acetone c) benzene, d) chloroform e) acid	3	4
	2.3	Aqueous extraction, Supercritical fluid extraction-CO_2, Microwave assisted extraction	5	4
	2.4	Relevance and application of herbal dyes	2	4
3	**Applied aspects of herbal products and Conservation aspects (12 hours)**			
	3.1	Biopesticides- Preparation and applications of Neem decoction, Tobacco decoction	3	4
	3.2	Biofuels- *Jatropha curcus* (Brief)	1	4
	3.3	Apiculture and pollination enhancement in relation to herbal garden	3	4
	3.4	Conservation and sustainable maintenance (Cultivation practices) of herbal plants in association with botanical garden and home garden	5	2
	Experiential learning (30 hours)			
4	4.1	Visit to a well-maintained herbal garden such as JNTBGRI, Malabar Botanical Garden and other recognized institutes. (1 day)	10	1, 2
	4.2	Visit to scientific labs regarding extraction, identification of phytochemicals. (1 day)	10	1, 2
	4.3	Submit any 5 rooted plants/propagules mentioned in the syllabus.	10	1, 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/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. Daniel, M., Arun, A., Raole, V.M. (2007). Herbal Technology: Recent Trends and Progress, Scientific Publishers.
2. Sujanapal, P; Prabhu N.H., Pius, O.L., Sajeev, V.B. (2008). Susthira Oushadha Sasya Krishi, State Medicinal Plants Board, Thrissur, Kerala.
3. https://www.researchgate.net/publication/327304552_an_overerview_of_major_classes_of_phytochemicals_their_types_and_role_in_disease_prevention
4. Agarwal, P., Alok, S., Fatima, A and A. Verma. (2013) Current scenario of Herbal Technology worldwide: An overview. Int J Pharm Sci Res; 4(11): 4105-17.
5. https://www.researchgate.net/deref/https%3A%2F%2Fdoi.org%2F10.31881%2FTLR.202
1.09?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6In B1YmxpY2F0aW9uIn19.
6. Dottoa, J.M., S. A. Abihudi. (2021). Nutraceutical value of Carica papaya: A review. Scientific African 13 (2021) e00933.
7. Kokate, C.K., Purohit, A.P., Gokhale, S. B. (1999). Pharmacognosy. Nirali Prakashan.
8. Green, A. (2000) Principles of Ayurveda, Thomsons, London.
9. Arber, A. (1999). Herbal plants and Drugs, Mangal Deep Publications.
10. Chopra, R.N., Nayar, S.L., and Chopra, I.C., (1956). Glossary of Indian medicinal plants, C.S.I.R, New Delhi.
11. Sivarajan, V.V., and Balachandran, I.(1994). Ayurvedic drugs and their plant source. Oxford IBH publishing Co.
12. Chen, SL., Yu, H., Luo, HM. Wu, Q., Li, C., & Steinmetz, A., (2016) Conservation and sustainable use of medicinal plants: problems, progress, and prospects. Chin Med 11, 37. https://doi.org/10.1186/s13020-016-0108-7.
13. Aziz, A., Beg, M.R. (2022). Green Building: Future Ahead. In: Agarwal, P., Mittal, M., Ahmed, J., Idrees, S.M. (eds) Smart Technologies for Energy and Environmental Sustainability. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978- 3-030-80702-3_10.

<table>
<tr><td>Est. in 1921</td><td colspan="6">UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Thallophytes and Archegoniates</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC B</td></tr>
<tr><td>Course Code</td><td colspan="6">UC3DSCBOT202</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course provides a basic overview regarding the evolutionary significance, classification, morphology, and distinguishing characters of thallophytes and archegoniates. It also gives a basic outlook towards the ecological and economic significance of Thallophytes and Archegoniates.</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"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify Thallophytes and Archegoniates on the basis of morphology.	K	PO1
2	Explain the evolutionary significance of Thallophytes and Archegoniates.	U	PO7
3	Classify Thallophytes and Archegoniates based on their characters.	A	PO2
4	Distinguish between Thallophytes and Archegoniates.	An	PO1
5	Appraise the ecological and economic significance of Thallophytes and Archegoniates.	E	PO6, PO7
Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Diversity of Thallophytes (15 hours)**			
	1.1	Introduction to Thallophytes: Evolutionary insight of thallophytes and its ecological role towards the rich biodiversity of our planet.	5	2
	1.2	**Algae** Introduction: General characters, habitat diversity, range of thallus structure and pigments in algae. Classification up to division (Brief study): by Fritsch (1945). Thallus structure of the following types: *Nostoc*, *Volvox*, *Oedogonium*, *Cladophora*, *Polysiphonia and Sargassum*. Economic importance of algae	10	1,3,5
2	**Fungi and Lichens (10 hours)**			
	2.1	General characters of fungi. Classification of fungi up to class - Ainsworth (1973).	10	1,3,4,5
		Distinguishing characters of *Xylaria* and *Puccinia* with special reference to reproductive structures and life cycle. Economic importance of fungi. General characters of Lichens, types. Economic and ecological significance of lichens.		
	Archegoniates (20 hours)			

3	3.1	Introduction,Common traits of Archegoniates; tracing the transition of dominant phase from gametophyte to sporophyte and its significance.	2	2
	3.2	Bryophytes: General characteristics**,** Classification by Rothmaler (up to family); Morphology, anatomy, and reproduction of *Riccia* (Developmental details not needed). Ecological and economic importance of bryophytes.	6	1,3,5
	3.3	Pteridophytes: General characteristics; brief account of the classification by Smith up to divisions (2006). Morphology, anatomy and reproduction of *Pteris* (Developmental details not needed). Heterospory and seed habit in Lycophyte (*Selaginella*). Ecological and economic importance of Pteridophytes	6	1,3,4,5
	3.4	Gymnosperms: General characteristics, classification Sporne (1965) (up to family)**.** Morphology, anatomy and reproduction of *Cycas* (Developmental details not needed)**.** Economic importance of Gymnosperms: as food, medicine, in industry and as ornamental plants.	6	1,3,4,5
	Practical (30 hours)			
	Thallophytes, Fungi and Lichens			
4	4.1	Conduct a field visit to algal ecosystems and submit a report with geotagged photographs of few collected algae. Make micro-preparations of types mentioned in the syllabus.	10	5
		Collect and submit at least 2 latest research publications on thallophytes. Also submit a summary report		
	4.2	Conduct a field study to familiarize with the habitat of fungi and lichen and submit a report. Collect, identify and submit few thallophytes mentioned in the syllabus	6	1
	Archegoniates			
	4.3	Document geotagged photos/ images of gametophytes and/or sporophytes of archegoniates mentioned in the syllabus. Field study to familiarize with the habitat of archegoniates.	4	5

	4.4	Collect, identify the genus and submit gametophytes and/or sporophytes of archegoniates. Collect and submit at least 2 latest research publications on archegoniates. Also submit a summarized/comparison report	5	1
	4.4	*Riccia* – Morphology and anatomy of thallus. *Pteris*- Morphology of sporophyte and anatomy of stem. *Cycas*- Morphology of coralloid roots and reproductive structures; Anatomy of leaflet.	5	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. Anand,N. (1989).CulturingandcultivationofBGA.HandbookofBlueGreenAlgae.
2. Beck, C.B.(1988).*Origin and Evolution of Gymnosperms*, Columbia University Press, New York.
3. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
4. Biswas and John, B.M.(2004).*Gymnosperms*, Naresa Publishing house.
5. Bower, F.O.(1935). *Primitive Land Plants*, Cambridge, London.
6. Campbell, H D, (1940). T*he Evolution of land plants (Embryophyta)*. Univ. Press, Stanford.
7. Chamberlain, C.J.(1935). *Gymnosperms: Structure and Evolution*. Chicago University Press.
8. Chandra, S. Srivastava, M.(2003). *Pteridology in New Millennium*. Kluwer Academic Publishers.
9. Chopra, R.N. and Kumar, P. K.(1988). *Biology of Bryophytes*, Wiley Eastern Ltd, New Delhi.
10. Coutler, J.M. and Chamberlain, C. J.(1958). *Morphology of Gymnosperm*s, Central Book Depot, Allahabad.
11. Dutta, S.C.(1991).*An Introduction to Gymnosperms*, Kalyan Publishing Co. New Delhi.
12. Eames, A. J.(1979). *Morphology of vascular plants, lower group*. Wiley International edition, New Delhi.
13. Fritsch,F.E.(1935).*Thestructureandreproductionofthealgae,Vol.1andII.*Uni.Press.C ambridge.
14. Gangulee, Dasand Dutta. (2011) *College Botany Vol.I*. Central BookDepot.Calcutta.
15. Gangulee,Kar,A.K. (2011) *College Botany Vol. II*. New Central Book Agency ,Calcutta.
16. Maarten, J. M. Christenhusz, Mark, W. Chase.(2014). *Trends and concepts in fern classification,Annals of Botany*, Volume 113, Issue 4,Pages 571–594, https://doi.org/10.1093/aob/mct299
17. Maarten, J.M..Christenhusz, James L Reveal, AljosFarjon, Martin, F. Gardner, Robert,R. Mill. Mark, W. Chase.(2011). *A new classification and linear sequence of extant gymnosperms*. Phytotaxa, 19: 55 –70.
18. Mamatha, Rao.(2009), *Microbes and Non flowering plants- impact and application*Ane Books Pvt Ltd.
19. Mehltreter, K. Walker, L. R. Sharpe, J. M. (eds), (2010). *Fern Ecology*. Cambridge University Press.
20. Morris, I, (1967). *An Introduction to the Algae*,HutchinsonandCo.London.
21. Parihar, N.S. (1965). *AnIntroductionto Bryophyta*. Central BookDepot,Allhabad.
22. Parihar, N. S.(1977). *Biology and Morphology of Pteridophytes*. Central Book Depot, Allhabad.
23. PPG- I, (2016). A *community-derived classification for extant lycophytes and ferns*. *Journal of Systematics and Evolution*, vol. 54, no. 6, pp. 563-603. http://dx.doi.org/10.1111/jse.12229
24. Ranker T A, Haufler C H (2008),. Biology and Evolution of Fern sand Lycophytes.

25. Rasheed, A. (1999).*An Introduction to Pteridophyta*, Vikas Publishing House, New Delhi.
26. Rasheed, A. (2000).*An Introduction to Bryophyta*, Vikas Publishing House, New Delhi.
27. Rashid, A.(1976). *An Introduction to Pteridophyta*. Vikas Publishing House, New Delhi.
28. Robert Edward Lee. (2008).*Phycology*,CambridgeUniversityPress,
29. Sharma, O.P. (2016). *Series on Diversity of Microbes and Cryptogams - Pteridophyta*, Tata McGraw Hill Education Private Limited, New Delhi.
30. Shaw, J.A., Goffinet,B. (2000). *Bryophyte Biology*. CambridgeUniversityPress.
31. Singh V, Pandey P C,Jain DK (2018). A text book of botany.
32. Singh, Pande, Jain.(2007), *Diversity of Microbes and Cryptogam*,Rastogi Publications.
33. Smith,G.M. (1938). *Cryptogamic Botany Vol. II. Bryophytes and pteridophytes.* McGrawHillBookCompany,London.
34. Sporne,K.R. (1967). *TheMorphology of Bryophytes*. HutchinsonUniversityLibrary, London.
35. Sporne, K.R.(1967). *The Morphology of Gymnosperms*. Hutchinson and Co. Ltd. London.
36. Sreevastava, H.N.(1980). *A Text Book of Gymnosperms*. S Chand and Co. Ltd., New Delhi.
37. Timell, T.L. (1986).*Compression Wood in Gymnosperms*: Springer-Verlag Berlin Heidelberg New York Tokyo.
38. Vashista, B. R, (1993). *Bryophyta*, S Chand & Co., New Delhi.
39. Vashista, B. R, (1993). *Gymnosperms*, S Chand & Co., New Delhi.
40. Vashista, B. R, (1993). *Pteridophyta*, S Chand & Co., New Delhi.
41. Watson,E.V.(1971).*The structure and life of Bryophytes*. Hutchinson University Library, London.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Agri-based microenterprises</td></tr>
<tr><td>Type of Course</td><td colspan="6">MDC</td></tr>
<tr><td>Course Code</td><td colspan="6">UC3MDCBOT200</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</td></tr>
<tr><td>Semester</td><td>III</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	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. **<u>Activity-</u>** 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

1. Sharma, Arun K. 2002. A Handbook of Organic farming. Agrobios, India.
2. Sathe, T.V. 2004, Vermiculture and Organic Farming. Daya Publishers.
3. Alvares, C. 1996. The Organic Farming Source Book. The Other India Press, Mapusa, Goa.
4. Gopal Chandha De, 2002. Fundamentals of Agronomy. Oxford and IBH Publishing House.
5. George Acquciah, 2004. Horticulture: Principles and Practices (II Edn). Prentice Hall. India.
6. Hudson T, Hartmann, Dale E Kester, 2001. Plant Propagation, Principles and Practices (VI Edn). Prentice Hall, India.
7. Kaul T N, 2002. Biology and Conservation of Mushroom. Oxford and IBH Publishing Co.
8. Pandey R K, S K Ghosh, 1996. A Handbook on Mushroom Cultivation. Emkey Publications.
9. Adams C R, Early M P, 2004. Principles of Horticulture. Elsevier, N. Delhi.
10. Barton West R, 1999. Practical Gardening in India. Discovery Pub. House, New Delhi.

SUGGESTED READINGS

1. Edmond J B, Senn T L, Andrews F S, Halfacre P G, 1975. Fundamentals of Horticulture (IV Edn). TMH, New Delhi.
2. Purohit S S, 2005. Plant Tissue Culture. Student Edition.
3. Rema L P, 2006. Applied Biotechnology. MJP Publishers
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.

Est. in 1921	# UNION CHRISTIAN COLLEGE, ALUVA
Programme	BOTANY
Course Name	**Bioethics and IPR**
Type of Course	VAC
Course Code	UC3VACBOT200
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	**Activity – 2** Traditional Knowledge - Meaning, importance of TK, Sources of TK, TKDL (Traditional Knowledge Digital Library.	3	CO4 CO5
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= 1

References

1. Ahuja, V.K. (2017). Law relating to Intellectual Property Rights. India, In: Lexis Nexis.
2. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
3. Bernard R Glick, Jack J Pasternak, Cheryl L Pattern (2010). *Molecular biotechnology: Principlesand applications of recombinant DNA.* ASM press.
4. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
5. Government of India's Patents Website: patinfo.nic.in
6. Intellectual property India: www.ipindia.nic.in
7. Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights. India, In: PHI learning Private Limited.
8. Nithyananda, K.V. (2019). Intellectual Property Rights: Protection and Management. India, In: Cengage Learning India Private Limited.
9. Parulekar, Ajit & D'Souza, Sarita, (2006). Indian Patent Law : Legal and Business Implications, Macmillan India publication,
10. Santaniello,V., Evenson, R.E., Zilberman, D. and Carlson, G.A. (Eds) (2003).Agriculture and Intellectual Property Rights", University Press publication,
11. Sateesh, MK (2008), Bioethics & Biosafety, IK International publications,
12. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
13. USPTO Web Patent Databases at: www.uspto.gov/patft
14. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf

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/)

SEMESTER IV

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Archegoniates**					
Type of Course	DSC A					
Course Code	UC4DSCBOT200					
Course Level	200					
Course Summary	The course provides a basic overview regarding the evolutionary significance, classification, morphology, and distinguishing characters of archegoniate. It also gives a basic outlook towards the ecological and economic significance of Archegoniates.					
Semester	IV	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	Explain the general characters of Archegoniates	U	PO4
2	Classify archegoniates to different plant groups	A	PO1, PO2
3	Compare the structure of gametophyte and sporophyte of Archegoniates	AN	PO1, PO2
4	Assess the economic and ecological significance of Archegoniates	E	PO10
5	Discuss the recent trends in archegoniate research	U	PO4, 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 Archegoniates (5 hours)**			
	1.1	Unifying features of archegoniates; Transition to land habit; Alternation of generations.	2	1
	1.2	Evolution/ transition of the sporophyte and gametophytic phase of archegoniates	3	1
2	**Bryophytes and Pteridophytes (25 hours)**			
	2.1	• General characteristics of Bryophytes • Classification of Bryophytes by Rothmaler 1951 (up to family)	2	1
	2.2	Type study:Morphology, anatomy, and reproduction of *Riccia*, *Anthoceros* and *Pogonatum* (Developmental details not needed).	7	1, 2, 3
	2.5	Ecological and economic importance of bryophytes.	1	4
	2.6	• General characteristics of Pteridophytes. • Classification of Pteridophytes up to classes by Smith (2006) and PPG system (Brief account only)	3	1, 2
	2.7	Morphology, anatomy, and reproduction of *Psilotum*, *Selaginella* and *Pteris* (Developmental details of sex organs and embryo not needed).	7	1, 3
	2.8	• Heterospory and seed habit • Stelar evolution in pteridophytes	3	3
	2.9	• Ecological and economic importance of Pteridophytes.	2	4
		• Ornamental pteridophytes		
3	**Gymnosperms (15 hours)**			
	3.1	• General characteristics of Gymnosperms • Classification Sporne (1965) (up to family), Brief account of classification by Christenhusz (2011)	4	1
	3.2	Morphology, anatomy, and reproduction of *Cycas* and *Pinus* (Developmental details of sex organs not needed)	8	1, 2, 3
	3.3	• Economic importance of Gymnosperms • Ornamental Gymnosperms	3	4

	Practical (30 hours)			
	4.1	Conduct a survey and submit a report with geo-tagged photos / images of gametophytes and/or sporophytes of archegoniates in your locality.	5	1, 2, 3, 4
	4.2	Collect three research publications (within five years) on archegoniates and submit a comparison report.	2	5
	4.3	Collect, identify the genus, and submit gametophytes and/or sporophytes of any five archegoniates.	5	1, 2, 3
4	4.4	*Riccia* and *Anthoceros*– Morphology and anatomy of thallus. *Pogonatum*- Morphology of the sporophyte and gametophyte	6	1, 2, 3
	4.5	● *Psilotum*- Morphology of sporophyte and synangium ● *Selaginella*- Morphology of sporophyte, transverse section of the stem. ● *Pteris*- Morphology of sporophyte, transverse section of sporophyll	8	1, 2, 3
	4.6	● *Cycas*- Morphology of coralloid roots and reproductive structures; TS of leaflet. ● *Pinus*- Morphology of male and female cones; TS of the needle	4	1, 2, 3

	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. Chopra R N, P K Kumar, 1988. Biology of Bryophytes. Wiley Eastern Ltd. New Delhi.
2. Parihar N S, 1965. An Introduction to Bryophyta. Central Book Depot, Allhabad.
3. Shaw J A, Goffinet B, 2000. Bryophyte Biology. Cambridge UniversityPress.
4. Smith G M, 1938. Cryptogamic Botany Vol. II. Bryophytes and pteridophytes. McGraw Hill Book Company, London.
5. Sporne K R, 1967. The Morphology of Bryophytes. Hutchinson University Library, London.
6. Vasishta B R. Bryophyta. S Chand and Co. New Delhi.
7. Watson E V, 1971. The structure and life of Bryophytes. Hutchinson University Library, London.
8. Coutler J M, C J Chamberlain, 1958. Morphology of Gymnosperms. Central book depot. Allahabad.
9. Sporne K R, 1967. The Morphology of Gymnosperms. Hutchinson and Co. Ltd. London.
10. Sreevastava H N, 1980. A Text Book of Gymnosperms. S Chand and Co. Ltd., New Delhi.
11. Vasishta P C, 1980. Gymnosperms. S Chand and Co., Ltd., New Delhi.
12. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
13. Chandra S, Srivastava M, 2003. Pteridology in New Millennium. Kluwer Academic Publishers.
14. Parihar N S, 1977. Biology and Morphology of Pteridophytes. Central Book Depot, Allhabad.
15. Rashid A, 1976. An Introduction to Pteridopyta. Vikas publ. Co., New Delhi.
16. Sporne K R,1967. Morphology of Pteridophytes. Hutchi University Library, London.
17. Sreevastava H N. A text book of Pteridophyta. S Chand and Co., New Delhi.
18. Vasishta B R, 1993. Pteridophyta. S Chand and Co., New Delhi.

