

# UNIVERSITY OF KERALA

THIRUVANANTHAPURAM

## FOUR YEAR UNDERGRADUATE PROGRAMME SYLLABUS

**UoK - FYUGP**

**(2024 Admission Onwards)**



<b>Faculty:</b>	:	<b>Science</b>
<b>BoS:</b>	:	<b>Botany</b>
<b>Subject:</b>	:	<b>Botany</b>

University of Kerala  
Senate House Campus, Palayam  
Thiruvananthapuram – 695 034,  
Kerala, India

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## Preface

Kerala is currently at a pivotal moment in its journey towards becoming a knowledge-based society. A progressive higher education curriculum is deemed essential to achieve this transformation, coinciding with a significant national qualification framework, resulting in a four-year undergraduate program. In this context, the Government of Kerala has taken steps to reform higher education by establishing three commissions. The first commission proposes policy changes related to higher education's structure, content, and institutional practices. The second commission suggests changes in the legal and regulatory mechanisms governing higher education institutions, while the third commission reviews the current evaluation and examination systems in higher education.

Considering the above said commission reports, the Department of Higher Education, Government of Kerala decided to introduce the four-year undergraduate programme in the state of Kerala from the academic year 2024 -25. The introduction of the four-year degree program (FYUGP) represents a significant paradigm shift in Higher Education within Kerala. In response, the University of Kerala has undertaken a comprehensive process of curriculum design, ensuring alignment with guidelines established by the Department of Higher Education, Government of Kerala.

Botany is a fascinating subject that reveals the secret of nature. By the study of the fundamental details of plants, students can understand the growth and development, reproduction, life cycle, and medicinal and economic importance of food resources. This course being an important component of Life Sciences offers immense opportunities in other related fields and applied disciplines such as Biochemistry, Biotechnology, Cell and Molecular Biology, Bioinformatics, Host plant interaction, Environmental Science and Management, and many others. Recent advances in Botany, functional aspects of various processes of plants, molecular genetics, and modern tools i.e. tissue culture, genetic engineering, and computational studies are required to be introduced at the undergraduate level. One of the most popular and much-needed areas of study is climatic change.

The knowledge of plant science can be used to solve environmental challenges. While studying Botany the students learn all these aspects of plants including its applications. Besides, the students will have greater opportunities open to them in higher studies and research along with better job prospects. The primary objective of this curriculum is to equip students with a deep understanding of various branches of plant science. This syllabus is formulated in such a way that it will provide them with the knowledge and skills essential for navigating the

complexities of the plant world. This syllabus will help students to explore the complex web of plant life.

The process of restructuring the existing curriculum, in line with the FYUGP regulations, commenced with a five-day workshop on UoK -FYUGP organized by the UG Board of Studies (BoS) in Botany from 19<sup>th</sup> to 23<sup>th</sup> February 2024 at University College, Thiruvananthapuram with faculty representatives from various Botany departments of the university participated wholeheartedly. This workshop laid the foundation for subsequent discussions and collaborations. A three-day meeting to finalize the syllabus took place from 1<sup>st</sup> to 2<sup>nd</sup> and 9<sup>th</sup> April 2024 at the University College, Thiruvananthapuram. A panel of experts including both external and internal prominent and proficient faculties, conducted a vetting and scrutiny process on 16<sup>th</sup> to 18<sup>th</sup> April 2024 for the finalization of the curriculum and syllabi proposal.

The successful structuring of FYUGP in Botany is a testament to the dedicated and wholehearted efforts, support, and involvement of all members of the Board of Studies, the expert committee, and participants of the workshop. The workshop, organized for reforming the syllabus, witnessed active participation from the Botany fraternity across affiliated colleges, contributing significantly to this colossal task. On behalf of the UG BoS, Botany, I express sincere gratitude to all participants for their wholehearted efforts, which have elevated the syllabus to international standards. I wish to extend my special gratitude to respected Head of the Department of Botany, University College and Hon. Member, Academic Council, UoK for their continuous support and advice throughout the process of this syllabus revision.

In conclusion, we eagerly look forward to guiding students through the diverse and enriching landscapes of Botany. May this syllabus serve as the gateway to a transformative and fulfilling experience, laying the foundation for a lifelong pursuit of knowledge and a meaningful contribution to the world of science.