Websites

http://www.artdata.slu.se/guest/SSCBryo/SSCBryo.html
http://www.northernontarioflora.ca/links.cfm?val=bryophytes
http://bryophytes.plant.siu.edu/
http://worldofmosses.com/
http://www.unomaha.edu/~abls/
http://www.anbg.gov.au/bryophyte/index.html
http://www.bryoecol.mtu.edu/
http://www.mobot.org/MOBOT/tropicos/most/Glossary/glosefr.html
http://www.fairhavenbryology.com/Master_Page. html
http://www.gymnosperms.org/
http://www.plantapalm.com/vce/toc.htm
http://www.cycad.org/conservation.htm
http://allwebhunt.com/cgi.cfm/Top/Science/Biology/Flora_and_Fauna/Plantae/Cycadoph ytCyca dopsida/Cycadaceae/Cycas

UNION CHRISTIAN COLLEGE,ALUVA

Programme	BOTANY
Course Name	**Plant anatomy and reproductive botany**
Type of Course	DSC A
Course Code	UC4DSCBOT201
Course Level	200
Course Summary	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.

Semester	IV	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.	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.
	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	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
	Anatomical organization of Plant body - Secondary structure (19 hrs)			
2	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, 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.	9	5

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.	20	1, 3, 4

		b. Collect herbaceous members of dicot and monocot – prepare stained sections of root, stem, leaves, and flower bud. 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

References

1. Murphy, D. B., & Davidson, M. W. (2012). Fundamentals of light microscopy and electronic imaging. John Wiley & Sons.
2. Yeung, E. C. T., Stasolla, C., Sumner, M. J., & Huang, B. Q. (Eds.). (2015). Plant microtechniques and protocols (No. 11831). Cham, Switzerland: Springer International Publishing.
3. Pandey, B. P. (2001). Plant anatomy. S. Chand Publishing.
4. Evert, R. F. (2006). Esau's plant anatomy: meristems, cells, and tissues of the plant body: their structure, function, and development. John Wiley & Sons.
5. Easu, K. (1977). Anatomy of seed plants (II Edn). Wiley Eastern, New York.
6. Stevens, W. C. (1924). Plant Anatomy from the Standpoint of the Development and Functions of the Tissues, and Handbook of Microtechnic. P. Blakiston's son.

7. Vasishta, P. C. (2016). Plant Anatomy.Pradeep publication, Jalandhar.
8. Beck, C. B. (2010). An introduction to plant structure and development: plant anatomy for the twenty-first century. Cambridge University Press.
9. Luque, R., & Clark, J. (Eds.). (2010). Handbook of biofuels production: Processes and technologies. Elsevier.
10. Carere, C. R., Sparling, R., Cicek, N., & Levin, D. B. (2008). Third-generation biofuels via direct cellulose fermentation. International journal of molecular sciences, 9(7), 1342-1360.
11. Neto, J. M., Komesu, A., da Silva Martins, L. H., Gonçalves, V. O., De Oliveira, J. A. R., & Rai, M. (2019). Third generation biofuels: an overview. Sustainable bioenergy, 283-298.
12. Wiedenhoeft, A. (2014). Curating xylaria. J. Salick, K. Konchar & Ma. Nesbitt (eds.), 127- 134.
13. Stern, W. L. (1976). Multiple uses of institutional wood collections. Curator: The Museum Journal, 19(4), 265-270.
14. Cutler, D. F., Botha, C. E. J., Stevenson, D. W. (2008). Plant Anatomy: An Applied Approach. United Kingdom: Wiley.
15. Sandberg, D., Kutnar, A., &Mantanis, G. (2017). Wood modification technologies-a review. Iforest-Biogeosciences and forestry, 10(6), 895.
16. Panigrahi S and Rout, S (2020) Wood modification: An alternative strategy for use and protection of wood In Agriculture and Forestry: Current Trends, Perspectives, Issues-I. PP - 267 -286
17. Maiti R, Satya P, Rajkumar D, and Ramaswamy A. (2012). Crop plant anatomy. CABI
18. Maheshwari, P. (1971). An introduction to the embryology of angiosperms. Tata McGraw Hill Publishing Company Ltd., New Delhi.
19. Pandey, S. N. (2009). Plant Anatomy and Embryology. India: Vikas Publishing House Pvt Limited.
20. Bhojwani, S. S, Bhatnagar, S. P., & Dantu, P. K. (2015). The embryology of angiosperms. Vikas Publishing House.
21. Hoadley, R. B. (1990). Identifying Wood: Accurate Results with Simple Tools. United States: Taunton Press.
22. Ruffinatto, F., Crivellaro, A. (2019). Atlas of Macroscopic Wood Identification: With a Special Focus on Timbers Used in Europe and CITES-listed Species. Germany: Springer International Publishing.

<table>
<tr><td></td><td colspan="6">UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Food science and quality control</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC4DSEBOT200</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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">Basic understanding of the structure of carbohydrates, proteins and fats as components of food</td></tr>
</table>

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 etcVitamins- 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

1. Adams, M.R. & Mass, M.D. (2008). Food Microbiology, New age international Pvt Ltd.
2. Banwart, G.T. (2017). Basic Food Microbiology, 2nd edition, CBS Publications, New Delhi ISBN-13 978-8123906461
3. Black, J.G. (1999). Microbiology Principles and exploration, 4th Edition. John Wiley and sons Inc. ISBN-13 978-0471377320
4. Frazier, W.C. (1989). Food Microbiology. 4th Edition, McGraw Hill Education. ISBN-13 978- 0071004367
5. Grumezescu, A. M., & Holban, A. M. (2017). Microbial Contamination and Food Degradation. Academic Press.
6. Jay, J. M. (2005) Modern Food Microbiology. Fourth edition, CBS Publishers, and Distributors Pvt. Ltd. ISBN-13 978-8123904757
7. Jay, J.M., Lossner, M.J.& Golden, D.A. (2008). Modern food Microbiology. 7th edition, Springer, ISBN0387231803.

8. Jha, S. N. (2015). Rapid detection of food adulterants and contaminants- Theory and practice Academic Press (Elsevier). ISBN 978-0-12-420084-5
9. Kawata, J. G. (1963). Environment sanitation in India. Lucknow publishing House.
10. Lara, W (2019). Food science and quality control ED Tech press, ISBN-978-1-83947-260-2
11. Liu, D. (Ed.) (2018). Handbook of Foodborne diseases. CRC Press
12. Longree K. (1972). Quantity Food Sanitation. John Wiley & Sons, ISBN-13 978-0471544463
13. Pelczar, J.M., Chan, E. C.S., & Kreig, N.R. (2023). Microbiology 5th Edition, Affiliated East West Press ISBN-13 978-8176711234
14. Damodaran, S., Parkin, K.L. & Fennema, D.R. (Eds.) (2007). Fennema's Food Chemistry, 4th Edition, CRC press.
15. Guthrie, H.A. (1983). Introductory nutrition. 5th edition. Mosby, 5th Edition, St. louis, ISBN-13 978-0801619977
16. Meyer, L.H. (2004). Food Chemistry, Textbook publishers. ISBN: 0758149204
17. Mudambi, S.R., Rao, S.M.& Rajagopal, M.V. (2006). Food Science. 2nd edition,*New Age International*. Pvt. Ltd. *Publishers*
18. Mudambi, S.R. & Rajagopal, M.V. (2001). Fundamentals of Food and Nutrition, 4th edition. New Age International Publishers
19. Shakuntla, M.N.&Shadaksharaswamy, M. (2013). Food facts and principles. New Age International
20. Srilakshmi, B. (2003). Food science, 3rd edition. New Age International. ISBN-13 978- 8122414813
21. Swaminathan, M. (2022) Advanced text book on Food and nutrition, Vol II, The Bangalore Press.
22. Swaminathan, M. (2018) Handbook of Food and Nutrition, 5th Edition, The Bangalore Press.
23. Swaroop, A., Bagchi, D., & Preuss, H.G. (2015). Nutraceuticals and Functional Foods in Human Health and Disease Prevention CRC Press, ISBN- 9781482237221
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

UNION CHRISTIAN COLLEGE,ALUVA

Programme	BOTANY					
Course Name	**Horticulture and post-harvest technology**					
Type of Course	DSE					
Course Code	UC4DSEBOT201					
Course Level	200					
Course Summary	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.					
Semester	IV	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	-	-	-	60
Pre- requisites, if any	Familiarity with basic plant science, soil science and environmental science					

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,	2	6,7

		Role of Horticorp and VFPCK.		
	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

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Introduction to flowering plants and their economic importance</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC B</td></tr>
<tr><td>Course Code</td><td colspan="6">UC4DSCBOT202</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">Upon completion of the course, a student should be able to:
• Identify and classify plants based on natural system of classification
• use taxonomic aids for scientific studies and research.
• understand the use and importance of plants
• appreciate the traditional knowledge of local culture and people
• know the basic techniques of dry preservation of plants</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>
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<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse morphological characters of plants helpful in the identification of plants	An	PO2
2	Apply techniques in plant taxonomy for the identification and preservation of plant species.	A	PO2, PO7
3	Interpret angiosperm families based on Bentham and Hookers Classification for the identification of common plants	A	PO7, PO10
4	Explain the botanical details and uses of selected plants of daily use.	U	PO10, PO2,
5	Appraise the utility of plants in the daily life of tribal people.	An	PO8, PO1, PO6, PO 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	**Morphology of Angiosperms (10 Hours)**			
	1.1	Leaf – types, phyllotaxy. Flower as a modified shoot Structure of flower - floral parts, Flower types - Hypogyny, Perigyny, Epigyny, Symmetry of flowers, aestivation and placentation; floral diagram and floral formula.	10	CO1
	1.2	Inflorescence: racemose – simple raceme, spike, corymb, umbel, head; cymose – simple cyme		
	1.3	Fruits: Simple: Fleshy - drupe, berry, hesperidium.		
		Dry - Dehiscent and Indehiscent with examples. Aggregate fruit Multiple fruit: Sorosis		
	Classification, Nomenclature. and Systematic Botany (20 Hours)			
	2.1	Types of Classification: Bentham and Hookers System of Classification (up to Series)	5	CO2
	2.2	Binomial nomenclature, Author Citation		
	2.3	Herbarium Techniques		

2	2.4	Study of the following families of Bentham and Hooker's system of classification with special reference to major identifying characters and economic importance: Malvaceae, Leguminosae (Fabaceae) Rubiaceae, Apocynaceae, Poaceae (Graminae).	15	CO3
3	**Economic Botany &Ethnobotany (15 Hours)**			
	3.1	Binomial and Uses of the following plants: Cereals – Rice Pulses - Green gram Sugar-yielding plants – Sugarcane Fruits - Mango and Jackfruit Vegetables – Amaranthus and Moringa Tuber crops – Tapioca Beverages - Tea, Coffee Oil yielding plants - Coconut, Spices – Pepper, Turmeric Fibre yielding plants – Cotton Rubber yielding plant- Rubber Medicinal plants – Tulsi, Neem	10	CO3
	3.2	Introduction, scope and significance of ethnobotany.	5	CO4
		Study of the following plants used in daily life by tribals and village folks. Food- Finger Millet, Little millet Shelter - *Bambusa*, *Calamus*; Medicine –*Trichopuszeylanicus*,*Alpinia galanga.*		
4	**Practicals (30 Hours)**			
		1. Collect and submit specimens/geotagged photos of at least three items each of the inflorescence and fruits mentioned in the syllabus. 2. Study of floral parts and construction of floral diagram and floral formula of at least one plant from each family and mentioned in the syllabus and submit a record. 3. Prepare a herbarium of 5 plants representing each family. 4. Conduct a field visit to explore the Angiosperm diversity and submit a report 5. Study the useful parts of plants mentioned under economic botany and ethnobotany, with special reference to the binomial and uses.	30	CO5
5	Teacher Specific Content			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, hands-on training in plant identification, lab-to-field connection through field visits, nature study, specimen collection, documentary, and use of online tools and resources in taxonomic and ethnobotanical studies.
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. Bell, A.D (1991) Plant form- An illustrated guide to Flowering plant morphology. OXFORD UNIVERSITY PRESS, New York, Tokyo.
2. Davis PH &HeywoodVH (1967) Principles of Angiosperm Taxonomy. Oliver and Boyl, Edinburgh.
3. EamesAJ (1961)Morphology of Angiosperms. Mc Graw Hill, New York.
4. Harris, J.G & M. W. Harris. (1994) Plant Identification Terminology -An illustrated Glossary, Spring Lake Publishing, Spring Lake, Utah
5. Heywood V H (1967).Plant Taxonomy. Edward Arnold, London.
6. Hill AF (1982) Economic Botany. McGraw-Hill, NewYork.
7. Jain SK & Rao R (1976) A handbook of field and herbarium technique. Today and Tomorrow Publishers, New Delhi.
8. Jeffery C (1968) An Introduction to Plant Taxonomy. Jand A Churchill, London.
9. Lawrence H M (1951). Taxonomy of vascular plants. Macmillan, New York.
10. Maheshwari Pand U. Singh (1965) Dictionary of Economic Plants in India. ICAR, New Delhi.
11. Naik VN, (1984). Taxonomy of angiosperms. Tata Mc Graw-Hill Publishing Company, New Delhi.
12. Prenner, G, Bateman, R & Rudall, P (2010) Floral formulae updated for routine inclusion in formal taxonomic descriptions. *Taxon.* 59. 241-250. 10.2307/27757066.
13. Rendle AB,1979.Classification of flowering plants, Vols. I&II. Vikas Publishing House, U.P.
14. Sambamurthy A, 2005.Taxonomy of Angiosperms. I.K. International Pvt .Ltd, New Delhi.
15. Simpson, M G (2006) Plant Systematics. Elsevier Academic Press publications, USA
16. SreemaliJL,1979.EconomicBotany.KitabMahal,Allahabad.
17. Singh VandJain DK,1989.TaxonomyofAngiosperms. Rastogi Publication, Meerut.
18. SivarajanV.V,1991.IntroductiontothePrinciplesofPlanttaxonomy.OxfordIBHPublishing Co.Pvt. Ltd., New Delhi.

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https://sweetgum.nybg.org/science/ih/

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UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</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">UC4SECBOT200</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>
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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 **.** **Learning activity:** 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: Neem and tobacco-based products (Brief account only).	7	CO3

		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.		
	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	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.	6	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 biological beneficial organisms. Methods to improve	8	CO5

		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.
7. Nollet, L. M., &Rathore,H., S. (Eds.). (2023). Biopesticides handbook. CRC Press.
8. Rajeshwari, R., &Appanna, V. (Eds.). (2021). Biopesticides in Horticultural Crops. CRC Press.
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.
13. Arora, N. K., Mehnaz, S., & Balestrini, R. (Eds.). (2016). Bioformulations: for sustainable agriculture (pp. 1-283). Berlin: Springer.
14. Giri, B., Prasad, R., Wu, Q. S., & Varma, A. (Eds.). (2019). Biofertilizers for sustainable agriculture and environment. Cham: Springer International Publishing.
15. Kannaiyan, S. (Ed.). (2002). Biotechnology of biofertilizers. Springer Science & Business Media.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Conservation biology and sustainable development</td></tr>
<tr><td>Type of Course</td><td colspan="6">VAC</td></tr>
<tr><td>Course Code</td><td colspan="6">UC4VACBOT200</td></tr>
<tr><td>Course Level</td><td colspan="6">200</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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	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.
	Conservation Biology (15 hours)			
	1.1	Introduction to conservation Biology –Definition, career prospects in conservation biology, Conservation and management practices	3	1
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
	Biodiversity (15 hours)			
	2.1	Definition, types and importance	3	4
2	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
	Sustainable development (15 hours)			
3	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.	3, 6	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

References

1. Ahmedullah M, Nayar M P (1987). Endemic plants of India
2. Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London.
3. Gilpin, M. E. & Soulé, M. E. "Minimum viable populations: Processes of species extinction." In Conservation Biology: The Science of Scarcity and Diversity, ed. M. E. Soulé (Sunderland: Sinauer & Associates, 1986): 19–34.
4. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. "An introduction to sustainable development." (2012).
5. Wilson E O (1988). Biodiversity. The national academic press. 37. Wilson E O (1999). The diversity of life. W.W. Norton and Company
6. https://asuonline.asu.edu/newsroom/online-learning-tips/what-is-conservation-biology- ecology/
7. https://www.nature.com/scitable/knowledge/library/conservation-biology-16089256/
8. https://sumas.ch/5-examples-of-sustainable-development/

SUGGESTED READINGS

1. IUCN (2007). The 2000 IUCN red list of threatened species. IUCN. England.
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.
5. Richard T. Wright, Dorothy F. Boorse (2017). Environmental Science: Toward A Sustainable Future, Pearson, 13th Edition

INTERNSHIP

	UNION CHRISTIAN COLLEGE, ALUVA
Programme	BOTANY
Course Name	**Internship**
Course Code	UC4INTBOT200
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

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY
Course Name	**Angiosperm systematics and economic botany**
Type of Course	DSC A
Course Code	UC5DSEBOT300
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.
		Plant Morphology (10 hours)		
1	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
		Plant Taxonomy (32 hours)		
2	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

REFERENCES

1. Davis, P.H. & Heywood, V.H. (1967). Principles of Angiosperm Taxonomy. Oliver and Boyl, Edinburgh.
2. Eames, A.J. (1961). Morphology of Angiosperms. McGraw Hill, New York.
3. Foster, A.S. &Giffad, E.M. (1962). Comparative morphology of vascular plants. Allied Pacific Pvt. Ltd. Bombay.
4. Harris, J.G & M.W. Harris (1994). Plant Identification Terminology -An illustrated Glossary, Spring lake publishing, Spring lake, Utah.
5. Heywood, V. H. (1967). Plant Taxonomy. Edward Arnold, London.
6. Hill, A. F. (1982). Economic Botany. McGraw Hill, New York.
7. Jain, S.K. & Rao, R. (1976). A handbook of field and herbarium technique. Today and tomorrow,Publishers, New Delhi.
8. Jeffery, C. (1968). An Introduction to Plant Taxonomy. J and A Churchill, London.
9. Lawrence, G. H. M. (1951). Taxonomy of Vascular Plants. Macmillan, New York.
10. Maheshwari, P. & Singh, U. (1965). Dictionary of Economic Plants in India. ICAR, New Delhi.
11. Naik, V.N. (1984). Taxonomy of angiosperms. Tata Mc Graw- Hill Publishing Company, New Delhi.
12. Pandey, S. N. & Misra, S. P. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.
13. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press publications, USA.
14. Singh, G. (2010). Plant systematics - an integrated approach (3rd Edn) Science Publishers.
15. Sreemali, J. L. (1979). Economic Botany. Kitab Mahal, Allahabad.
16. Singh, V. & Jain, D.K. (1989). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
17. Sivarajan, V.V. (1991). Introduction to the Principles of Plant Taxonomy. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
18. Turland, N. (2013). The Code Decoded. A user's guide to the International Code of Nomenclature for algae, fungi, and plants. Koeltz Scientific Books, Königstein, Germany. 169 pp

   https://www.ipni.org/ https://powo.science.kew.org/ www.botanicus.org
   https://sweetgum.nybg.org/science/ih/

SUGGESTED READINGS

1. Beentje, H. (2016). The Kew Plant Glossary- An illustrated dictionary of plant terms (2nd Edn). Kew Publishing. Royal Botanic Garden, Kew, England.
2. Bell, A.D (1991). Plant form- An illustrated guide to Flowering plant morphology. Oxford University Press, New York, Tokyo.
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.
5. Prenner, G, Bateman, R. & Rudall, P. (2010). Floral formulae updated for routine inclusion in formal taxonomic descriptions. *Taxon.* 59. 241-250. 10.2307/27757066.
6. Rendle, A. B. (1979). Classification of flowering plants, Vols. I & II. Vikas Publishing House, U.P.
7. Sambamurthy, A. (2005). Taxonomy of Angiosperms. I.K. International Pvt. Ltd, New Delhi.
8. Sharma, O. P. (1996). Plant Taxonomy. Tata McGraw Hill, New Delhi.

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<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Plant cell and molecular biology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">UC5DSCBOT301</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">Cell and Molecular biology play a crucial role in shaping understanding of life. The course emphasizes the basic principles that buttress the processes unique to living organisms at the molecular and cellular levels. Students will acquire a basic understanding of architecture of plant cells, organization of genetic material, the storage, transfer, and regulation of genetic information etc. Students learn how genes and proteins organize cells for cellular activities thereby gaining an in-depth understanding of cellular function. On completion of this course, they are equipped to tackle fundamental scientific questions. The course envisages the application of modern molecular and cellular biology in Plant Sciences and provides a solid foundation for further studies in the areas of molecular life sciences, bioengineering, and biotechnology.</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>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 cell structure in plants, process of cell division and knowledge of experiments that led to the discovery of genetic material</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Outline the historical developments in cell and molecular biology	U	PO3
2	Illustrate the structure and function of plant cell wall and cell organelles	A	PO2
3	Describe the function of the nucleus and chromosome condensation process and their role in heredity	U	PO1, PO2, PO10
4	Assess the gene regulatory network and inheritance in organisms	E	PO1, PO2
5	Examine how Cell division and programmed cell death occur within a plant cell	An	PO3, PO10
6	Investigate the role of enzymes in regulating cell activities	E	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	**Introduction, cellular architecture and cell organelles (20 hours)**			
	1.1	History and Scope of Cell and Molecular biology; Major developments in Cell and Molecular Biology.	1	1
	1.2	Architecture (Brief Account) and Functions of Plant Cell Wall. Cell Membrane and Chemical Composition of Cell Membrane.	3	2
	1.3	Structure and Major Functions of the following cell organelles: Endoplasmic Reticulum, Lysosomes, Dictyosomes, Vacuole, Ribosomes (Brief Account) and Cytoskeleton. Structure and Major Functions of Semi-autonomous Cell Organelles - Chloroplast, Mitochondria, Major Components and Definitions of GERL and Endomembrane System.	6	2
	1.4	Ultra Structure of Nucleus, Nuclear Envelope, Nuclear Pore Complex (NPC). Structure and Function of Nuclear lamina and Nucleolus.	3	3
	1.5	Morphology of a typical chromosome, Organization of genetic material in chromosomes. Structural organization: Histones, Non-histone proteins, Nucleosomes, Chromatosomes. Higher level of chromosome organization; Solenoid model. Special Chromosomes: Structure and Function of Polytene and Lamp brush chromosomes.	6	3
	1.6	Types and Organization of Chromatin: Heterochromatin, Euchromatin, Karyotype, Idiogram	1	3
2	**Genetic material, cell cycle and mutations (15 hours)**			
	2.1	Significance of mitosis and meiosis, Eukaryotic Cell cycle (G1, S, G2, M) Evolutionarily conserved genes and proteins.	3	5
	2.2	Cell Death, Programmed Cell Death (Apoptosis), Necrosis (Overview). **<u>Activity</u>:** Students may submit appropriate illustrations with short descriptions to explain how events of meiosis together with gametic fusion during sexual reproduction, brings about genetic variability in progenies of plants.	2	5
		Basic understanding of Genetic material Types of DNA: A, B and Z DNA, Plastome - Chloroplast DNA.		

	2.3	Types and functions of RNA: hnRNA, mRNA, tRNA, rRNA, snRNA and microRNA **<u>Activity:</u>** Prepare a comparative account on the types of RNA and submit for evaluation	4	5
	2.4	DNA replication (prokaryotic): Role of enzymes - DNA Polymerases, Primases, Helicases, Ligases and DNA Topoisomerases.	3	6
	2.5	Point Mutations: Definitions of Transition Mutations, Transversion Mutations, Silent mutations, Missense mutations, Nonsense Mutations.Molecular basis of point mutations. Definition and Significance of Frameshift mutations. Significance of DNA repair mechanisms in cells. **<u>Activity:</u>** Discuss how mutation in a single nucleotide leads to altered phenotype citing suitable examples.	3	6
3	**Gene expression (10 hours)**			
	3.1	Gene expression: Central dogma of molecular biology and its revisions. Basic mechanism of Transcription in Prokaryotes. Perspective of transcription in Eukaryotes: Split genes, Introns, Exons, Spliceosomes (Definitions and significance). Post transcriptional modification of mRNA Translation in Prokaryotes.	5	6
	3.2	Genetic code, Wobble hypothesis, Regulation of gene expression in prokaryotes by Operons: Lac and Trp operon, Regulation in eukaryotes (brief study).	4	5
	3.3	Endosymbiont hypothesis (Overview), Significance of chloroplast and nuclear DNA in the biosynthesis of RUBISCO.	1	6
	Practical (30 hours)			
	4.1	Study of mitosis by squash preparation of *Allium* sp. root tip	30	2, 3, 5
	4.2	Calculate mitotic index of root tips prepared by squash preparation		
	4.3	Identification of various stages of meiosis I using appropriate illustrations		
	4.4	Isolation of plant DNA from appropriate plant specimen		
		Demonstration (any one) of		

4	4.5	• Cell viability using tri-phenyl tetrazolium chloride (TTC). • Cell counting using hemocytometer • Observation of cyclosis and Chloroplast in leaf of *Hydrilla* orStaminal hairs of *Rheo discolor*		
	4.6	Separation of cells from cell suspension/ cell culture using centrifugation (yeast cells)		
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. Alberts, A., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts K., & Walter, P, (2014). Molecular biology of the cell. Garland Science, 2015. 6th edition. ISBN-1J: 978- 0815345244
2. Alberts, B., Hopkin, K., Johnson, A., Morgan, D., Roberts, K., Walter, P., &Heald,
   R. Essential Cell Biology. W. W. Norton & Company, Inc., New York. ISBN: 978-1-324- 03348-6
3. Alberts, B., Hopkin, K., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts K., & Walter, P. (2005). Molecular Biology-Understanding the Genetic revolution. Clark, D. P. (Ed.), Elsevier Academic Press. ISBN:0-12-175551-7.
4. Ana, Z. M., Diana, F., Arraes Fabricio B.M., Anne-Sophie, P., Bruno, P.M., …. et al. (2020). Evolutionarily conserved plant genes responsive to root-knot nematodes identified by comparative genomics. *Molecular Genetics and Genomics*, 295 (4), 1063- 1078.https://doi.org/10.1007/s00438-020-01677-7
5. Andersson, I. (2008). Catalysis and regulation in Rubisco. J*ournal of Experimental Botany*, 59 (7), 1555–1568, https://doi.org/10.1093/jxb/ern091
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. & Bertoni, G. P. (2009). The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
7. Cooper, G.M., & Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinnauer Academic Press.
8. De Robertis, E.D.P. & De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
9. Gruber, A.V., & Feiz, L. (2018). Rubisco assembly in the chloroplast. Front. Mol. Biosci., 5, https://doi.org/10.3389/fmolb.2018.00024
10. Karp, G. (2012). Cell and molecular biology- concepts and experiments, John Wiley & Sons Inc; 7th edition, ISBN-13: 978-1118568484
11. Lodish, H., Berk, A., Kaiser, C.A., Amon, A., Ploegh, H., Bretscher, A., , Krieger, M., &Martin, K.C. (2016). Molecular Cell Biology, WH Freeman 8th edition ISBN-13 978- 1464187445
12. Mermet, S., Voisin, M., Mordier, J., Dubos, T., Tutois, S., Tuffery, P., Baroux, C., Tamura, K., Probst, A.V., Vanrobays, E. (2023). Evolutionarily conserved protein motifs drive interactions between the plant nucleoskeleton and nuclear pores. *The Plant Cell*, 35 (12), 4284–303, https://doi.org/10.1093/plcell/koad236
13. Pollard, T., Earnshaw W., Lippincott-Shwartz J., & Johnson G. (2017). Cell biology, 3rd edition Elsevier Ie, ISBN-13 978-0323417402
14. Watson, J., Baker, T., Bell, S., Gann, A., Levine, M., Losick, R. (2013). Molecular Biology of the Gene, Pearson 7th edition ISBN-13 978-0321851499

<table>
<tr><td>Est. in 1921</td><td colspan="6">UNION CHRISTIAN COLLEG, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Plant breeding and plant genetic resources</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC5DSEBOT300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course on Plant Breeding and Plant Genetic Resources provides a comprehensive understanding of the principles and practices involved in enhancing the genetic makeup of plants for improved traits and characteristics. Students delve into the conservation, and sustainable utilization of plant genetic resources, emphasizing the importance of biodiversity in agricultural systems. The curriculum covers various breeding methods, including classical and molecular techniques, enabling students to grasp both traditional and cutting-edge approaches to develop crop varieties with desirable traits such as yield, disease resistance, and environmental adaptation. Overall, this course equips students with the knowledge and skills needed to contribute to the advancement of sustainable agriculture and food security through effective plant breeding practices and responsible use of genetic resources.</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">Basics of plant hybridization or basic plus two knowledge.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No.
1	Summarize the origin and scope of plant breeding along with the major research centers involved in plant breeding	U	PO4, PO6,
2	Choose a proper plant breeding method for a crop improvement programme	A	PO1, PO2, PO7, PO10
3	Explain the nuances of heterosis and inbreeding depression	U	PO1, PO2, PO4, PO7
4	Explore the importance and applications of plant genetic resources for food security and agriculture	A	PO1, PO2, PO3, PO4, POPO8, PO9, PO10
5	Develop strategies for conserving the regional plant genetic resources	C	PO1, 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		**Introduction to plant breeding (10 hours)**		
	1.1	Significance of plant breeding.	2	1
	1.2	The centres of origin: Nikolai Vavilov's Centres of Origin of Cultivated Plants - Different centres and their significance.	4	1
	1.3	National and International Centres of Plant breeding- ICAR, NBRI (National Botanical Research Institute), IRRI Philippines, IPGRI (International plant genetic resource institute, Rome). Plant breeding Stations in Kerala and their achievements – CPCRI, CTCRI, RRII.	4	1
2		**Plant Breeding methods for crop improvement (10 hours)**		
	2.1	Plant introduction: procedure of plant introduction - quarantine regulations, acclimatization, agencies of plant introduction in India, major achievements.	2	2
	2.2	Plant Selection: mass, pure-line, clonal	2	2
	2.3	Hybridization: types, procedure, important achievements.	2	2
	2.4	Mutation breeding and polyploidy breeding: methods and applications	2	2
	2.5	Advanced tools and techniques in plant breeding (Brief account).	2	2
		(Optional reading: Breeding of virus-resistant transgenic sugarcane by the integration of the Pac1 gene.)		
3		**Heterosis and Inbreeding depression (22 hours)**		
	3.1	Heterosis in plant breeding - characteristic features, applications and achievements in crop improvement, dominance, overdominance and pseudo-overdominance hypothesis of heterosis.	3	3
	3.2	Effects of inbreeding. Inbreeding depression-features, degree of inbreeding depression.	2	3
	3.3	Methods of segregating generations - pedigree method, bulk method, back cross method.	3	3
		Activity		
	a	Compare the effectiveness of any one Emasculation method in any bisexual plant and take photos of the same.	3	2
	b	Demonstration of hybridization in plants	2	2

	c	Identify self- pollinated and cross-pollinated plants present in your locality based on floral morphology and make an album with details (at least ten plants are required)	3	2
	d	Find any 10 plant breeding centres in India using google map. Prepare a report on these research centres.	2	1
	e	Visit any plant breeding station in Kerala and understand various breeding practices followed there.	4	1
4	**Plant genetic resources for food and agriculture (18 hours)**			
	4.1	Exploration and collection of genetic resources - importance of wild relatives of crop plants and their genetic diversity in crop improvement.	2	4
	4.2	Ethnobotany in relation to conservation of genetic resources. Identification of farming systems of: food crop – Rice (need to learn any 5 traditional rice varieties in Kerala); Vegetables - Cow pea, Bitter gourd; Spices- Ginger, Black pepper; Medicinal plants - *Aloe*; Plantation crops – Coffee and Coconut; Fruits - Banana.	5	4
	4.3	Binomial, Family and uses of the following underutilized edible plants - Vegetables - *Averrhoa carambola* (Chathurappuli), *Dioscorea esculenta* (Nanakizhangu), *Canavalia gladiata* (Valpayar), *Psophocarpus tetragonolobus* (Chathurapayar), *Sauropusandrogynus* (Velicheera), *Ipomoea turbinata* (Nithya Vazhuthana); Fruits - *Artocarpus hirsutus* (Anjili), *Aporosacardiosperma* (Vetti), *Spondias pinnata* (Ambazham), *Syzygiumcumini* (Njaval), *Flacourtiamontana* (Kattuloovika), Millets - *Echinochloa crus-galli* (Barnyard grass)	3	4
	4.4	Major threats to the genetic resources: anthropogenic activities – deforestation, habitat destruction and invasive species.	2	5
	4.5	Conservation of genetic resources - biodiversity conservation, in-situ conservation – national parks, sanctuaries, and biosphere reserves; ex-situ conservation – Botanical gardens, gene banks, germplasm banks and cryopreservation, NBPGR	3	5
	Activity			
	a	Collect and submit any two traditional cultivars of the vegetables, fruits, spices, medicinal plants and plantation crops mentioned in the syllabus.	3	1,2,4, 5
	b	Make a list of traditionally cultivating crops in the local area, and make a registry	2	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, 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. Allard, R. W. 1999. *Principles of plant breeding*. John Wiley and Sons.
2. Acquaah, G. 2009. *Principles of plant genetics and breeding*.John Wiley & Sons.
3. Ahlawat, S. P., Bhatt, K. C., Semwal, D. P., Pradheep, K. and Dhariwal, O. P. 2022. Exploration and Collection of Plant Genetic Resources in India: Status and Priorities. *Indian Journal of Plant Genetic Resources*, *35*(03), 117-123.
4. Arora RK and Nayar, E. R. 1984. Wild Relatives of Crop Plants in India. NBPGR Monograph no. 7, NBPGR, New Delhi.
5. Arora, R. K. and Pandey, A. 1996. Wild edible plants of India diversity, conservation and use, National Bureau of plant genetic resources. *New Delhi*.
6. Chahal, G.S. and Gosal, S. S. 2002. *Principles and procedures of plant Breeding*. Narosa Publishing House. New Delhi.
7. Hayward, M. D., Bosemark, N. O., and Romagosa, T. (Eds.). 2012. *Plant breeding: principles and prospects*. Springer Science & Business Media.
8. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Western and Central Africa Region. 2009. Protecting Biodiversity, Providing Options. BP 12404, Niamey, Niger: ICRISAT. 64 pp.
9. IWANAGA, M. 1994. Role of International Organizations in Global Genetic Resources. In *Plant Genetic Resource Management in the Tropics: Proceedings of the 27th International Symposium on Tropical Agriculture Research, Tsukuba, Japan, August 25-26, 1993* (No. 2, p. 1). Japan International Research Center for Agricultural Sciences, Ministry of Agriculture, Forestry and Fisheries.
10. Kirtikar, K R and Basu, B. D. 1991. *Indian Medicinal Plants.* Dehra Dun.
11. Kurian, A. and Peter, K. V. 2007. *Commercial crops technology* (Vol. 8). New India Publishing.
12. Mahour, K. 2016. Role of women in environment conservation. *Journal of Advanced Laboratory Research in Biology*, *7*(1), 17-26.
13. Paroda, R. S. and Arora, R. K. 1991. *Plant Genetic Resources Conservation and Management*, NBPGR, New Delhi.
14. Peter, K.V. and Abraham, Z. 2007. *Biodiversity in Horticultural Crops* Vol.1, Daya Publishing House. New Delhi.
15. Ram, M. 2014. *Plant breeding methods*. PHI Learning Pvt. Ltd.
16. Salgotra, R. K., and Chauhan, B. S. 2023. Genetic diversity, conservation, and utilization of plant genetic resources. *Genes*, *14*(1), 174.
17. Singh, B. B., Neeta Singh and Kalyani Srinivasan (eds). 1996. *Principles and Procedures* in Germplasm Conservation, NBPGR. New Delhi
18. Singh, B. P. and Umesh Srivastava. 2004. *Plant Genetic Resources in Indian Perspective- Theory and Practice*, Directorate of Information and Publications of Agriculture, ICAR. New Delhi.
19. Singh, B. D. 2015. *Plant Breeding, principles and methods* (X Edn.). Kalyani publishers, New Delhi.
20. Singh, D. P., Singh, A. K. and Singh, A. 2021. *Plant breeding and cultivar development*. Academic Press.
21. Singh, K. 2018. Role of ICAR-NBPGR in PGR Management. *ICAR-National Bureau of*

Plant Genetic Resources, New Delhi, 10.