**Dr. Bindumole V R**  
Chairperson,  
UG Board of Studies in Botany  
University of Kerala  
Thiruvananthapuram

### **Board of Studies**

<b>Sl. No.</b>	<b>Name</b>	<b>Position</b>
01	<b>Dr. Bindumole V R</b> Associate Professor, Department of Botany University College, Thiruvananthapuram	Chairperson
02	<b>Dr. Shiburaj S</b> Professor, Department of Botany University of Kerala, Kariyavattom	Member
03	<b>Dr. Sekharan S</b> Professor, Department of Botany Sree Narayana College for Women, Kollam	Member
04	<b>Dr. K R Kavitha</b> Associate Professor, Department of Botany Sree Narayana College, Chempazhanthu Thiruvananthapuram	Member
05	<b>Dr. Ajith Kumar P</b> Associate Professor, Department of Botany Govt. Arts College Thiruvananthapuram	Member
06	<b>Dr. Hima R</b> Associate Professor, Department of Botany Sree Narayana College, Varkala Thiruvananthapuram	Member
07	<b>Dr. Bobby T Edwin</b> Assistant Professor, Department of Botany TKM Arts and Science College Kollam	Member
08	<b>Dr. Jyothi Kanchan</b> Assistant Professor, Department of Botany Christian College, Chengannur Alappuzha	Member
09	<b>Dr. Smitha C K</b> Associate Professor, Department of Botany Govt. Arts College Thiruvananthapuram	Member
10	<b>Dr. Asha Devi</b> Principal Scientist Central Tuber Crops Research Institute Thiruvananthapuram	Member

### **Panel of Experts for Scrutiny Process**

<b>Sl. No.</b>	<b>Name</b>	<b>Institute</b>	<b>Position</b>
01	<b>Dr. E.A. Siril</b>	Professor and Head, Department of Botany, University of Kerala, Thiruvananthapuram.	<b>PG BoS Chairperson</b>
02	<b>Dr. Sushama Raj R V</b>	Assistant Professor, Department of Botany, VTM NSS College Dhanuvachapuram	<b>Member, Academic Council, UoK</b>
03	<b>Dr. Laija S Nair</b>	Professor and Head, Department of Botany, University College, Thiruvananthapuram.	<b>External Expert</b>
04	<b>Dr. Remakanthan A</b>	Associate Professor, Department of Botany, University College, Thiruvananthapuram.	<b>External Expert</b>
05	<b>Dr. T S Preetha</b>	Associate Professor, Department of Botany, University College, Thiruvananthapuram.	<b>External Expert</b>
06	<b>Dr. Mahesh S</b>	Assistant Professor, Department of Botany, Christian College, Kattakkada	<b>External Expert</b>
07	<b>Dr. Geetha Krishnan Nair P</b>	Kumbalathu Sankupillai Memorial Devaswom Board College Sasthamcotta, Kollam	<b>External Expert</b>
08	<b>Dr. Bindumole V R</b>	Associate Professor, Department of Botany, University College, Thiruvananthapuram	<b>UG BoS Chairperson</b>
09	<b>Dr. Shiburaj S</b>	Professor, Department of Botany University of Kerala, Kariyavattom	<b>Member UG BoS</b>
10	<b>Dr. K R Kavitha</b>	Associate Professor, Department of Botany, Sree Narayana College, Chempazhanthy, Thiruvananthapuram	<b>UG BoS Member</b>
11	<b>Dr. Ajith Kumar P</b>	Associate Professor, Department of Botany, Govt. Arts College, Thiruvananthapuram	<b>UG BoS Member</b>
12	<b>Dr. Hima R</b>	Associate Professor, Department of Botany, Sree Narayana College, Varkala, Thiruvananthapuram	<b>UG BoS Member</b>
13	<b>Dr. Bobby T Edwin</b>	Assistant Professor, Department of Botany, TKM Arts and Science College, Kollam	<b>UG BoS Member</b>
14	<b>Dr. Jyothi Kanchan</b>	Assistant Professor, Department of Botany, Christian College, Chengannur, Alappuzha	<b>UG BoS Member</b>
15	<b>Dr. Smitha C K</b>	Associate Professor, Department of Botany, Govt. Arts College Thiruvananthapuram	<b>UG BoS Member</b>