22. Varaprasad, K. S., Abraham, Z, Pandravada, S. R. *et al*. 2006. *Medicinal Plants Germplasm of Peninsular India*, NBPGR New Delhi.
23. Wang, W., Wang, J., Feng, X., Shen, L., Feng, C., Zhao, T., ... & Zhang, S. (2022). Breeding of virus-resistant transgenic sugarcane by the integration of the Pac1 gene. *Frontiers in Sustainable Food Systems*, *6*, 925839.
24. http://www.nbpgr.ernet.in/About_NBPGR/At_a_Glance.aspx

<table>
<tr><td colspan="7">UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Phytogeography, forestry and ecotourism</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC5DSEBOT301</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">The course ‘Phytogeography, Forestry and ecotourism’ deals with the study of distribution of plant community, its management and conservation.</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 various theories and principles related to plant distribution	U	PO1,PO6
2	Identify and categorize the interactions in the ecosystem and factors affecting the plant growth	An	PO1,PO2
3	Describe the principles and practices in forest management	U	PO1
4	Evaluate and appreciate the role of youth, Clubs, organizations in conservations.	Ap	PO3,PO4,PO7
5	Appreciate the role of ecotourism projects in nature conservations	Ap	PO3,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	**Plant and Environment (17 hours)**			
	1.1	Ecological complexes and factors affecting plants growth and distribution. Biotic factors: interactions – positive and negative	3	2
	1.2	Topographic factors: altitude and aspects. Edaphic factors – soil profile and physical and chemical properties of soil, soil formation	4	2
	1.3	Climatic factors: temperature and pressure, water - precipitation, humidity, soil water holding capacity, light - global radiation	3	2
	1.4	Morphological, anatomical, and physiological adaptation of plants to the environment with references to biomes.	7	2
	Phytogeography (16 hours)			
	2.1	Definition, principles governing plant distribution, factors affecting plant distribution	2	1

2	2.2	Plant distribution- distribution of plants- continuous, discontinuous, and endemic. Theories of plant distribution – migration hypothesis, long distance dispersal hypothesis, theory of continental drift, age area hypothesis, land bridge theory.	5	1
	2.3	World Biomes - aquatic and terrestrial, Climatic, vegetational and botanical zones of India.	4	1
	2.4	Remote sensing - Definition and data acquisition techniques. Application of remote sensing in vegetation classification, understanding environmental issues and ecosystem management. Geographic information system (GIS).	5	1
3	**Forestry (17 hours)**			
	3.1	Introduction to forestry: Classification of forests (Champion and Seth, 1968). Major types of forests in India. Silviculture; principles and practices- clear felling system, coppice system. Common plants in silviculture. Sustainable forest management approaches with reference to Kerala - timber plantation, agroforestry, social forestry, JFM	6	3
	3.2	Forest Ecosystems and biodiversity- Forest ecology and ecosystem services. Biodiversity- definition, values of biodiversity, levels of biodiversity. Biodiversity loss, Concept of endemism. Types of endemism.	5	3
	3.3	Species extinction – Rate of species extinction, reasons to stop extinction- methods to save species. Threats to forest biodiversity, IUCN- threat categories. IUCN account of biodiversity, red data book and hot spots.	6	4
4	**Ecotourism(10 hours)**			

	4.1	Ecotourism definition, Elements and characteristics of ecotourism. Types of ecotourism – Heritage ecotourism, coastal ecotourism, cultural ecotourism, festival ecotourism, ayurvedic ecotourism. positive and negative impacts of ecotourism.	5	5
	4.2	Major ecotourism centers in Kerala – Gavi, Thattekadu, Thenmala. Learning activity: Visit an ecotourism center and identify the ecotourism components of the ecotourism and submit a report.	2	5
	4.3	Wildlife tourism and its opportunities with reference to Kerala-Periyar tiger reserve, Tholpetty wildlife sanctuary	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, 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. Woodward, S. L. (2009). Introduction to biomes. Greenwood Press.
2. Britannica Educational Publishing. (2010). Biomes and Ecosystems. Britannica Educational Publishing.
3. Stiling, P. D. (2015). Ecology: global insights & investigations. Mcgraw-Hill Education.
4. Richardson, J., R. Björheden, P. Hakkila, Lowe, A. T., & Smith, C. T. (2006). Bioenergy from Sustainable Forestry. Springer Science & Business Media.
5. Montagnini, F., & Jordan, C. F. (2005). Tropical Forest Ecology. Springer Science & Business Media.
6. Köhl M., Magnussen, S. S., Marchetti, M., &Springerlink (Online Service. (2006). Sampling Methods, Remote Sensing and GIS Multiresource Forest Inventory. Springer Berlin Heidelberg.
7. Schulze E. D., Beck, E., & Klaus Müller-Hohenstein. (2005). Plant ecology. Springer.
8. Ballantyne, R., & Packer, J. (2013). International Handbook on Ecotourism. Edward Elgar Publishing.

SUGGESTED READINGS

1. Raven, C. (2006). Forestry. Infobase Publishing.
2. Fennell, D. A. (2002). Ecotourism. Routledge.
3. Newsome, D., Dowling, R. K., & Moore, S. A. (2005). Wildlife tourism. Channel View Publications.
4. Dr Jennifer Hill, & Dr Tim Gale. (2012). Ecotourism and Environmental Sustainability. Ashgate Publishing, Ltd.
5. Wearing, S., & Neil, J. (2013). Ecotourism. Routledge.
6. Wearing, S., & Schweinsberg, S. (2019). Ecotourism: transitioning to the 22nd century. Routledge.
7. Begon, M., Harper, J. L., & Townsend, C. R. (2006). Ecology: individuals, populations, and communities. Blackwell Science.

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Plant biotechnology**					
Typeof Course	DSE					
Course Code	UC5DSEBOT302					
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 secondary metabolite production-, cryopreservation for germplasm conservation. Protoplast isolation, culture and fusion, somatic hybridisation, and applications - cybrids	9	1
	Recombinant DNA Technology (29 Hours)			

2	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

1. Chawla H. S (2009): Introduction to Plant Biotechnology 3rd Edition, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Desmond S. T Nicholl (2008): An Introduction to Genetic Engineering; Studies in Biology. Cambridge University Press. 3rd Edition.
3. Keshavachandran R and Peter K V (2008): Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient Blackswan.
4. Razdan M K. (2015): Introduction to Plant Tissue Culture. Oxford and IBH, MKM Publishers 2nd. Edition

Suggested readings:

1. Smita Rastogi and Neelam Pathak (2009). Genetic Engineering. Oxford University Press. New Delhi.
2. Timir Baran Jha and Biswajit Ghosh (2016): Plant Tissue Culture. Platinum Publishers. Revised 2nd Edition. Kolkata
3. Razzaq, A., Saleem, F., Kanwal, M., Mustafa, G., Yousaf, S., Imran Arshad, H. M., & Joyia, F.

A. (2019). Modern trends in plant genome editing: an inclusive review of the CRISPR/Cas9 toolbox. *International Journal of Molecular Sciences*, *20*(16), 4045.

4. Liu, D., Hu, R., Palla, K. J., Tuskan, G. A., & Yang, X. (2016). Advances and perspectives on the use of CRISPR/Cas9 systems in plant genomics research. *Current Opinion in Plant Biology*, *30*, 70-77.
5. Liu, W., & Stewart, C. N. (2015). Plant synthetic biology. *Trends in Plant Science, 20*(5), 309- 317.
6. DeLisi, C. (2019). The role of synthetic biology in climate change mitigation. *Biol Direct* **14**, 14

<table>
<tr><td></td><td colspan="6">UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Green technology and sustainable development</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC5DSEBOT303</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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"></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.
1	**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
	1.3	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
	Cleaner development mechanism and technologies (10 hours)			

2	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**			

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>
</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.
4. Lancaster M., (2002) *An Introductory Text on Green Chemistry*, Royal Society of Chemistry, Cambridge.
5. Clark J.H. and Macquaries. (2002) *Handbook of Green Chemistry and Technology*, Blackwell Publishers.
6. Bharat, J., Khan B.H, (2006) *Cleaner Production and its implementation in Industries GCPC. Non conventional energy resources*, Tata McGraw-Hill, New Delhi.
7. Sanghi. R., and M.M. Srivastava. (2009) *Green Chemistry-Environment Friendly Alternatives*, Narosa Publishing House, New Delhi.
8. Paul L. Bishop, (2000) Pollution prevention –Fundamentals and Practices, McGraw-Hill-international
9. Vinutha bai, N., R. Ravindra, (2014) *Energy efficient and green technology concepts, International Journal of Research in Engineering and Technology* p 253-258, Volume: 03 Special Issue: 06 eISSN: 2319-1163 pISSN: 2321-7308.
10. Anastas, P.T. & Warner, J.C. (1998). *Green Chemistry: Theory & Practice*. Oxford University Press.
11. Arceivala, S.L. (2014). *Green Technologies: For a Better Future*. Mc-Graw Hill Publications.
12. Baker, S. (2006). *Sustainable Development*. Routledge Press.
13. Hrubovcak, J., Vasavada, U. & Aldy, J. E. (1999). *Green technologies for a more sustainable agriculture* (No. 33721). United States Department of Agriculture, Economic Research Service.
14. Thangavel, P. & Sridevi, G. (2015). *Environmental Sustainability: Role of Green Technologies*. Springer publications.
15. Woolley, T. & Kimmins, S. (2002). *Green Building Handbook* (Volume 1 and 2). Spon Press.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Analytical techniques in plant science</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC5DSEBOT304</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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">Basic knowledge in science</td></tr>
</table>

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.

<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>
</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>
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REFERENCES

1. Berlyn, G.P. &Miksche, J.P. (1976). Botanical Microtechnique and Cytochemistry. Wiley-Blackwell.
2. Campbell, I.D. and Dwek, R. A., "Biological Spectroscopy", Benjamin Curmmings PublicationCo. Inc., 1984.
3. Glasel, J. and Deutscher, M. B., "Introduction to Biophysical Methods for Protein and Nucleic acid Research", Academic Press, 1995.
4. Huang, B.Q. & Yeung, E.C. (2015). Chemical and Physical Fixation of Cells and Tissues: An Overview. In E.C.T. Yeung, C. Stasolla, M.J. Sumner & B.Q. Huang (Eds.) Plant Microtechniques and Protocols (pp. 23-44), Springer
5. Khandpur, R.S. (2006). Handbook of analytical instruments. Tata Mc Graw Hill.
6. Khasim, S.M. (2002). Botanical Microtechnique: Principles and Practice. Capital Publishing Company.
7. Nakara, B.C. & Choudhari, K.K. (2003). Instrumentation measurements and analysis. Tata Mc Graw Hill.
8. Pattabhi, N.V. & Gautham, N. (2002). Biophysics. Narosa Publishing House.
9. Prasad, M.K. & Prasad, M.K. (1972). Outlines of Botanical Microtechnique. Emkay Publishers.
10. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York, U.S.A.
11. Willard, H.H., Merritt L.L. Dean J.A. and Settle F.A., "Instrumental Methods of Analysis", 7thEd., Wadsworth Publishing Co., 1986.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</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</td></tr>
<tr><td>Course Code</td><td colspan="6">UC5DSEBOT305</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>
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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)	5	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

1. Agrawala, S., & Corfee-Morlot, J. (Eds.). (2008). The Economics of Climate Change Impacts: Measuring the Costs of Climate Change Adaptation. OECD Publishing.
2. Ministry of Environment, Forest and Climate Change, Government of India. (2018). India: Second Biennial Update Report to the United Nations Framework Convention on Climate Change.
3. Ahluwalia, M. S. (Ed.). (2011). Energy Security and Climate Change. Academic Foundation.
4. Swart, R. J., & Raes, F. (2007). Making Integration of Adaptation and Mitigation Work: A Guidance Note. United Nations Development Programme (UNDP). Link
5. Ministry of Home Affairs, Government of India. (2016). National Disaster Management Plan. Link
6. Dlugolecki, A., & Kreft, S. (Eds.). (2002). Adapting to Climate Change: An International Perspective. Springer.
7. Niyogi, D., Pyle, P., & Lei, M. (Eds.). (2019). Climate Change and Disaster Risk Management. CRC Press.
8. National Disaster Management Authority, Government of India. (2016). National Guidelines on Disaster Management of Drought.
9. Gupta, J., & van Asselt, H. (Eds.). (2006). Climate Change Adaptation and Development: Transforming Paradigms and Practices. Edward Elgar Publishing. [Book]
10. Indian Institute of Technology (IIT) Bombay. (2015). Climate Change Adaptation Policy & Practice. National Programme on Technology Enhanced Learning (NPTEL).

<table>
<tr><td>Est. in 1921</td><td colspan="6">UNION CHRISTIAN COLLEGE, ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Mushroom production and value addition</td></tr>
<tr><td>Type of Course</td><td colspan="6">SEC</td></tr>
<tr><td>Course Code</td><td colspan="6">UC5SECBOT300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</td></tr>
<tr><td>Semester</td><td>V</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	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.
	Introduction to Mushrooms and Nutritional Value (10 hours)			
1	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)			
	2.1	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	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
3. Bahl,N. (2002). *Hand book on Mushrooms*. Oxford & IBH Publishing C. Pvt.
4. Chang, S.F., Miles, P.G. and Chang, S.T. (2004). *Mushrooms Cultivation, nutritional value, medicinal effect and environmental impact.* 2nd ed., CRC press.
5. Chang, S.T., Miles, P.G.(1979). *Edible Mushrooms and their Cultivation*. Boca Raton; CRC Press.
6. Marimuth et al., (1991). *Oyster Mushrooms*. Dept. of Plant pathology, TNAU, Coimbatore.
7. Nair, M.C. (1990). *Mushroom Technical Bulletin* 17. Kerala Agricultural University, Mannuthy.
8. Nita Bahl. (1988). *Hand book of Mushrooms*, 2nd Edition, Vol I & II.
9. Pandey, R.K. and Ghosh, S.K.(1996). *A HandBook on Mushroom Cultivation*. Emkey Publications.
10. Rai, R.D. and Arumuganathan, T. (2008) *Post Harvest Technology of mushrooms*, Technical bulletin, NRCM, ICAR, Chambaghat, Solan 1731213, Himachal Pradesh
11. Stamets, P. and Chilton, J.S. (2004). *Mushroom cultivation- A practical guide to growing mushrooms at home*,Agarikon Press.
12. Tewari, S.C. and Kapoor, P. (1993). *Mushroom cultivation*. Mittal Publication. Delhi.
13. https://dmrsolan.icar.gov.in/
14. https://kau.in/institution/department-plant-pathology-0

SEMESTER VI

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Plant physiology and biochemistry**					
Type of Course	DSC A					
Course Code	UC6DSCBOT300					
Course Level	300					
Course Summary	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.					
Semester	VI	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Concept of a plant cell and cell components, Basic chemistry of compounds					

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
		Practical (30 Hours)		

4	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	**<u>Activity</u>** (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.	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

REFERENCES

1. Dayananda B, 1999. Experiments in Plant Physiology. Narosa Publishing House, New Delhi.
2. Hopkins W G, Norman P A Huner, 2008. Introduction to plant physiology. John Wiley and sons. New York.
3. Jain J L, Sanjay Jain, Nitin Jain, 2005. Fundamentals of Biochemistry. S Chand, New Delhi.
4. Lehninger A L, 1961. Biochemistry. Lalyan publishers, Ludhiana.
5. Nelson D L, Cox M M, 1993. Principles of Biochemistry. MacMillan Publications.
6. Pandey S N, Sinha B K, 2006. Plant Physiology. Vikas Publishing House Pvt. Ltd.
7. Plummer D T, 1988. An introduction to practical biochemistry. Tata McGraw-Hill Publishing Company, New Delhi.
8. Sadasivam S, Manickan A, 1996. Biochemical Methods. New Age International Ltd. New Delhi.
9. Salisbury F B, Ross C W, 1992. Plant Physiology. CBS Publishers and Distributers, Delhi.
10. Srivastava H S, 2005. Plant Physiology. Rastogi publications, Meerut.
11. Verma V, 2007. Textbook of Plant Physiology. Ane Books India, New Delhi.
12. Taiz L, Zeiger E, Moller I, Murphy A 2023. Plant Physiology and Development (VII Edn). Oxford University Press

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Genetics and evolutionary biology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">UC6DSCBOT301</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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>4</td><td>-</td><td>-</td><td>-</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">History of genetics and contributions of Gregor Johann Mendel. Concept of gene and chromosome.</td></tr>
</table>

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.
1	**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
	1.2	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 **<u>Learning activity:</u>** ● 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
	Evolution (10 hours)			

4	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

References

1. Monroe W Strickberger, Evolution. Jones and Bartlett publishers 19
2. Simpson, The Major Features of Evolution, Oxford and IBH Publishing, New Delhi.
3. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
5. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
6. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
7. Pierce, Benjamin A. (2017). *Genetics: A Conceptual Approach*. W.H Freeman.
8. Futuyma, Douglas J., (1998). *Evolutionary biology*. 3rd Sinauer Associates Inc, Publishers, Sunderland.
9. Pandey S.N.et al, 2006, A text book of Botany, Vikas Publishing House, New Delhi.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Bioinformatics in plant sciences</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC6DSEBOT300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">Bioinformatics in plant sciences provides a foundational understanding of bioinformatics, focusing on the fundamental principles, tools, and applications that form the backbone of this interdisciplinary field. Students will explore topics such as sequence analysis, molecular databases, and basic computational techniques essential for biological data analysis. Through a balanced mix of theoretical concepts and hands-on exercises, students will gain practical skills applicable to diverse areas within bioinformatics. Students can understand key concepts in genomics and proteomics, get familiarized with major biological databases and repositories, and learn how to extract relevant information for research. This course is ideal for students with a background in biology or related fields seeking to integrate computational approaches into their research or broaden their knowledge in this rapidly evolving field.</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">Basics of molecular biology and basic computer skills</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall fundamental bioinformatics concepts, databases and tools	K	PO 3
2	Utilize bioinformatics tools to analyse molecular sequences	An	PO1
3	Display and manipulate three-dimensional structures of biological macromolecules using molecular visualization tools	A	PO1, PO2
4	Explain how molecular data are used to infer evolutionary relationship	U	PO1
5	Interpret evolutionary relationships through phylogenetic trees	A	PO1, PO2
6	Design potential biomolecules as drug candidates	C	PO1,PO2, PO3
7	Integrate various bioinformatics techniques to solve biological research challenges	C	PO1,PO2, 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 Bioinformatics (10 hours)**			
	1.1	Bioinformatics – significance and scope A brief account of omics- genomics, proteomics, transcriptomics, metabolomics	2	1
	1.2	Biological databases – types – Primary, secondary, Composite Nucleotide database – GenBank, ENA, DDBJ, NDB Protein database – PDB, UniProt, PIR Bibliographic databases -PubMed Organismal – *Arabidopsis thaliana*- TAIR	5	1, 2
	1.3	Sequence retrieval and submission – Entrez, BankIt	3	2
2	**Molecular Phylogenetics (15 hours)**			
	2.1	Sequence alignment – types, pairwise, multiple sequence, local, global, Gaps, scoring, scoring matrix – Dot matrix method Tools – BLAST -types, CLUSTAL and Lalign	5	1,2, 4, 7
	2.2	Molecular clock Sequence homology-Homolog, ortholog, paralog	2	1, 3

	2.3	Phylogenetic tree -rooted -unrooted, monophyletic, paraphyletic and polyphyletic groups, phylogram, cladogram, dendrogram. Phylogenetic tree construction methods-brief account for Distance-based and Character-based methods. Advantages of phylogenetic trees	8	1,2, 4,5, 7
3	**Genomics, Proteomics and Drug Designing (20 hours)**			
	3.1	A brief account of Structural genomics, Functional genomics and Comparative genomics	1	1
	3.2	Sequencing techniques – Sanger's method, HGP Next-gen sequencing – brief study (Mention the platform – Roche454) Protein sequencing- Edman's degradation method	3	1, 7
	3.4	Gene prediction in prokaryotes and eukaryotes- *Ab initio*, homology-based, consensus-based methods, ORF. Protein structure prediction-secondary and tertiary- *ab initio* and homology methods. Molecular visualization- RasMol, PyMOL	7	1, 2, 3,6, 7
	3.5	Drug Designing Introduction to computational methods in Drug designing, Basics of molecular biology relevant to Drug design Computer-Aided Drug Designing (CADD)- Ligand-based, Structure-based Molecular Docking- Basics of AutoDock	9	1
4	**Practicals (30 hrs)**			
		1. Hands-on training for familiarizing various databases 2. Download nucleotide sequence from GenBank / ENA / DDBJ 3. Hands-on training for familiarizing various databases		
		3. Download 10 research papers from PubMed on a specific topic 4. Hands-on training on how to submit sequence. 5. Hands-on training - ORF finder 6. Hands-on training in primer designing – NCBI Primer- BLAST, Primer3 7. Perform BLAST for a specific sequence, select 6 sequences, and familiarize sequence alignment using Lalign and CLUSTALW (give DNA or protein sequence). Phylogenetic analysis by MEGA (Protein or DNA sequence data). Download specific sequences from PDB and visualize	2, 3, 7	

		using RasMol.		
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. Jin Xiong, 2006. *Essential Bioinformatics*, Cambridge University press
2. David W Mount, 2004. *Bioinformatics: sequence and genome analysis*. CBS Publishers.
3. Arthur M. Lesk, 2002, *Introduction to Bioinformatics*. Oxford University Press
4. Seethatrama D, Sathyanarayana Jois, 2011. *Drug Design and Discovery- methods and protocols*, Humana press
5. TA Brown, 2002. *Genomes*. Wiley-Liss.
6. Leelananda, S. P., & Lindert, S. 2016. Computational methods in drug discovery. *Beilstein journal of organic chemistry*, *12*(1), 2694-2718.
7. Orpita Bosu, Simminder Kaur Thukral, 2007. *Bioinformatics, databases: tools and algorithms*. Oxford university press
8. S Ignasimuthu, 2009. *Basic Bioinformatics*. Narosa Publications.
9. Zhumur Ghosh, Bibekanand Mallik, 2008. *Bioinformatics*: Principles and applications. Oxford University press
10. Supratim Choudhuri, 2014. *Bioinformatics for beginners*: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools, Academic press

UNION CHRISTIAN COLLEGE,ALUVA

Programme	BOTANY					
Course Name	**Plant chemical ecology**					
Type of Course	MAJOR - DSE					
Course Code	UC6DSEBOT301					
Course Level	300					
Course Summary	Plant chemical ecology is a branch of ecology that focuses on the study of chemical interactions between plants and other organisms in their environment. It explores the chemical compounds produced by plants, how these compounds mediate interactions with other living organisms, and the ecological consequences of these interactions. The primary aim is to understand how chemical signals influence plant interactions with herbivores, pollinators, pathogens, neighbouring plants, and other organisms.					
Semester	VI	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Basic knowledge in plant defence and plant secondary metabolites					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Distinguish the diverse array of plant secondary metabolite and its orchestration in defense	E	PO1, PO2, PO3, PO9
2	Explain the significance of herbivore-induced plant volatiles to attract predators or parasitoids of the herbivores	An	PO1, PO2, PO3, PO9

3	Estimate the phenomenon of allelopathy in the germination or growth of competing plant species, influencing the composition of plant communities	E	PO1, PO2, PO3, PO7, PO9
4	Illustrate the role of volatile organic compounds (VOCs) in plant communication	An	PO1, PO2, PO3, PO7, 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	**Chemical Defences (10 hours)**			
	1.1	Biosynthesis and storage of secondary metabolites in plants	3	1
	1.2	Plant chemicals against pathogens; Terpenoids, Phenolics, Nitrogen compounds – Alkaloids and Cyanogenic glycosides	3	1
	1.3	Proteins and Enzymes that specifically inhibit pathogen – Defensins, Digestive enzyme inhibitors, Protease inhibitors, Hydrolytic enzymes.	4	1
2	**Herbivore-Induced Plant Defencesand allelopathy (20 hours)**			
	2.1	Introduction on Herbivore-Associated Molecular Patterns (HAMPs)	2	2
	2.2	Biosynthesis of HIPVs (Herbivore-induced plant volatiles)	4	2
	2.3	Role of HIPVs in plant defense against herbivores	4	2
	2.4	Introduction to Allelopathy	1	3
	2.5	Ecological importance and consequences of Allelopathy.	4	3
	2.6	Direct allelopathy, Apparent competition, Apparent predation	3	3
	2.7	Biogeographical Variation in Allelopathy	2	3
3	**VOCs and Plant Communication (10 hours)**			
	3.1	Roles of volatile organic compounds (VOCs)	2	4
	3.2	Plant-plant signalling - above-ground signalling	2	4
	3.3	The Chemistry of Plant-Plant Signalling	2	4
	3.4	Plant-plant signalling - below-ground Signalling	2	4
	3.5	Self and nonself recognition in plants	2	4

4	**Practical** (Any two practical can be provided to the students)**(30 hours)**			
	4.1	Allelopathic Potential of some local plants on the seeds of weedy plants.	10	3
	4.2	Isolation of VOCs using hydrodistillation, Hot Extraction, Cold Pressing, Supercritical extraction	5	4
	4.3	Familiarize the isolation and synergistic/ antagonistic activities of VOCs using VOC chambers	5	4
	4.4	Identification of VOCs using GC-MS, HPLC and EI/MS (If facilities available)	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, 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. War, A. R., Paulraj, M. G., Ahmad, T., Buhroo, A. A., Hussain, B., Ignacimuthu, S., & Sharma, H. C. (2012). Mechanisms of plant defense against insect herbivores. *Plant signaling & behavior*, *7*(10), 1306-1320.
2. Wink, M. (2011). *Annual plant reviews, biochemistry of plant secondary metabolism*. John Wiley & Sons.
3. https://www.apsnet.org/edcenter/disimpactmngmnt/topc/Pages/OverviewOfPlantDiseases. aspx
4. Arimura, G. I., Kost, C., & Boland, W. (2005). Herbivore-induced, indirect plant defences. Biochimica et Biophysica Acta (BBA)-Molecular and Cell Biology of Lipids, 1734(2), 91- 111.
5. Singh, I. K., & Singh, A. (Eds.). (2021). Plant-Pest Interactions: From Molecular Mechanisms to: Chemical Ecology (pp. 31-55). New York NY: Springer.
6. Erb, M., & Reymond, P. (2019). Molecular interactions between plants and insect herbivores. Annual review of plant biology, 70, 527-557.
7. War, A. R., Sharma, H. C., Paulraj, M. G., War, M. Y., &Ignacimuthu, S. (2011). Herbivore induced plant volatiles: their role in plant defense for pest management. Plant signaling & behavior, 6(12), 1973-1978.
8. Kessler, D., Gase, K., & Baldwin, I. T. (2008). Field experiments with transformed plants reveal the sense of floral scents. Science, 321(5893), 1200-1202.
9. Cheema, Z. A., Farooq, M., & Wahid, A. (Eds.). (2012). Allelopathy: current trends and future applications. Springer Science & Business Media.
10. Hierro, J. L., & Callaway, R. M. (2021). The ecological importance of allelopathy. Annual Review of Ecology, Evolution, and Systematics, 52, 25-45.
11. Holopainen, J. K., & Blande, J. D. (2012). Molecular plant volatile communication. Adv Exp Med Biol, 739, 17-31.
12. Kessler, A., & Baldwin, I. T. (2001). Defensive function of herbivore-induced plant volatile emissions in nature. Science, 291(5511), 2141-2144.
13. Demey, M. L., Mishra, R. C., & Van Der Straeten, D. (2023). Sound perception in plants: from ecological significance to molecular understanding. Trends in Plant Science.
14. Álvarez-García, S., Mayo-Prieto, S., Carro-Huerga, G., Rodríguez-González, Á., González- López, Ó., Gutiérrez, S., &Casquero, P. A. (2021). Volatile organic compound chamber: A novel technology for microbiological volatile interaction assays. Journal of Fungi, 7(4), 248.
15. Álvarez-García, S., Manga-Robles, A., Encina, A., Gutiérrez, S., &Casquero, P. A. (2022). Novel culture chamber to evaluate in vitro plant-microbe volatile interactions: Effects of Trichoderma harzianum volatiles on wheat plantlets. Plant Science, 320, 111286.

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Research methodology and biometrics**					
Type of Course	DSE					
Course Code	UC6DSEBOT302					
Course Level	300					
Course Summary	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.					
Semester	VI	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	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.
	Major Steps in research (15 hours)			
1	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	5	3
		– observation method, interview method, questionnaire method, through schedules; analysis and interpretation of data, Report writing (Brief account).		
	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
	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	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
	Practicals (30 hrs)			

4	4.1	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	
	4.2	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)	3,5	
	4.3	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	6	
	4.4	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.	6	
	4.5	Prepare a worksheet using a set of data collected and find out the SUM.	6	
	4.6	Preparation of PowerPoint presentation using M.S PowerPoint / LibreOffice – Impress, based on a given topic.	6	
	4.7	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)	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: 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. Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.
2. Gastel, B., Day, R. A. (2022). How to Write and Publish a Scientific Paper. United States: Bloomsbury Academic.
3. https://www.inflibnet.ac.in/
4. https://pubmed.ncbi.nlm.nih.gov/
5. https://www.ncbi.nlm.nih.gov/
6. Creswell, J. W., Creswell, J. D. (2017). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. United States: SAGE Publications.
7. Holmes, D., Moody, P., Dine, D., & Trueman, L. (2017). Research methods for the biosciences. Oxford university press.
8. Jeffrey A Lee, 2009. The Scientific Endeavour: Methodology and perspectives of sciences. Pearson.
9. Goel, A. (2010). Computer Fundamentals. India: Pearson Education.
10. Courter, G., Marquis, A. (2006). Mastering Microsoft Office 2003 for Business Professionals. Germany: Wiley.
11. Holding, H., & Martin, C. (2001). Mastering Microsoft Office. Palgrave Master Series (Computing)
12. Documentation Team, L. (2018). LibreOffice 6.0 Writer Guide. Australia: Friends of OpenDocument, Incorporated.

13. Leete, G., Finkelstein, E., Leete, M. (2004). OpenOffice.org For Dummies. Germany: Wiley.
14. Foulkes, L. (2020). Learn Microsoft Office 2019: A Comprehensive Guide to Getting Started with Word, PowerPoint, Excel, Access, and Outlook. United Kingdom: Packt Publishing.
15. https://www.google.com/
16. https://www.metacrawler.com/
17. https://scholar.google.com/
18. https://www.nature.com/scitable/
19. https://www.dnai.org/
20. Khanna, R. (2008). Basics of computer science. New Age.
21. Rosner, B. (2015). Fundamentals of Biostatistics. Brooks/Cole, Cengage Learning
22. Rao, P. S., & Richard, J. (2012). Introduction to biostatistics and research methods. PHI Learning Pvt. Ltd..
23. Khanal, A. B. (2015). Mahajan's Methods in Biostatistics For Medical Students and Research Workers. India: Jaypee Brothers Medical Publishers Pvt. Limited.
24. Banerjee, P. K. (2007). Introduction to biostatistics (a textbook of biometry). S. Chand Publishing.
25. Arora, P. N., Malhan, P. K. (2010). Biostatistics. India: Himalaya Publishing House.

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Plant ecology, conservation and sustainable development**					
Type of Course	DSE					
Course Code	UC6DSEBOT303					
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.
	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	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
	Autecology & Synecology (15 hours)			
2	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.	3	2
	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.	3	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.	5	3

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.	5	4
	3.5	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 CO_2, 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

1. Law Relating to Human Rights, Asia Law House, 2001.
2. Shireesh Pal Singh, Human Rights Education in 21st Century. Discovery Publishing House Pvt. Ltd. New Delhi.
3. Khanna, S.K. (1998). Children and the human rights. Commonwealth publishers.
4. Sudhir Kapoor (2001). Human Rights in 21st Century. Mangal Deep Publications, Jaipur.
5. United Nations Development Programme, Human Development Report 2004. Cultural liberty in today‟s diverse world. Oxford University Press, New Delhi.
6. Santhra, S.C. (2004). Environmental Science. New Central Book Agency.
7. Sulekha, Chendel. Plant Ecology and Soil. S Chand & Co. Ltd. New Delhi.
8. Dash, M.C. (1993). Fundamentals of Ecology. Tata McGraw Hill.
9. Panday, S.N. & S.P. Misra (2011). Environment and Ecology. Ane Books Pvt.Ltd. New Delhi
10. Misra, K.C. Manual of plant ecology. Oxford and IBH Pub. Com. P. Ltd.
11. Sachs, J., Kroll, C., Lafortune, G., Fuller, G., & Woelm, F. (2022). Sustainable development report 2022. Cambridge University Press.
12. Verma, M. K. (2022). Environment and Sustainable Development. British

Library Cataloguing-inPublication Data.
13. Thangavel, P., & Sridevi, G. (2016). Environmental Sustainability. Springer, India, Private.
14. Xavier Savarimuthu, S. J., Rao, U., & Reynolds, M. F. (Eds.). (2021). Go Green for Environmental Sustainability: An Interdisciplinary Exploration of Theory and Applications. CRC Press.

SUGGESTED READINGS

1. Sharma, P.D. (1999). Ecology and Environment. Rastogy Pub.
2. Varma P S, Agarwal V K. Principles of Ecology. S Chand and Co.
3. Chaturvedi, P. (2003). Energy, environment and sustainable development. Concept Publishing Company.
4. Odum, E.P. (1971). Fundamentals of Ecology. WB Sunders.
5. Kumar, H. D. (2000). Modern Concepts of Ecology. Vikas Publishing House, New Delhi.
6. Kumar, U., & M. Asija (2006). Biodiversity: Principles and conservation. Agrobios India.
7. Misra, D. D. (2008). Fundamental concepts in Environmental Studies. S. Chand & Co. Ltd., New Delhi.
8. Nayar, M.P. (1997). Biodiversity challenges in Kerala and science of conservation biology. *In*: P. Pushpangadan, K.S.S. Nair (Eds), Biodiversity of tropical forests the Kerala scenario. STEC, Kerala.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Entrepreneurial botany</td></tr>
<tr><td>Type of Course</td><td colspan="6">SEC</td></tr>
<tr><td>Course Code</td><td colspan="6">UC6SECBOT300</td></tr>
<tr><td>Course Level</td><td colspan="6">300</td></tr>
<tr><td>Course Summary</td><td colspan="6">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</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"></td></tr>
</table>

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

<table>
<tr><th>Module</th><th>Units</th><th>Course description</th><th>Hrs</th><th>CO No.</th></tr>
<tr><td rowspan="3">1</td><td colspan="4">Fundamentals of Botanical Entrepreneurship (15 hours)</td></tr>
<tr><td>1.1</td><td>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</td><td>8</td><td>1, 4</td></tr>
<tr><td>1.2</td><td>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</td><td>7</td><td>2, 4</td></tr>
<tr><td>2</td><td colspan="4">Bio Ventures, Business Planning, and Government Initiatives (15 hours)</td></tr>
<tr><td rowspan="2"></td><td>2.1</td><td>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</td><td>8</td><td>1, 4</td></tr>
<tr><td>2.2</td><td>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</td><td>7</td><td>2, 4</td></tr>
<tr><td></td><td colspan="4">Integrating Government Initiatives and entrepreneurial ventures (15 Hrs)</td></tr>
</table>

3	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.	3	
	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.	3	
	3.3	. Entrepreneurial Impact Assessment : Evaluating the impact of government schemes on entrepreneurial	3	
		ventures Discussing challenges faced and proposing solutions for improvement. Make an audio-visual document of an interview with an entrepreneur.		
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

References

1. Lokare, P., & Patra, K. K. (2022). *Botanical entrepreneurship*. Book Saga Publications.
2. Wickens, G. E. (2012). *Economic botany: principles and practices*. Springer Science & Business Media.
3. Youssef, A. B., Boubaker, S., & Omri, A. (2018). Entrepreneurship and sustainability: The need for innovative and institutional solutions. *Technological Forecasting and Social Change*, *129*, 232-241.
4. Milutinovic, Olivera & Anđelić, Slavica &Vukosavljević, Danijela &Pušara, Aleksandra. (2023). ROLE OF INNOVATION IN ENTREPRENEURSHIP DEVELOPMENT. International Journal of Management Trends: Key Concepts and Research. 2. 64-70. 10.58898/ijmt.v2i1.64-70.
5. Carayannis, E. G., Samara, E. T., &Bakouros, Y. L. (2015). Innovation and entrepreneurship. *Innovation, Technology, and Knowledge Management.[Online]. Cham, Springer International Publishing. Available from: doi*, *10*, 978-3.
6. Altan, M. Z. (2019). Education for Creating an Entrepreneurship and Innovation Ecosystem. *Educația Plus*, *24*(SI ISAT), 195-200.
7. Vinitha, K. An Analysis of Performance of Agro-Based Industries in Kerala with Special Reference to Coconut. *KEIZAI: FOR WHOM THE BELL TOLLS?*, 91.
8. Rajeevan, P. K., Geetha, C. K., & Rajendran, P. (2016, January). Orchid-centric floriculture development in Kerala, India. In *International Symposium on Succulents and Other Ornamentals 1165* (pp. 15-26).
9. Kumar[1], R. S., & Manimegalai, G. (2004). Fruit and vegetable processing industries and environment. *Industrial Pollution & Management*, 97.
10. Sharma, V. P., Annepu, S. K., Gautam, Y., Singh, M., & Kamal, S. (2017). Status of mushroom production in India. *Mushroom Res*, *26*(2), 111-120.
11. Radhakrishnan, A., Balan, S., Indulekha, V. P., Simi, S., & Krishnan, S. (2021). Potential, economics and constraints of mushroom cultivation in Wayanad, Kerala. *Journal of Krishi Vigyan*, *9*(2), 171-176.
12. DEEJA, D. (2021). A STUDY ON THE PROBLEMS OF WORKING CAPITAL OF FPIs IN KERALA. *Elementary Education Online*, *20*(5), 5612-5612.
13. Harisha, B. N. (2017, October). An economic analysis of floriculture in India. In *Proceedings of the Sixth Middle East Conference on Global Business, Economics, Finance and Banking (ME17Dubai Conference* (pp. 6-8).