**Experts participated in syllabus restructuring (Other than BoS)**

<b>Sl. No.</b>	<b>Name</b>	<b>Official Address</b>
01	Dr. Laija S Nair	Professor and Head, Department of Botany, University College, Thiruvananthapuram
02	Dr. Remakanthan A	Associate Professor, Department of Botany, University College, Thiruvananthapuram
03	Dr. T S Preetha	Associate Professor, Department of Botany, University College, Thiruvananthapuram
04	Dr. Mahesh S	Assistant Professor, Department of Botany, Christian College, Kattakkada, Thiruvananthapuram
05	Dr. Sushama Raj R V	Assistant Professor, Department of Botany, VTM NSS College, Dhanuvachapuram
06	Dr. Bosco Lawrence	Professor, Department of Botany, Govt. College for Women, Thiruvananthapuram
07	Dr. Dinesh Raj R	Assistant Professor, Department of Botany, Bishop Moore College, Mavelikara
08	Dr. Anil Kumar A K	Assistant Professor, Department of Botany, Govt College for Women, Thiruvananthapuram
09	Dr. Sheeba M S	Assistant Professor, Department of Botany, Govt College for Women, Thiruvananthapuram
10	Dr. Ratheesh N	Assistant Professor, Department of Botany, Sree Narayana College, Kollam
11	Dr. Rubin Jose A S	Associate Professor, Department of Botany, Fatima Mata National College, Kollam
12	Dr. Sinilal B	Assistant Professor, Department of Botany, Fatima Mata National College, Kollam
13	Dr. Mani Shankar Babu	Assistant Professor, Department of Botany, University College, Thiruvananthapuram
14	Dr. Cinthya Christopher	Assistant Professor, Department of Botany, All Saint's College, Thiruvananthapuram
15	Ms. Priyanjana C Prabhakar	Assistant Professor, Department of Botany, University College, Thiruvananthapuram
16	Dr. Chithra Vijayan	Assistant Professor, Department of Botany, Sree Narayana College, Kollam
17	Mr. Shalaj R	Assistant Professor, Department of Botany, St'. Gregorius College, Kottarakkara
18	Ms. Smitha D G	Associate Professor, Department of Botany, University College, Thiruvananthapuram

19	Dr. Sr. Shaina T.J.	Assistant Professor, Department of Botany, All Saint's College, Thiruvananthapuram
20	Dr. Sumitha V R	Assistant Professor, Department of Botany, N.S.S. College. Panthalam
21	Dr. Manoj G S	Assistant Professor, Department of Botany, Mahatma Gandhi College, Thiruvananthapuram
22	Dr. Dhanya C	Assistant Professor, Department of Botany, Sree Narayana College Cherthala
23	Ms. Sharanya K P	Assistant Professor, Department of Botany, Mahatma Gandhi College, Thiruvananthapuram
24	Dr. Smitha P D	Assistant Professor, Department of Botany, Sree Narayana College, Varkala, Thiruvananthapuram
25	Ms. Sreelekshmi S	Assistant Professor, Department of Botany, Mahatma Gandhi College, Thiruvananthapuram
26	Dr. Divya K R	Assistant Professor, Department of Botany, N.S.S. College, Neeramankara, Thiruvananthapuram
27	Dr. Latha Devi L	Assistant Professor, Department of Botany, A. J. College, Thonnakkal, Thiruvananthapuram





University of Kerala

## **Graduate Attributes**

Graduate attributes bridge the gap between academia and the real world, fostering lifelong learning and meaningful contributions. They denote the skills, competencies and high-level qualities that a student should acquire during their university education. Apart from gathering content knowledge, these attributes go beyond the assimilation of information to its application in various contexts throughout a graduate's life. It aims in inculcating the art of critical thinking, problem solving, professionalism, leadership readiness, teamwork, communication skills and intellectual breadth of knowledge. The University of Kerala envisages to pave the path in guiding the student's journey to shape these attributes uniquely, making them integral to personal growth and success in various spheres of life. The University strives to ensure that these graduate attributes are not just checkboxes, but they play a pivotal role in shaping the students into capable, compassionate and responsible individuals with a high degree of social responsibility.