14. Chawla, S. L., Patil, S., Ahlawat, T. R., & Agnihotri, R. (2016). Present status, constraints and future potential of floriculture in India. *Commercial Horticulture*, 29-38.
15. Emerging Lessons on Women's Entrepreneurship in Asia and the Pacific, ADB and The Asia Foundation, 2018
16. Wasnik, Anurag & Jain, Abhinav. (2023). Government Support for Startups: A Comprehensive Analysis of Funding Initiatives and the Role of the Indian Government in Nurturing the Startup Ecosystem. 10.31014/aior.1992.06.03.523.
17. Nakku, V. B., Agbola, F. W., Miles, M. P., & Mahmood, A. (2020). The interrelationship between SME government support programs, entrepreneurial orientation, and performance: A developing economy perspective. *Journal of Small Business Management*, *58*(1), 2-31.
18. Akther, F. (2023). Role of Skill India Programs in Fostering Entrepreneurship among Rural Youth in India. *Formosa Journal of Science and Technology*, *2*(10), 2891-2902.

SUGGESTED READINGS

1. Kerala startup mission handbook 2021

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</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">UC6VACBOT300</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) c) Sustainable practices for resource utilization	4	3
	1.3	Overview of Environmental Pollution:	1	4
		Definition and types of pollution. Overview of air, water, soil, noise, and light pollution.		
		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
		Climate Change and Environmental Legislation and Laws (15 hours)		

2	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]. d) Corporate Environmental Responsibility [brief account only]	5	5
	Human Rights (15 hours)			
3	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.
	    ● 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

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. H D Kumar, 2000. *Modern Concepts of Ecology*. Vikas Publishing House, New Delhi.
2. Kumar U, M Asija, 2006. *Biodiversity: Principles and conservation*. Agrobios India.
3. Misra D D, 2008. *Fundamental concepts in Environmental Studies*. S. Chand & Co. Ltd., New Delhi.
4. Nayar M P, 1997. *Biodiversity challenges in Kerala and science of conservation biology*. In: P. Pushpangadan, K S S Nair (Eds), Biodiversity of tropical foreststhe Kerala scenario. STEC, Kerala.
5. Odum E P, 1971. *Fundamentals of Ecology*. WB Sunders.
6. Law Relating to Human Rights, Asia Law House, 2001.
7. Shireesh Pal Singh. 2011.*Human Rights Education in 21st Century*. Discovery Publishing House Pvt. Ltd. New Delhi.
8. S K Khanna, 1998, 2011. *Children and the human rights*. Commonwealth publishers.
9. Sudhir Kapoor, 2001. *Human Rights in the 21st Century*. Mangal Deep Publications, Jaipur.
10. United Nations Development Programme, Human Development Report 2004. *Cultural liberty in today's diverse world*. Oxford University Press, New Delhi.
11. Santhra S C, 2004. *Environmental Science*. New Central Book Agency.
12. Panday S N, S P Misra, 2011. *Environment and Ecology*. Ane Books Pvt.Ltd. New Delhi
13. Sharma P D,1999. *Ecology and Environment*. Rastogy Pub.
14. Varma P S, Agarwal V K.1983*Principles of Ecology*. S Chand and Co.

SEMESTER VII

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Research methodology and biostatistics**					
Type of Course	DCC					
Course Code	UC7DCCBOT400					
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
	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 copy; discussion, summary and conclusion; references, abstract(s) and appendix.	5	3

2	2.2	Reference styles – APA, MLA, Harvard, Chicago. Bibliography Management system: Mendeley, Zotero (Brief Account)**,** Endnote. **<u>Learning Activity:</u>** 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	6	3
		review articles. (iii) Proofreading-standard abbreviations for proof correction. (iv) Presentation of Research findings in Seminars and Workshops. **<u>Learning Activity</u>:** Submit a review paper to the instructor based on a topic of choice.		
	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. **<u>Learning activity:</u>** 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
	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	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. **<u>Learning activity:</u>** 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.
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. Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.
2. Ramadass, P. & Aruni, A.W. (2019) Research and Writing Across the Disciplines : MJP Publisher.
3. Singh, I., Kaushal.V., Kaur. R. & Kaur. P. (2007) Research methodology and statistical methods: Kalyani Publishers.
4. Kumar, R. (2010). Research Methodology: A Step-by-Step Guide for Beginners. United Kingdom: SAGE Publications.
5. Krishnakumar K. (1981). An introduction to cataloguing practice. Vikas Publishing house.
6. Parshar R. G. (1989). Index and indexing systems. Me dallion press New Delhi.
7. https://scholar.google.com/
8. https://www.ncbi.nlm.nih.gov/
9. https://pubmed.ncbi.nlm.nih.gov/
10. https://www.nlm.nih.gov/medline/medline_overview.html
11. https://www.inflibnet.ac.in/
12. https://nlist.inflibnet.ac.in/
13. https://shodhganga.inflibnet.ac.in/
14. Szilvássy, J. (Ed.). (1996). Basic serials management handbook (Vol. 77). International Federation of Library Science
15. Gastel, B., Day, R. A. (2022). How to Write and Publish a Scientific Paper. United States: Bloomsbury Academic.
16. Holmes, D., Moody, P., Dine, D., & Trueman, L. (2017). Research methods for the biosciences: Oxford university press.
17. Neville, C. (2010). EBOOK: The Complete Guide to Referencing and Avoiding Plagiarism. United Kingdom: McGraw-Hill Education.
18. Perrin, R. (2009). Pocket Guide to APA Style. United States: Cengage Learning.
19. The Chicago Manual of Style. (2003). United Kingdom: University of Chicago Press.
20. Kurniawan, D. (2023). Mastering Mendeley: Simplifying Paper Management, Citation, And Bibliography : Jejak Pustaka.
21. https://www.mendeley.com/
22. Catherine Pope (2021) Getting Started with Zotero: The easy way to manage your references, citations, and bibliographies. Catherine Pope Limited
23. https://www.zotero.org/
24. Hartley, J. (2008). Academic Writing and Publishing: A Practical Handbook. (n.p.): Taylor & Francis.
25. Clifford Hawkins, C., & Sorgi, M.(2013) Research: How to Plan, Speak and Write About It : Springer London.
26. Thomas, C. G. (2021). Research Methodology and Scientific Writing. Germany: Springer International Publishing.

27. Gupta, S.K. & Rangi, P. (2012) Research methodology - methods, tools and techniques: Kalyani Publishers.
28. Panneerselvam, R. (2014). Research Methodology. India: PHI Learning.
29. Gupta, C.B. & Gupta, V. (1995) An introduction to statistical methods (9th edition), Vikas Publishing House Pvt. LTD.
30. Rosner, B. (2015). Fundamentals of Biostatistics. Brooks/Cole, Cengage Learning
31. Rao, P. S.S.S., & Richard, J. (2012). Introduction to biostatistics and research methods. PHI Learning Pvt. Ltd.
32. Khanal, A. B. (2015). Mahajan's Methods in Biostatistics For Medical Students and Research Workers. India: Jaypee Brothers Medical Publishers Pvt. Limited.
33. Banerjee, P. K. (2007). Introduction to biostatistics (a textbook of biometry). S. Chand Publishing.
34. Arora, P. N., Malhan, P. K. (2010). Biostatistics. India: Himalaya Publishing House.
35. Le, C. T., Eberly, L. E. (2016). Introductory Biostatistics. Germany: Wiley.
36. van Belle, G., Fisher, L. D., Heagerty, P. J., Lumley, T. (2004). Biostatistics: A Methodology For the Health Sciences. Germany: Wiley.
37. Banerjee, P. K. (2007). Introduction to biostatistics (a textbook of biometry). S. Chand Publishing.
38. Verma, J. (2012). Data Analysis in Management with SPSS Software. India: Springer India.
39. Cronk, B. C. (2017). How to Use SPSS®: A Step-By-Step Guide to Analysis and Interpretation. United Kingdom: Taylor & Francis.
40. McCormick, K., Salcedo, J., Peck, J., Wheeler, A. (2017). SPSS Statistics for Data Analysis and Visualization. Germany: Wiley.
41. Thulin, M. (2021). Modern Statistics with R: From Wrangling and Exploring Data to Inference and Predictive Modelling. Sweden: Eos Chasma Press.
42. Baldock, S., Stowell, S. (2014). Using R for Statistics. Netherlands: Apress.
43. Navarro, D. J. (2013). Learning Statistics with R. United States: Lulu Press, Incorporated.
44. Hammer , Harper, D. A. T. (2008). Paleontological Data Analysis. Germany: Wiley.
45. Agrawal, A. (2009). EndNote 1 - 2 - 3 Easy! Reference Management for the Professional. Germany: Springer US.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Advances and applications in plant science – Thallophytes</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCC</td></tr>
<tr><td>Course Code</td><td colspan="6">UC7DCCBOT401</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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>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	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
	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	2.2	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,	4	5,6

		Fusarin		
	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>
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<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. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
2. Bold, H.C., Wynne M.J. (1978). Introduction to Algae: Structure and reproduction. Prentice Hall
3. Deacon, J. W. (2005). Fungal biology. John Wiley & Sons.
4. Fritsch, F.E. (1935). The Structure and Reproduction of the Algae. Volume I. Cambridge University Press, Cambridge
5. Iyengar, M. O. P. and Desikachary, T. V. 1981. Volvocales. I.C.A.R., New Delhi. pp-532.
6. Jacob-Lopes, E., Maroneze, M. M., Queiroz, M. I., & Zepka, L. Q. (Eds.). (2020). Handbook of microalgae-based processes and products: fundamentals and advances in energy, food, feed, fertilizer, and bioactive compounds. Academic Press.
7. Kim, S.K. (2011). Marine medicinal foods: Implications and Applications of micro and macroalgae. Academic Press, New York.
8. Lee, R. (2008). Phycology (4th ed.). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511812897
9. Linda, E.G & Lee, W.W., (2000). Algae, Prentice Hall, New Jersy.
10. Moheimani, N.R., McHenry N.P., de Boer, K., Bahri, P.A. (2015). Biomass and Biofuels
11. Pringsheim E G. Pure culture of Algae. Cambridge University Press
12. Sahho, D &Seckback, J. (2015). The algae world. Springer Dordrecht Heidelberg, New York.
13. Sethi, L.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
14. Sharma, O.P (2011). Algae. Tata McGraw- Hill, New Delhi, p.419.
15. Sharma, P.D. (2011). Plant Pathology. Rastogi Publication, Meerut, India.
16. Smith, G.M. (1938). Cryptogamic Botany (Vol. 1): Algae and Fungi. Tata McGraw Hill Edition.
17. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.

SUGGESTED READINGS

1. https://www.routledge.com/Algal-Biotechnology-Current-Trends-Challenges-and-Future- Prospects-for/Sahu-Sridhar/p/book/9781032112688
2. https://www.nature.com/articles/nature.2012.11811
   https://www.cell.com/current-biology/pdf/S0960-9822(19)31164-9.pdf

UNION CHRISTIAN COLLEGE ALUVA

<table>
<tr><td colspan="2">Est. in 1921</td><td colspan="5">UNION CHRISTIAN COLLEGE ALUVA</td></tr>
<tr><td>Programme</td><td colspan="6">BOTANY</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</td></tr>
<tr><td>Course Code</td><td colspan="6">UC7DCCBOT402</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

References

1. Alam, A. (2019). *Textbook of Bryophyta*,Dreamtech Press.
2. Arnold, H.N. (1967). *Introduction to Paleobotany*, Tata Mc Graw- Hill, New Delhi.
3. Beck, C.B. (1988). *Origin and Evolution of Gymnosperms,* Columbia University Press, New York.
4. Biswas and John, B.M. (2004). *Gymnosperms*, Naresa Publishing house.
5. Bower, F.O. (1935). *Primitive Land Plants*, Cambridge, London.
6. Chopra, R.N. and Kumar, P. K. (1988). *Biology of Bryophytes*, Wiley Eastern Ltd, New Delhi.
7. Coutler, J.M. and Chamberlain, C. J. (1958). *Morphology of Gymnosperm*s, Central Book Depot, Allahabad.
8. Dutta, S.C. (1991). *An Introduction to Gymnosperms*, Kalyan Publishing Co. New Delhi.
9. Kashyap, S. R. (1932). *Liverworts of Western Himalayas and the Punjab plains (Vol. I & II)*. Research.
10. Maarten, J. M. Christenhusz, Mark, W. Chase. (2014). *Trends and concepts in fern classification,Annals of Botany*, Volume 113, Issue 4, Pages 571–594, https://doi.org/10.1093/aob/mct299
11. Mamatha, Rao. (2009), *Microbes and Non flowering plants- impact and application* Ane Books Pvt Ltd.
12. PPG- I, (2016). A *community-derived classification for extant lycophytes and ferns. Journal of Systematics and Evolution*, vol. 54, no. 6, pp. 563-603. http://dx.doi.org/10.1111/jse.12229
13. Rasheed, A. (1999). *An Introduction to Pteridophyta*, Vikas Publishing House, New Delhi.
14. Rasheed, A. (2000). *An Introduction to Bryophyta*, Vikas Publishing House, New Delhi.
15. Sharma O.P. (2016). *Series on Diversity of Microbes and Cryptogams - Pteridophyta*, Tata McGraw Hill Education Private Limited, New Delhi.
16. Sharma, O.P. (2014). *Bryophyta*, McGraw Hill education (India) Pvt Ltd
17. Singh, Pande, Jain. (2007), *Diversity of Microbes and Cryptogam*, Rastogi Publications.
18. Taylor, T.N. Taylor, E.L. Krings, M. (2009). *Paleobotany—The Biology and Evolution of Fossil Plants*. Burlington: Academic Press.
19. Timell, T.L. (1986).*Compression Wood in Gymnosperms*:Springer-Verlag Berlin Heidelberg New York Tokyo.
20. Vanderpoorten, A. and Goffinet, B. (2009) *Introduction to Bryophytes*. Cambridge University Press.
21. Vashishta, B. R. Sinha, A.K. Kumar, A. (2003). *Bryophyta*. S Chand & Co. Ltd.
22. Vashista, B. R, (1993). *Bryophyta*, S Chand & Co., New Delhi.
23. Vashista, B. R, (1993). *Gymnosperms*, S Chand & Co., New Delhi.
24. Vashista, B. R, (1993). *Pteridophyta*, S Chand & Co., New Delhi.

Websites

http://www.artdata.slu.se/guest/SSCBryo/SSCBryo.html
http://www.northernontarioflora.ca/links.cfm?val=bryophytes

http://bryophytes.plant.siu.edu/
http://worldofmosses.com/
http://www.unomaha.edu/~abls/
http://www.anbg.gov.au/bryophyte/index.ht
ml http://www.bryoecol.mtu.edu/
http://www.mobot.org/MOBOT/tropicos/most/Glossary/glosefr.ht
ml http://www.fairhavenbryology.com/Master_Page.html
http://www.mygarden.ws/fernlinks.htm
http://www.anbg.gov.au/fern/index.html
http://www.bioimages.org.uk/HTML/T77.HTM
http://botany.csdl.tamu.edu/FLORA/gallery/gallery_query.htm
http://homepages.caverock.net.nz/~bj/fern/
http://www.home.aone.net.au/~byzantium/ferns/
http://www.northernontarioflora.ca/links.cfm?val=pteridophytes
http://www.fiu.edu/~chusb001/giant_equisetum.html
http://www.mygarden.ws/fernlinks.htm
http://www.nrm.se/en/menu/researchandcollections/departments/cryptogamicbotany/coll
ec tions/pteridophytes.652_en.html
http://www.amerfernsoc.org/
http://www.gymnosperms.og/
http://www.plantapalm.com/vce/toc.htm

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY
Course Name	**Agronomy horticulture and agroforestry**
Type of Course	DCE A
Course Code	UC7DCEBOT400
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)

C O 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).	5	1,3
		Learning activity: Demonstration of budding/grafting techniques		
	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
	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.	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.
8. Lenka, D. 2001. *Irrigation and Drainage*. Kalyani Publishers, New-Delhi.
9. Panda, S.C. 2006. *Cropping and Farming Systems*. Agrobios Publishers, Jodhpur
10. Surendra Prasad and U. Kumar. 1999. *Principles of Horticulture*. Agro Botanica Publishers, Bikaner, India.
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.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Plant genomics</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC7DCEBOT401</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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">Basics of molecular biology and genetics</td></tr>
</table>

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*
5. Cullis, C. A. (2004). *Plant genomics and proteomics.* John Wiley & Sons.
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.
8. Snustad, D P, Simmons M J. (2010). *Principles of genetics* (V Ed). John Wiley and Sons.
9. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
10. Pierce B A (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
11. C W Sensen (2002). *Genomics and Bioinformatics*. Wiley – VCH.
12. Thieman, W J, Palladino M A. (2009). *Introduction to biotechnology* (II Edn). Pearson
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.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Seed technology</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE A</td></tr>
<tr><td>Course Code</td><td colspan="6">UC7DCEBOT402</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">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
		Seed quality and vigour (17 Hours)		

2	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. **<u>Activity:</u>** ● Seed viability testing method (Tetrazolium), ● Seed germination test (Between paper/Top of paper method) ● Visit to seed production Unit	7	2
	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.
	MODE OF ASSESSMENT

Assessment Types	**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.
3. Kulkarni GN. 2011. Principles of Seed Technology. Kalyani Publishers, New Delhi
4. Baskin C and Baskin JM. 2014. Seeds: Ecology, Biogeography, and Evolution ofDormancy and Germination. Academic Press, Cambridge, UK.
5. Bewley J and Black M. 1994. Physiology of Development and Germination. Springer, New York.
6. Bewley JD, Bradford KJ, Hilhorst HWM and Nanogaki H. 2013. Seeds: Physiology of Development, Germination and Dormancy. Springer, New York.
7. Adkins SW, Ashmore SE and Navi SC. 2007. Seeds: Biology, Development and Ecology. CABInternational, Oxford shire, UK.
8. Anon. 2016. Manual of Seed Certification Procedures. Directorate of Seed Certification, Coimbatore, Tamil Nadu.
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

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY
Course Name	**Ecology and ecotourism**
Type of Course	DSE B
Course Code	UC7DSEBOT400
Course Level	300
Course Summary	The course 'Ecology and Ecotourism' deals with the study of how organisms interact with their environment and ecotourism deals with sustainable management of natural ecosystems.