## **Programme Outcomes (PO)**

No.	Programme Outcomes (POs)
PO-1	<b>Critical thinking</b> <ul style="list-style-type: none"><li>➤ analyze information objectively and make a reasoned judgment</li><li>➤ draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions</li><li>➤ identify logical flaws in the arguments of others</li><li>➤ evaluate data, facts, observable phenomena, and research findings to draw valid and relevant results that are domain-specific</li></ul>
PO-2	<b>Complex problem-solving</b> <ul style="list-style-type: none"><li>➤ solve different kinds of problems in familiar and no-familiar contexts and apply the learning to real-life situations</li><li>➤ analyze a problem, generate and implement a solution and to assess the success of the plan</li></ul>

	<ul style="list-style-type: none"> <li>➤ understand how the solution will affect both the people involved and the surrounding environment</li> </ul>
<b>PO-3</b>	<b>Creativity</b> <ul style="list-style-type: none"> <li>➤ produce or develop original work, theories and techniques</li> <li>➤ think in multiple ways for making connections between seemingly unrelated concepts or phenomena</li> <li>➤ add a unique perspective or improve existing ideas or solutions</li> <li>➤ generate, develop and express original ideas that are useful or have values</li> </ul>
<b>PO-4</b>	<b>Communication skills</b> <ul style="list-style-type: none"> <li>➤ convey or share ideas or feelings effectively</li> <li>➤ use words in delivering the intended message with utmost clarity</li> <li>➤ engage the audience effectively</li> <li>➤ be a good listener who are able to understand, respond and empathize with the speaker</li> <li>➤ confidently share views and express himself/herself</li> </ul>
<b>PO-5</b>	<b>Leadership qualities</b> <ul style="list-style-type: none"> <li>➤ work effectively and lead respectfully with diverse teams</li> <li>➤ build a team working towards a common goal</li> <li>➤ motivate a group of people and make them achieve the best possible solution.</li> <li>➤ help and support others in their difficult times to tide over the adverse situations with courage</li> </ul>
<b>PO-6</b>	<b>Learning ‘how to learn’ skills</b> <ul style="list-style-type: none"> <li>➤ acquire new knowledge and skills, including ‘learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self-paced and self-directed learning</li> <li>➤ work independently, identify appropriate resources required for further learning</li> <li>➤ acquire organizational skills and time management to set self-defined goals and targets with timelines</li> <li>➤ inculcate a healthy attitude to be a lifelong learner</li> </ul>
<b>PO-7</b>	<b>Digital and technological skills</b> <ul style="list-style-type: none"> <li>➤ use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources</li> <li>➤ use appropriate software for analysis of data</li> <li>➤ understand the pitfalls in the digital world and keep safe from them</li> </ul>
<b>PO-8</b>	<b>Value inculcation</b>

	<ul style="list-style-type: none"> <li>➤ embrace and practice constitutional, humanistic, ethical, and moral values in life including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values</li> <li>➤ formulate a position/argument about an ethical issue from multiple perspectives</li> <li>➤ identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights</li> <li>➤ adopt an objective, unbiased, and truthful actions in all aspects of work</li> </ul>
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### **Programme Specific Outcomes (PSO)**

<b>No.</b>	<b>Upon completion of the programme the graduate will be able to</b>	<b>PO No.</b>
<b>PSO-1</b>	The curriculum creates an all-around conceptual awareness in the students about the overall diversity of plants, structure, genetics, reproduction, functioning, ecology, and economic importance of various plant groups.	1, 6
<b>PSO-2</b>	Students will be able to understand the diversity of plants from lower to higher groups with details in structure, function, reproduction, and life cycle of selected groups and generate enthusiasm and inquisitiveness to learn more about the plant world.	1, 2
<b>PSO-3</b>	Students will understand the concepts of Morphology, Taxonomy, Anatomy, Ecology, physiology, metabolism, Chemistry of molecules, Cellular Biology, Genetics and Molecular Biology. They will also get concepts in advanced areas of plant science like Plant Biotechnology, Molecular level Plant Pathogen interaction, and Developmental Botany.	2, 6
<b>PSO-4</b>	Students will get exposed to the opportunities and the nitty-gritty of professionally oriented applied branches like Landscaping, Gardening, Floriculture, Organic farming, Biofertilizers, Herbal technology, Mushroom cultivation, Ecotourism, Forensic Botany, and can become future entrepreneurs.	3, 6, 7
<b>PSO-5</b>	Students will be familiar with the use of various analytical techniques and tools in plant biology for both basic and applied	6, 7