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

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the properties of different levels of organization ecosystem	U	1,4
2	Outline the structure and functions of an ecosystem	An	1,2,4
3	Illustrate conservation strategies	A	2,4
4	Critically assess the environmental and economical impacts of ecotourism	E	2,6,9

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	**Plant Ecology (15 hours)**			
	1.1	Introduction to ecology, levels of organizations (species, population, community, ecosystem, biome).	4	1
	1.2	Population ecology, Characteristics of population - Population size, density, natality, mortality, age structure, growth form. Population growth models – S and J	5	1
	1.3	Community ecology - Population interactions – Positive and negative; Mutualism, Commensalism, Competition, Predation. **Learning activity:** *Visit an ecosystem and submit any type of interaction with report.*	6	1
2	**Ecosystem (15 hours)**			
	2.1	Ecosystem structure - biotic and abiotic. Trophic levels - producers, consumers decomposers.	4	2
	2.2	Function of ecosystems - Food chain and food web and flow of energy-homoeostasis and cybernetics. Productivity of ecosystem; Primary, Secondary, gross and net productivity.	6	2
	2.3	Ecological pyramids; Pyramid of number, Pyramid of biomass, pyramid of energy.	5	2
		Biogeochemical cycles - Gaseous cycle (Nitrogen) and Sedimentary (Phosphate).		
3	**Conservation Ecology (15 hours)**			
	3.1	Definition, strategies and practices, Role of protected areas in conservation, Local, national, international efforts to conserve biodiversity. IUCN categories.	6	3
	3.2	Threats to biodiversity - Habitat loss, over exploitation, poaching, invasive species, climate change.	4	3
	3.3	Awards and appreciations in conservation biology - Nobel Peace award, Goldman Environmental Prize, International Conservation Award, *Indira Gandhi ParyavaranPuraskar*, Kerala state biodiversity board award, Haritha Mitra award.	5	3
4	**Ecotourism (15 hours)**			
	4.1	Understanding ecotourism: Definition, scope and prospects, principles and types of Ecotourism.	4	4
	4.2	Sustainable tourism practices - Community-based tourism and its benefits. Challenges and solutions in ecotourism. Ecotourism and ethics. Ecotourism centres in Kerala-Thenmala/ Thattekkad-A case study.	6	4
	4.3	**Learning activity:** *Visit an ecotourism centre, identify the components, and prepare a report and submit it for valuation.*	5	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

Reference

1. Anubha Kaushik & Kaushik C.P. (2010). Basics of Environment and Ecology, New Age International Publications.
2. Stuart Chapin F, Pamela Matson A & Peter Vitousek M, (2011). Principles of Terrestrial Ecosystem Ecology, Springer.
3. Roy Ballantyne & Jan Packer (2013). International Handbook on Ecotourism, Edward Elgar Publishing Limited
4. Fennel David A (2004). ecotourism an introduction, outledge,11 New Fetter Lane, London.

SUGGESTED READINGS

1. May Robert M & McLean Angela R (2007). Theoretical Ecology Principles and Applications, Oxford University Press.
2. Stephen Wearing & John Neil (2009). Ecotourism: Impacts, Potentials and Possibilities, Reed Educational and Professional Publishing Ltd

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Biological approaches and evolutionary trends in plants**					
Type of Course	DSE B					
Course Code	UC7DSEBOT401					
Course Level	300					
Course Summary	Upon completion of the course, a student should: have a better understanding of how evolutionary science generates knowledge by way of hypothesis testing, systematic observations, and the comparative method have phylogenetic thinking; how new species arise; the major species concepts be able to better distinguish scientific from unscientific arguments apply evolutionary principles in her or his own 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	Evaluate and Summarize the fundamental evolutionary processes in the natural world and their influence on the origin of life and its diversity	E	PO 1, PO 2, PO 10
2	Develop phylogenetic thinking; how new species arise and the major species concepts	A	PO 2, PO 3, PO8
3	Formulate sound evolutionary hypotheses for a variety of biological phenomena	A	PO1, PO 10
4	Examine the benefits of evolution	An	PO 10

5	Apply evolutionary biology as a powerful set of tools for approaching current changes in biodiversity and addressing future challenges	S	PO 1, PO 2, PO 7, PO 8
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 Evolution (10 Hours)**			
	1.1	Origin of life- Oparin and Haldane's theory, Urey Miller's Experiment. [1]	5	CO 1
	1.2	Overview of evolution, Role of evolution in plant diversity [1]	2	
	1.3	Origin of Photosynthesis, evolution of oxygen, ozone buildup, endosymbiotic theory of eukaryotic origin	3	
2	**Evidence and Mechanism of Evolution (18 Hours)**			
	2.1	Biological evolution and evidence for biological evolution from living organisms (comparative anatomy, embryology and molecular phylogeny) and fossil record (paleontological) **Activity:** Collect the evidence of evolution as pictures using e-resources and submit a report (Anyone mentioned in the syllabus)	5	CO 2
	2.2	Types of fossils and fossilization, dating techniques	3	
	2.3	Variation (Mutation and Recombination) and Natural Selection with examples; Gene flow and genetic drift; Hardy- Weinberg's principle; Speciation, Adaptive Radiation **Activity:** 1. Compute allele frequencies using Hardy-Weinberg's principle Identify the role of mutation/ variation in crop improvement (Submit Report)	10	CO 4
	Darwin's Theory and Neo-Darwinism			

3	3.1	Darwin's contribution to evolution, Types of natural selection (Directional, Stabilizing, Disruptive), Natural Selection as a guiding force of evolution: coloration, camouflage, and mimicry **Activities** Prepare a report on Darwin's contribution to evolution and submit it as e-copy.	5	CO 3
	3.2	Modern Synthetic Theory of Evolution, Modern advances in evolutionary biology, Micro and macroevolution (Brief study)	3	
	3.3	Extinction: Mass extinction (Causes, Names of five major extinctions), Role of extinction in evolution	7	
4	**Plants People Interaction: An Evolutionary Approach**			
	4.1	Detailed examination of evolution in plants, timeline of plant evolution, adaptations to environmental factors, co-evolution with other organisms **Activity:** Using a geological timescale identify the important eras of plant evolution	7	CO 5
	4.2	Human impact on plant evolution: Domestication and Agriculture	7	
	4.3	Manmade causes of evolution: Brief mention of pesticide, and herbicide resistance in plants **Activities:** Critically evaluate the paper- 'Plants and people: Our shared history and future' (Group Discussion) https://nph.onlinelibrary.wiley.com/doi/full/10.1002/ppp3.12	3	
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Videos, PowerPoint Presentations, Group Discussion
	MODE OF ASSESSMENT **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 30 Marks**

Assessment Types	● 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. Arora, P.M. (2015). Evolutionary Biology. Himalaya Publishing House.
2. Hall, B.K. &, Hallgrímsson, B. (2013) Strickberger's Evolution. Ababil Books.
3. Herrera, C. M., &Pellmyr, O. (Eds.). (2009). Plant-animal interactions: an evolutionary approach. John Wiley & Sons.
4. Mathur, R., Singh, S. P. & Tomar, B.S. (2014). Evolution and Behavior. Rastogi Publication.
5. Niklas, K. J. (2020). Plant evolution: an introduction to the history of life. University of Chicago Press.
6. Rasthogi, V.B. (2023). Organic Evolution (Evolutionary Biology). MedTech Scientific Press.
7. Raup, D. M. (1994). The role of extinction in evolution. Proceedings of the National Academy of Sciences, 91(15), 6758-6763.
8. Ridley, M. (2004). Evolution. Blackwell Publishing.
9. Principles of Biology – An Introduction to Biological Concepts textbooks Creative Commons Attribution License 4.0
10. Turcotte, M. M., Araki, H., Karp, D. S., Poveda, K., & Whitehead, S. R. (2017). The eco- evolutionary impacts of domestication and agricultural practices on wild species. Philosophical Transactions of the Royal Society B: Biological Sciences, 372(1712), 20160033.

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY
Course Name	**Biotechniques**
Type of Course	DSE B
Course Code	UC7DSEBOT402
Course Level	300
Course Summary	The syllabus is designed with the objective to ● train the students in both theoretical and practical aspects ● to handle various equipment related to life science research and to enhance their practical skills. ● train the analytical techniques, which has unlimited career opportunities including academic research, working in industry from small tech start-ups to large biotech companies.

Semester	VII	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

<table>
<tr><td>5.</td><td>Acquire expertise in various preparative methods and analytical techniques in plant science</td><td>A,S</td><td>PO1,PO9, PO10</td></tr>
<tr><td colspan="4">*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</td></tr>
</table>

COURSE CONTENT

<table>
<tr><th>Module</th><th>Units</th><th>Course description</th><th>Hrs</th><th>CO No.</th></tr>
<tr><td rowspan="6">1</td><td colspan="4">Preparative Techniques in Microscopy (25 Hours)</td></tr>
<tr><td>1.1</td><td>Collection, preservation (Dry & Wet) and preparation of plant materials: Squash, Smear, Whole mount, Maceration, and Sectioning.
Learning Activity
1. Maceration of a given specimen (Cucurbita stem) and identify different thickening in Xylem vessels
or
2. Prepare squash/smears and observe under microscope (Demonstration)
or
3. Submit Herbarium and Bottled preserved specimen of plant/plant parts (One each)</td><td>6</td><td>CO1</td></tr>
<tr><td>1.2</td><td>Killing and fixing: Properties of good fixative: types of fixative and fixation; killing and fixing agents and their composition (Carnoy's fluid and FAA)</td><td>4</td><td>CO1</td></tr>
<tr><td>1.3</td><td>Sectioning- free hand and microtomy, Principle and use of Rotary Microtome (General Account)
Learning Activity
1. Hands on training on free hand sectioning of a given plant specimen (stem/root)
2. Familiarize with microtomes used in modern research (use internet data)</td><td>6</td><td>CO1
CO2</td></tr>
<tr><td>1.4</td><td>Stains and staining techniques – Different stains and their composition- Safranin, Acetocarmine; Types of staining – Single staining, Double staining (Brief Account)
Learning Activity
1. Identify different cells of a given plant specimen after single and double staining (stem/root)</td><td>4</td><td>CO1</td></tr>
<tr><td>1.5</td><td>Mounting media: Glycerine, DPX and Canada balsam
Preparation of slides: Temporary and Permanent
Learning Activity
1. Prepare a temporary slide showing anatomical details of plant part (root/shoot)</td><td>5</td><td>CO1</td></tr>
<tr><td></td><td colspan="4">Instrumentation for analysis (20 Hours)</td></tr>
</table>

2	2.1	Principle and application of Compound Microscope Phase contrast Microscopy, Scanning Electron Microscopy- (Brief account).	5	CO1 CO2 CO3
	2.2	Photometric Analysis – Principle, working and application of Colorimeter **Learning Activity** 1. Prepare a standard graph and estimate the concentration of a solution using colorimeter	5	CO2 CO3 CO4
	2.3	Principle, working, and application of pH meter **Learning Activity**: 1. Adjust the pH of a given solution using pH meter/pH pen	5	CO2 CO3
	2.4	Enumeration and Measurement Techniques: Haemocytometer **Learning Activity** 1. count the number of pollen grains with the help of haemocytometer	5	CO4
3	**Methods for sample preparation (5 Hours)**			
	3.1	Centrifugation - Principle and application of Ultra centrifuges **Learning Activity** Familiarize with the function of centrifuge	5	CO2 CO4
	3.2	Principle and application of lyophilizer and freeze-drying	5	CO2
4	**Techniques for Analysis and Separation (10 Hours)**			
	4.1	Chromatography Techniques: - Principles and applications of Paper chromatography, TLC, Column chromatography, and HPLC **Learning Activities** 1.Hands-on training on TLC/Paper Chromatography	2,3,5	CO2 CO3
	4.2	Electrophoresis: Electrophoretic mobility, Factors affecting electrophoretic mobility. principle and application of Agarose gel electrophoresis	5	CO2 CO3
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Lecture, Hands on training Interactive Instruction: Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Virtual lab
	MODE OF ASSESSMENT **A. Continuous Comprehensive Assessment (CCA)** **Theory/Hands on Work- 30 Marks**

Assessment Types	● 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.
2. Huang, B.Q. & Yeung, E.C. (2015). Chemical and Physical Fixation of Cells and Tissues: An Overview. In E.C.T. Yeung, C. Stasolla, M.J. Sumner & B.Q. Huang (Eds.)Plant Microtechniques and Protocols (pp. 23-44), Springer
3. Khandpur, R.S. (2006). Handbook of analytical instruments. Tata Mc Graw Hill.
4. Khasim, S.M. (2002). Botanical Microtechnique: Principles and Practice. Capital Publishing Company.
5. Nakara, B.C. & Choudhari, K.K. (2003). Instrumentation measurements and analysis. Tata Mc Graw Hill.
6. Pattabhi, N.V. & Gautham, N. (2002). Biophysics. Narosa Publishing House.
7. Prasad, M.K. & Prasad, M.K. (1972). Outlines of Botanical Microtechnique. Emkay Publishers.

SEMESTER VIII

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY
Course Name	**Plant metabolism**
Type of Course	DCC
Course Code	UC8DCCBOT400
Course Level	400
Course Summary	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

Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	-	1	-	75
Pre-requisites, if any	Introduction to plant cells, cell interaction, cytoskeleton, nucleic acids Knowledge about light reaction and dark reaction					

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	8	1,2,3,4,5,6

		(Oxidative phosphorylation). Comparison of mitochondrial and chloroplast electron transport		
	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.		
5	**Teacher specific course components**			

Teachi ng and Learni ng Approa ch	**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.
2. Heldt,H-W., and Piechulla, B. (2021). Plant Biochemistry. 5th ed. Academic Press
3. Taiz, L., Zeiger, E., Moller, I. M., and Murphy, A. (2015). *Plant Physiology and Development*. 6th ed. USA: Sinauer Associates Inc. Publishers.
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

1. Dayananda, B. (1999). Experiments in Plant Physiology. Narosa Publishing House, New Delhi.
2. Hopkins, W. G., Huner, N.P.A. (2008). Introduction to plant physiology. John Wiley and sons. New York.

3. Jain, J.L., Jain, S., Jain, N. (2005). Fundamentals of Biochemistry. S Chand, New Delhi.
4. Lehninger, A. L. (1961). Biochemistry. Lalyan publishers, Ludhiana.
5. Nelson, D. L., Cox, M.M. (1993). Principles of Biochemistry. MacMillan Publications.
6. Pandey, S.N., Sinha, B. K. (2006). Plant Physiology. Vikas Publishing House Pvt. Ltd.
7. Plummer, D.T. (1988). An introduction to practical biochemistry. Tata McGraw-Hill publishing Company, New Delhi.
8. Sadasivam, S., Manickan, A. (1996). Biochemical Methods. New Age International Ltd. New Delhi.
9. Salisbury, F.B., Ross, C.W. (1992). Plant Physiology. CBS Publishers and Distributers, Delhi.
10. Srivastava, H. S. (2005). Plant Physiology. Rastogi publications, Meerut.
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.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</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</td></tr>
<tr><td>Course Code</td><td colspan="6">UC8DCCBOT401</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**			

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. 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.
3. Shu, Q. Y., Forster, B. P., H Nakagawa, Food, I., & International Atomic Energy Agency. (2012). Plant mutation breeding and biotechnology. Cabi; Rome, Italy.
4. Beyl, C. A., &Trigiano, R. N. (2008). Plant propagation: concepts and laboratory exercises. CRC Press.
5. Murphy, D. J. (2007). Plant breeding and biotechnology: societal context and the future of agriculture. Cambridge University Press.
6. Sully G. (2020). Hydroponics: A Beginner's Guide to Grow Fruits, Vegetables And Herbs At Home (Hydroponic System + Homesteading + Horticulture + Gardening). Biribbi.
7. Acquaah, G. (2018). Horticulture: principles and practices. Langara College.
8. Garret D. (2020). Aquaponics for Beginners - A step by step complete guide for beginners on how to build their Aquaponics.
9. Pastor Sharon Simson, & Straus, M. C. (2010). Basics of Horticulture. Oxford Book Company
10. Jacobson, A. (2016) The Essential Aquaponics Guide - A Step-By-Step Aquaponics Gardening Guide to Growing Vegetables, Fruit, Herbs, and Raising Fish at the Same Time
11. Hamish A Collin, Sue Edwards (1998). *Plant tissue culture*. Bios scientific publishers.
12. S S Bhojwani, M K Razdan (1996). *Plant tissue culture: Theory and Practice*. Elsevier.
13. R A Dixon, R A Gonzales (2004). *Plant cell culture, a practical approach* (II Edn). Oxford University Press.
14. Colin Ratledge, Bjorn Kristianson (2001). *Basic biotechnology*. Cambridge University press.
15. L Gamborg, G C Philips (Eds.) (2005). *Plant cell, tissue and organ culture: Fundamental methods*. Narosa Publishing House.
16. *In vitro cultivation of plant cells*. Biotechnology by open learning. Elsevier.
17. D E Evans, J O D Coleman, A Kearns (2003). *Plant Cell Culture*. BIOS Scientific Publishers.
18. https://ncert.nic.in/textbook/pdf/ievs101.pdf
19. https://egyankosh.ac.in/bitstream/123456789/83794/1/Unit-1.pdf

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</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</td></tr>
<tr><td>Course Code</td><td colspan="6">UC8DCEBOT400</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
	Pharmacognosy-Introduction, classification and evaluation of drugs, sources, and techniques of drug production (15 Hours)			
	3.1	Definition, history, scope, and development	1	3

3	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
	3.3	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	5
	3.4	Plant kingdom as source of drugs- plant secondary metabolites as drugs	2	5
	3.5	Techniques for production of drugs– purification, filtration, adsorption, solubilization, absorption, suspension and emulsification. Histochemical localization of starch grains-rice, potato	4	4,5
4	**Practical (30 hours)**			
	4.1	Histochemical analysis of plant components: Starch grains in rice and potato.	15	1.2.3,5
	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	1.2.3,5
	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	1.2.3,5
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

References

1. Arumugam K R and Murugesh (2005) Textbook of Pharmacognosy. Sathya Publishers, Madurai.
2. Atul Shirkhedkar and Surana S J (2008) Pharmacognosy and Phytochemistry. Pragathi Books Pvt. Ltd
3. Biren N Shah and Seth A K (2014) Textbook of Pharmacognosy and Phytochemistry. Elsevier Science Publishing Company. Inc
4. Daniel Mammen (1991) Methods in Plant Chemistry and Economic Botany. Kalyani Publishers, New Delhi.
5. Dwivedi J N and Singh R B (1989) Essentials of Plant Techniques. Scientific Publishers, Jodhpur.
6. Jain S K (1981) Dictionary of Indian Folk medicine and Ethnobotany. National Book Trust, New Delhi.
7. Khandelwal K (2000) Practical Pharmacognosy, Techniques and Experiments. Nirali
8. Miller Lawrence P (1973) Phytochemistry Vol. I, II & III. Van Nostrand Reinhold Co., New York.

9. Ronald Darnly Gibbs (1974) Chemotaxonomy of Flowering Plants – Vol. I & II. Betterworld Books, New York.
10. Sabins S D and Daniel M (1990) A Phytochemical Approach to Economic Botany. Kalyani Publishers, New Delhi.
11. Syed A I and Khan M A (2004) Textbook of Phytochemistry. Discovery Publishing. New Delhi.
12. Vasishta P C and Gills P S (1995) Ethnobotany. Pradeep Publications, Jalandhar.