	research and also understand the intellectual and ethical issues of biological discoveries.	
<b>PSO-6</b>	Students will be able to understand the contribution of plant kingdom to human existence and develop skills for their documentation, conservation and sustainable development in the face of climate change.	6, 7, 8
<b>PSO-7</b>	Project work and research activities taken up by the students will necessitates the students to apply the various concepts they have generated from various fields of biology through critical thinking and develop problem solving abilities and creativity for new knowledge creation.	3, 6, 7
<b>PSO-8</b>	Acquiring hands-on training in various fields will develop practical skills, handling equipment and laboratory use along with collection, analysis, and interpretation of biological data.	4, 5, 6
<b>PSO-9</b>	Laboratory work and field studies help the students in development of teamwork and leadership qualities. Also through experiential learning in the field work, they will understand one of the methods of 'how to learn' skills.	5, 6, 7
<b>PSO-10</b>	Assignments and presentations that the student has to take up, and develop communication skills and ICT skills among them. Also, the activities covered in courses of Biostatistics and Bioinformatics give experiential learning of software and tools employed in these areas of biology.	7
<b>PSO-11</b>	The flexibility the curriculum offers, enables the teachers to give the students activities on inquiry based learning that prompt students to ask questions, investigate, and draw conclusions on their own. This promotes curiosity, self-directed learning, and a deeper understanding of scientific principles. Also, platforms given by teachers for debates and discussion on controversial scientific topics help students develop argumentation skills, learn to support their claims with evidence, and consider different viewpoints	5, 6, 8

*Note: More than one PO can correspond to a specific PSO*

## Syllabus index

Sl. No.	Course Code	Course Title	Credits		Page No
			T	P	
DISCIPLINE SPECIFIC CORE COURSES (DSC)					
1 <sup>st</sup> Semester					
01	UK1DSCBOT101	Plant World I	3	1	18
2 <sup>nd</sup> Semester					
01	UK2DSCBOT101	Plant World II	3	1	37
3 <sup>rd</sup> Semester					
01	UK3DSCBOT201	Histology and Reproductive Botany	3	1	57
4 <sup>th</sup> Semester					
01	UK4DSCBOT201	Lower Cryptogams, Phytopathology and Microbiology	3	1	77
5 <sup>th</sup> Semester					
01	UK5DSCBOT301	Angiosperm Morphology and Plant Systematics	3	1	84
02	UK5DSCBOT302	Plant Genetics	4	0	88
6 <sup>th</sup> Semester					
01	UK6DSCBOT301	Plant Physiology	3	1	96
7 <sup>th</sup> Semester					
06	UK7DSCBOT304	Biodiversity and Conservation	3	1	129
8 <sup>th</sup> Semester (Research Project – UK8RPHBOT401)					

<b>DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)</b>					
<b>3<sup>rd</sup> Semester</b>					
01	UK3DSEBOT201	Ethnobotany & IPR	4	0	149
<b>5<sup>th</sup> Semester</b>					
01	UK5DSEBOT301	Analytical Techniques in Plant Science	3	1	165
<b>6<sup>th</sup> Semester</b>					
02	UK6DSEBOT302	Phytochemistry and Drug Discovery	3	1	184
<b>7<sup>th</sup> Semester</b>					
02	UK7DSEBOT402	Industrial Tissue Culture	3	1	198
<b>MULTIDISCIPLINARY COURSES (MDC)</b>					
<b>2<sup>nd</sup> Semester</b>					
01	UK2MDCBOT101	Plants and Human Welfare.	2	1	218
<b>VALUE ADDITION COURSES (VAC)</b>					
<b>4<sup>th</sup> Semester</b>					
03	UK4VACBOT203	Phytonutraceuticals	3	0	244
<b>SKILL ENHANCEMENT COURSES (SEC)</b>					
<b>4<sup>th</sup> Semester</b>					
01	UK4SECBOT201	Mushroom Cultivation	2	1	250

<b>INTERNSHIP AND PROJECTS</b>				
01	UK8RPHBOT401	Research Project	Any One	12

## Semester wise Syllabus Index: Botany Major

### Semester 1

Sl. No	Course Code	Course Title	Course Type	Credit		Hours/Week		Total Hours
				T	P	T	P	
01	UK1DSCBOT101	Plant World I	DSC	3	1	3	2	75

### Semester 2

Sl. No	Course Code	Course Title		Course Type	Credit		Hours/Week		Total Hours
					T	P	T	P	
01	UK2DSCBOT101	Plant World II		DSC	3	1	3	2	75
06	UK2MDCBOT101	Plants and Human Welfare.		MDC	2	1	2	2	60



**Semester 3**

Sl. No	Course Code	Course Title		Course Type	Credit		Hours/Week		Total Hours
					T	P	T	P	
01	UK3DSCBOT201	Histology and Reproductive Botany		DSC	3	1	3	2	75
06	UK3DSEBOT201	Ethnobotany and IPR	Any One	DSE	4	0	4	0	60

**Semester 4**

Sl. No	Course Code	Course Title		Course Type	Credit		Hours/Week		Total Hours
					T	P	T	P	
01	UK4DSCBOT201	Lower Cryptogams, Phytopathology and Microbiology		DSC	3	1	3	2	75
07	UK4VACBOT203	Phytonutraceuticals		VAC	3	0	3	0	45
09	UK4SECBOT201	Mushroom Cultivation		SEC	2	1	2	2	60

**Semester 5**

Sl. No	Course Code	Course Title		Course Type	Credit		Hours/Week		Total Hours
					T	P	T	P	
01	UK5DSCBOT301	Angiosperm Morphology and Plant Systematics		DSC	3	1	3	2	75
02	UK5DSCBOT302	Plant Genetics		DSC	4	0	4	0	60
04	UK5DSEBOT301	Analytical Techniques in Plant Science		DSE	3	1	3	2	75

**Semester 6**

Sl. No	Course Code	Course Title		Course Type	Credit		Hours/Week		Total Hours
					T	P	T	P	
01	UK6DSCBOT301	Plant Physiology		DSC	3	1	3	2	75
05	UK6DSEBOT302	Phytochemistry and Drug Discovery		DSE	3	1	3	2	75

**Semester 7**

Sl. No	Course Code	Course Title		Course Type	Credit		Hours/Week		Total Hours
					T	P	T	P	
06	UK7DSCBOT304	Biodiversity and Conservation		DSC	3	1	3	2	75
08	UK7DSEBOT402	Industrial Tissue Culture		DSE	3	1	3	2	75

**Semester 8**

Sl. No	Course Code	Course Title		Course Type	Credit		Hours/Week		Total Hours
					T	P	T	P	
			RESEARCH PROJECT						

# **Discipline Specific Core Courses**



## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UKIDSCBOT101</b>				
Course Title	<b>PLANT WORLD I</b>				
Type of Course	<b>DSC</b>				
Semester	<b>I</b>				
Academic Level	<b>100 – 199</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	Basic understanding of plant biology at the higher secondary level.				
Course Summary	The course gives an all-round awareness of plants, their evolution, and how they respond to the environment. Kick-starting the process of scientific inquiry in students by observation of nature and recording its diversity along with problem solving and reporting of scientific data using digital tools and techniques is also envisaged.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
<b>I</b>	<b>Origin, Diversity &amp; Evolution of Life</b>		<b>02</b>
	1	<b>Are Plants Alive?</b> Circadian movements, Cyclosis, Tropic movements, Sensing the environment (photo, chemo), respiration, photosynthesis, secretion, allelopathy, and reproduction. (Brief account.)	
	2	<b>Where do they survive?</b> Terrestrial biomes, aquatic biomes, tundra biomes.	
<b>II</b>	<b>Diversity of Plants: Prokaryotic world</b>		<b>08</b>
	3	Geological time scale with special reference to plant evolution.	
	4	Viruses, Fungi and Lichens, Bacteria, Archaea and Eukaryotes. General account, Emphasize distinguishing characters.	
	5	Viruses: Virion types: Helical, Icosahedral, Icosahedral with tail, helical encapsulated, Giant Viruses.	
	6	Bacterial Cell Structure: Fundamental differences between Archaea and bacteria, Shape and size, Plasma membranes, Cell wall, Gram-positive and gram-negative bacteria.	
<b>III</b>	<b>Eukaryotic world</b>		<b>15</b>
	7	Algae: <b>Spirogyra, Pinnularia, Nitella</b> Microscopic study of thallus structure.	
	8	Fungi: <b>Yeast, Pleurotus</b> , Microscopic study of thallus morphology.	
	9	Lichens: Concept of Symbiosis, Various forms of Lichens- Crustose, Foliose and Fruticose.	
	10	Bryophyta: Thallus morphology of <i>Riccia, Bryum</i> .	
<b>IV</b>	<b>Recording Plant Life</b>		<b>05</b>