SUGGESTED READINGS

1. Harborne J B (1973) Phytochemical Methods. Chapman and Hall Limited, London.
2. John T and Romeo (2006) Recent Advances in Phytochemistry. Elsevier Science Publishing Company Inc.
3. Trease G E and Evans W C (2002) Pharmacognosy. Collis Macmillan Publishers, Madras.

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</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</td></tr>
<tr><td>Course Code</td><td colspan="6">UC8DCEBOT401</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	3
	4.2	Prepare a report on any of the above genome projects and submit for evaluation	5	4
	4.3	Extract protein from plant tissues using suitable methods	5	2,3
	4.4	Predicting protein structure from sequences from NCBI and predict their three-Dimensional structure	5	3
	4.5	Extract metabolites from plants using suitable solvent and use simple colorimetric assays to identify them.	5	4
	4.6	Use computational tools to predict protein secondary and tertiary structures and analyze Ramachandran plots	5	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. Ahmad, A., & Asif, A. (in press). Omics studies of medicinal plants, CRC press, ISBN 978- 1032015675
2. Ali, M. A., & Lee, J. (Eds.). (2022). Transcriptome Profiling: Progress and Prospects.
3. Aslam, B., Basit, M., Nisar, M. A., Khurshid, M., & Rasool, M. H. (2016). Proteomics: technologies and their applications. Journal of chromatographic science, 1-15.
4. Barh, D., Khan, M.S., & Davies, E. (Eds.). (2016). PlantOmics The omics of plant science, Springer ISBN: 978-81-322-2171-5 DOI 10.1007/978-81-322-2172-2
5. Eldakak, M., & Lodha, T. D. (2019). Plant Omics and crop breeding, Excelic press ISBN:9781642241570.
6. Elsliger, M. A., & Wilson, I. A. (2013). Structural Genomics. Brenner's Encyclopedia of Genetics: Second Edition, 576–580. https://doi.org/ 10.1016/B978-0-12-374984 -0.01487 -X
7. Ginsberg, S. D., & Mirnics, K. (2006). Functional genomic methodologies. Progress in brain research, 158, 15-40.
8. Hakeem, K.R., Tombuloglu, H., & Tombuloglu, G. (Eds.). (2016). Plant omics: trends and applications, Springer. ISBN: 978-3-319-31701-4
9. Hunt, S., & Livesey, F. (Eds.). (2000). Functional genomics: a practical approach (Vol.

235). OUP Oxford.
10. Liang, K. H. (2013). Bioinformatics for biomedical science and clinical applications. Elsevier.
11. Magar, N. D., Shah, P., Harish, K., Bosamia, T. C., Barbadikar, K. M., Shukla, Y. M., ... & Sundaram, R. M. (2022). Gene Expression and Transcriptome Sequencing: Basics, Analysis, Advances. In Gene Expression. IntechOpen.
12. Micheel, C. M., Nass, S. J., & Omenn, G. S. (2012). Omics-based clinical discovery: Science, technology, and applications. In Evolution of Translational Omics: Lessons Learned and the Path Forward. National Academies Press (US).
13. Ohyanagi, H., Yano, K., Yamamoto, E., & Kitazumi, A. (Eds.). (2022). Plant Omics Advances in Big Data Biology, CAB International, ISBN 978-1-78-924751-0.
14. Suna, G., & Mayr, M. (2018). Proteomics. Encyclopedia of Cardiovascular Research and Medicine, 1–4, 166–180. https://doi.org/10.1016/B978-0-12-809657-4.99573-5
15. Sussulini, A. (Ed.). (2017). Metabolomics: from fundamentals to clinical applications (Vol. 965). Springer.
16. Winck. F. V. (Ed.). (2021). Advances in plant omics and systems biology approaches, Springer
17. Yan, J., & Wang, X. (2023). Machine learning bridges omics science and plant breeding, 28(2), 199-210. https://doi.org/10.1016/j.tplants.2022.08.018
18. Yang, Q., Zhang, A. H., Miao, J. H., Sun, H., Han, Y., Yan, G. L., ... & Wang, X. J. (2019) Metabolomics biotechnology, applications, and future trends: a systematic review. RSC advances, 9(64), 37245-37257. DOI: 10.1039/C9RA06697G.
19. Zargar, S.M., & Rai, V. (Eds.). (2017). Plant omics and crop breeding, Apple Academic Press. ISBN: 978-1-77463-047-1
20. Zhu, H., Bilgin, M., & Snyder, M. (2003). Proteomics. Annual Review of Biochemistry, 72(1), 783–812. https://doi.org/10.1146/annurev.biochem.72.121801.161511.

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Modern trends in plant systematics**					
Type of Course	DCE					
Course Code	**UC**8DCEBOT402					
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		
	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	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

1. Ash, A et al (1999). Manual of Leaf Architecture' by leaf Architecture Working Group - morphological description and categorization of dicotyledonous and net-veined monocotyledonous angiosperms by Leaf Architecture Working Group. 65p.
2. Bell, A.D (1991). Plant form- An illustrated guide to Flowering plant morphology. Oxford university press, NewYork, Tokyo
3. Blackmore S & Cutler D. (1996). Systematics Agenda 2000: the challenge for Europe. London: Linnean Society.
4. Carvalho & Maria, M & Lapenta, A & P.S, Machado. (2003). Functional classification of esterases from leaves of AspidospermaPolyneuron M. Arg. (Apocynaceae). Genetics and Molecular Biology. 26.
5. Daly, M., Herendeen, P. S., Guralnick, R.P, Westneat, M.W & L. McDade (2012). Systematics Agenda 2020: The Mission Evolves. Syst Biol. 2012 Jul; 61(4): 549–552
6. Endress, P.K et al. (2000). Systematic plant morphology and anatomy: 50 years of progress
7. Taxon, Vol. 49, No. 3, Golden Jubilee Part 1 , pp. 401-434 (34 pages)
8. Felsenstein, J. (Ed.) (1983). Numerical Taxonomy. NATO ASI Subseries G
9. Guerra, M (2008). Chromosome numbers in plant cytotaxonomy: concepts and implications.Cytogenet Genome Res 120 (3-4): 339–350.
10. Hewitt, G.M, Johnston, A.W.B & J. P.W. Young (Eds..) (1991). Molecular Techniques in Taxonomy.NATO ASI Subseries H, Vol57

11. Hickey, L.J. (1973). Classification of the architecture of dicotyledonous leaves. American Journal of Botany 60(1): 17–33.
12. Hickey, L.J. & D.W. Taylor (1991). The leaf architecture of Ticodendron and the application of foliar characters in discerning its relationships. Annals of the Missouri Botanical Garden 105–130.
13. James Rohlf, F. (2009). NTSYSpc Numerical Taxonomy and Multivariate Analysis System Version 2.2, Applied Biostatistics Inc., 10 Inwood Road, Port Jefferson, New York. ISBN: 0-925031-31-3.

SUGGESTED READINGS

1. Mohammad, Q *et al* (2022). Pollen characters and their evolutionary and taxonomic significance: Using light and confocal laser scanning microscope to study diverse plant pollen taxa from central India. Palynology.
2. Prance GT. (1995). Systematics, conservation and sustainable development. Biodiv. Conserv4:490–500.
3. Ramawat, K.G. (Eds) (2019). Biodiversity and Chemotaxonomy (Sustainable Development and Biodiversity Book 24).Springer
4. Santanu, D & Bandyopadhyay, S (2009). Molecular Taxonomy: An Approach Based on Molecular Markers. Science and culture. 74. 397-496.
5. Simpson, M. G. (2019). Plant systematics. Academic press, London. pp.566–568
6. Sneath, P.H.A & Sokal, R.R (1973). Numerical Taxonomy: The Principles and Practice of Numerical Classification. W H Freeman & Co; First Edition
7. Systematics Agenda (2000). Systematics agenda 2000: charting the biosphere. Technical Report. New York: Systematics Agenda; 1994. pp. 1–34
8. Walker, J.W & J. A. Doyle (1975). The Bases of Angiosperm Phylogeny: Palynology. Annals of the Missouri Botanical Garden. Vol. 62, No. 3, pp. 664-723 (60 pages).

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Agroecology**					
Type of Course	DCE8DCEBOT403					
Course Code	UC					
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	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		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, texture and composition, Erosion control methods, cover cropping and mulching, contour plowing and terracing.	5	3
	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
	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	2.2	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
	Practical (30 hours)			
4.	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**			

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. Agroecology: The ecology of sustainable food systems, Stephen R Gliessman
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
4. Temegne Nono, Carine & Ngome, Ajebesone& Paul Agendia, Atabong & Youmbi, Emmanuel. (2021). Agroecology for Agricultural Soil Management. 10.1007/978-981-16- 3207-5_9.
5. Jose, S. Agroforestry for ecosystem services and environmental benefits: an overview. *Agroforest Syst* **76**, 1–10 (2009). https://doi.org/10.1007/s10457-009-9229-7
6. Bullock, D. G. (1992). Crop rotation. *Critical reviews in plant sciences*, *11*(4), 309-326.
7. Naik, S. K. (2019). Conservation Agriculture: A potential approach for carbon sequestration and climate resilient farming. *Conservation Agriculture for Climate Resilient Farming & Doubling Farmers' Income, 246p. ICAR Research Complex for Eastern Region, Patna Training Manual No*.
8. Reddy, P. P. (2015). *Climate resilient agriculture for ensuring Food security* (Vol. 373). New Delhi: Springer India.
9. Torquebiau, E. (1990). Introduction to the concepts of agroforestry. *Introduction to the concepts of agroforestry.*, (59).
10. Nair, PK Ramachandran, B. Mohan Kumar, Vimala D. Nair, PK Ramachandran Nair, B. Mohan Kumar, and Vimala D. Nair. "Definition and concepts of agroforestry." *An introduction to agroforestry: Four decades of scientific developments* (2021): 21-28., B. Mohan Kumar, Vimala D. Nair, PK Ramachandran Nair, B. Mohan Kumar, and Vimala D. Nair. "Definition and concepts of agroforestry." *An introduction to agroforestry: Four decades of scientific developments* (2021): 21-28.
11. Nair, PK Ramachandran, B. Mohan Kumar, Vimala D. Nair, PK Ramachandran Nair, B. Mohan Kumar, and Vimala D. Nair. "Definition and concepts of agroforestry." *An introduction to agroforestry: Four decades of scientific developments* (2021): 21-28.
12. Majumdar, D. K. (2001). *Irrigation water management: principles and practice*. PHI Learning Pvt. Ltd..
13. Bonaudo, T., Bendahan, A. B., Sabatier, R., Ryschawy, J., Bellon, S., Leger, F., ... &Tichit,

M. (2014). Agroecological principles for the redesign of integrated crop–livestock systems. *european Journal of Agronomy*, *57*, 43-51.

14. Soussana, J. F., Tichit, M., Lecomte, P., & Dumont, B. (2015). Agroecology: integration with livestock. FAO.
15. Martin, G., Moraine, M., Ryschawy, J., Magne, M. A., Asai, M., Sarthou, J. P., ... &Therond,

O. (2016). Crop–livestock integration beyond the farm level: a review. *Agronomy for Sustainable Development*, *36*(3), 53.

16. Altieri, M. A. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, ecosystems & environment*, *93*(1-3), 1-24.

17. Mondal, S., & Palit, D. (2021). Agroecology for sustainable food system and footprint mitigation. *Agroecological Footprints Management for Sustainable Food System*, 69-114.
18. Gliessman, S., &Tittonell, P. (2015). Agroecology for food security and nutrition. *Agroecology and Sustainable Food Systems*, *39*(2), 131-133.

SUGGESTED READING

1. Bruno Dorin (2022) Theory, Practice and Challenges of Agroecology inIndia, International JournalofAgricultural Sustainability, 20:2, 153- 167, DOI: 10.1080/14735903.2021.1920760

UNION CHRISTIAN COLLEGE, ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</td></tr>
<tr><td>Course Name</td><td colspan="6">Forest Botany</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">UC8DCEBOT404</td></tr>
<tr><td>Course Level</td><td colspan="6">400</td></tr>
<tr><td>Course Summary</td><td colspan="6">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.</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	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.
	Introduction to forest Botany (15 hours)			
	1.1	Introduction to forest ecosystems, Morphology or trees,	5	1
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
	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	2.3	Endemic and rare species- causes, significance, Threats, Red data book, consequences of loss	5	2,3
	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	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

1. Sangria, K. P. (1967). *Forest and Forestry*. New Delhi: National Book Trust India.
2. Nageswara-Rao, M., Soneji, J. R., & Sudarshana, P. (2012). Structure, diversity, threats and conservation of Tropical Forests. *Tropical Forests*, *1*.
3. Baker, F. S. (1950). *Theory and Practice of Silviculture*. California: McGraw Hill Book Company, INC.
4. Kirpal, J. S., & Verma, B. N. (1996, December 12). [Online] Retrieved from mahaforest.nic.in

› stand_ord_file.

5. UBC. (s.d.). *What is Forestry?*. University of British Columbia.
6. Jonathan, S. K., & Robert, T. (1914). *Woodland Management: Glossary of Forestry Terms*. Fact Sheet 620. University of Maryland.
7. IEA. (1998). *World Energy Outlook*. Paris: IEA Publications.
8. ISFR. (2019). *India State of Forest Report*. GOI.
9. Spurr, S. H. (1945). A new definition of silviculture. *Journal of Forestry*, 44.
10. ICFRE. (2011). *Forestry Statistics India*. Dehradun: ICFRE.
11. Venkateshwarlu, D. Definition of Forest- A review. Opendevelopmentmekong.net. [Online] Retrieved from https://data.opendevelopmentmekong.net › download › venkateswarlu.

12. FAO. (2015). *Global Forest Resources Assessment*. Rome: FAO of United Nations.
13. Helms, Jackson A.. "Forest, Forestry, Forester: What Do These Terms Mean?" *Journal of Forestry* 100 (2002): 15-19.
14. Nyland, R. D. (2016). *Silviculture: concepts and applications*. Waveland Press.
15. Bor, N. L. (1953). Manual of Indian forest botany. *Manual of Indian forest botany.*
16. Kramer, P. J. (1986). The role of physiology in forestry. *Tree physiology*, *2*(1-2-3), 1-16.
17. Sterck, F., & Turnbull, C. (2005). Woody tree architecture. *Annual Plant Reviews, Plant Architecture and its Manipulation*, *17*, 210-237.
18. Zhang, Y., Chen, H. Y., & Taylor, A. (2014). Multiple drivers of plant diversity in forest ecosystems. *Global Ecology and Biogeography*, *23*(8), 885-893.
19. Baker, F. S. (1950). Principles of silviculture. *Principles of silviculture.*
20. Endemic and rare species- causes, significance, Threats, Red data book, consequences of loss
21. Nageswara-Rao, M., Soneji, J. R., & Sudarshana, P. (2012). Structure, diversity, threats and conservation of Tropical Forests. *Tropical Forests*, *1*.
22. Rajora, O. P., &Mosseler, A. (2001). Challenges and opportunities for conservation of forest genetic resources. *Euphytica*, *118*, 197-212.
23. Keenan, R. J. (2015). Climate change impacts and adaptation in forest management: a review. *Annals of forest science*, *72*, 145-167.
24. Sedjo, R., &Sohngen, B. (201
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.

UNION CHRISTIAN COLLEGE, ALUVA

Programme	BOTANY					
Course Name	**Aquatic Botany**					
Type of Course	DCE					
Course Code	UC8DCEBOT405					
Course Level	400					
Course Summary	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.					
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	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. 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**	5	1,3
	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 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	4	3,5
	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
	Practicals (30 hours)			
	4.1	Collect common aquatic plants- Identify and set up and natural aquarium	5	2,6

4	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**			

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.
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. 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.
3. Cherry, J. A., & Pec, G. J. (2022). Advances, applications, and prospects in aquatic botany. *Applications in Plant Sciences*, *10*(4).
4. Doležal, J., Kučerová, A., Jandová, V., Klimeš, A., Říha, P., Adamec, L., &Schweingruber,
   F. H. (2021). Anatomical adaptations in aquatic and wetland dicot plants: disentangling the environmental, morphological and evolutionary signals. *Environmental and Experimental Botany*, *187*, 104495.
5. Jones, J. I., Li, W., & Maberly, S. C. (2003). Area, altitude and aquatic plant diversity. *Ecography*, *26*(4), 411-420.
6. Goel, P.K. (2006). Water pollution, New age international publishers, New Delhi. · Kukal
   S.S. and Dhaliwal, G.S. (2005). Essential of environmental science, Kalyani Publishers, Ludhiyana

UNION CHRISTIAN COLLEGE ALUVA

<table>
<tr><td>Programme</td><td colspan="6">BOTANY</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</td></tr>
<tr><td>Course Code</td><td colspan="6">UC8DCEBOT406</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. Fluorescence in situ hybridization (FISH) Live cell imaging, super resolution microscopy	5	1
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
	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	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

References

1. Alberts, B., et al. (2014). Molecular Biology of the Cell.
2. Murphy, D. B., & Davidson, M. W. (2012). Fundamentals of Light Microscopy and Electronic Imaging. Wiley.
3. Pawley, J. B. (2006). Handbook of Biological Confocal Microscopy (3rd ed.). Springer.
4. Hayat, M. A. (2000). Principles and Techniques of Electron Microscopy: Biological Applications (4th ed.). Cambridge University Press.
5. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
6. Bowman, R. H., et al. (1970). Centrifugation: Practical Manual. American Elsevier Pub. Co.
7. Berg, J. M., et al. (2015). Stryer's Biochemistry (8th ed.). W. H. Freeman.
8. Richmond, R. C., & Sykes, G. (2004). Isotopes in Biological Dinitrogen Fixation Research. Springer.
9. Comas, I., & Schuenemann, V. J. (2018). A Brief Review of Molecular Archaeology.
10. Zubay, G., et al. (1995). Principles of Biochemistry. WCB/McGrawHill.
11. Miller, J. M. (2010). Chromatography: Concepts and Contrasts. John Wiley & Sons.
12. Ettre, L. S., & Snyder, L. R. (1976). Quantitative Paper Chromatography of Carbohydrates. Analytical Chemistry, 48(4), 586592.
13. Skoog, D. A., et al. (2017). Fundamentals of Analytical Chemistry. Cengage Learning.
14. Jürgen H. Gross (Ed.). (2005). Mass Spectrometry: A Textbook.
15. Drenth, J. (2007). Principles of Protein Xray Crystallography. Springer.
16. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGrawHill Publishing Co. Ltd. New Delhi. 3rd edition.
17. Nelson, D. L., & Cox, M. M. (2008). Lehninger Principles of Biochemistry. W. H. Freeman.
18. Pagano, M., & Gauvreau, K. (2000). Principles of Biostatistics. Duxbury Press.
19. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.
20. Glantz, S. A. (2012). Primer of Biostatistics (7th ed.). McGrawHill.
21. Dawson Saunders, B., & Trapp, R. G. (1994). Basic & Clinical Biostatistics. Lange Medical Books/McGrawHill.

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.

PROJECT

UNION CHRISTIAN COLLEGE ALUVA	
Programme	BOTANY
Course Name	**Project**
Course Code	UC8PRJBOT400
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 (15 marks)** **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

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