	11	Process of scientific inquiry: Observation of nature, Identifying a problem, Formulating a hypothesis, Experimentation, Data collection, Analysis and Interpretation of results, Compiling and Reporting the results. (Discuss in light of experiments)	
	12	Basics of Macrophotography: Macro photography of Plants, Time-lapse video recording of plant movements, Microphotography and measurement. Basics of Lighting, f-stop, depth of field, bokeh, ISO values, Photographic equipment.	
	13	Outline of report writing: Introduction, Materials, and Methods, Discussion, References.	
V	<b>Influence of plants on the environment</b>		15
	14	<b>Specialties of the plant specimens/ecosystems are listed below:</b> <ol style="list-style-type: none"> <li><b>Conservation successes:</b> <i>Judean date palm</i>, <i>Nymphaea thermarum</i>.</li> <li><b>Botanical novelties:</b> <i>Victoria amazonica</i>, <i>Welwitschia</i>, <i>Podocarpus wallichianus</i>, <i>Cycas annaikalensis</i>, <i>Wollemia nobilis</i>, <i>Wolffia arriza</i>, <i>Rafflesia arnoldii</i>, <i>Amorphophallus titanum</i>.</li> <li><b>Alluring assassins:</b> <i>Amanita muscaria</i>, <i>Abrus precatorius</i>, <i>Thevetia nerifolia</i>, <i>Cerbera odollum</i>, <i>Strychnos nux-vomica</i>.</li> <li><b>Foreign exchange earners:</b> <i>Morels of Kashmir</i>, <i>Crocus sativus</i>, Marayoor Sandalwood, <i>Tectona grandis</i>.</li> <li><b>Invasive alien:</b> <i>Eichornia crassipes</i>, <i>Mikania micrantha</i>.</li> <li><b>Metal Prospectors:</b> <i>Equisetum arvensis</i>.</li> <li><b>Pharma factories:</b> <i>Trichopus zeylanicus</i>, <i>Vinca rosea</i>, <i>Ephedra foliata</i>, <i>Artemesia</i>, <i>Rauwolfia serpentina</i>, <i>Atropa belladonna</i>.</li> <li><b>Adaptation kings:</b> <i>Myristica</i> swamps, Mangrove vegetation, Insectivorous plants, <i>Cephaeleuros</i>, <i>Parmelia</i>, <i>Ficus religiosa</i> var. <i>krishnae</i>, Peat bogs.</li> <li><b>Early warning systems:</b> Lichens.</li> <li><b>Kerala's own:</b> Rice cultivation below sea level, Pokkali rice, Sacred Groves, Marayoor jaggery, <i>Cassytha filiformis</i>,</li> <li><b>Timeless giants:</b> <i>Giant redwoods</i>, <i>Bristlecone pines</i>.</li> </ol>	

Practicals		
	<ol style="list-style-type: none"> <li>Familiarisation with simple and compound microscopes, Identifying the various parts, and measurement of microscopic structures using micrometry.</li> <li>Observing algal filaments using a microscope to detect cyclosis movements.</li> <li>Setting up &amp; Demonstrating experiments to show the Evolution of oxygen (Photosynthesis) and CO<sub>2</sub> during respiration. (Discuss given the Process of Scientific Enquiry).</li> <li>Field visits to familiarise diverse environments, and collection of samples.</li> <li>Documentation of collected samples, and preparation of semi-permanent slides of bacteria and algae.</li> </ol>	30

	6. Differentiating gram-positive and gram-negative bacteria using Gram staining (Demonstration only).	
	7. Collection, recording, and preservation of the various plant groups from nearby ecosystems.	
	8. Photographic records of botanical specimens encountered <i>in vivo</i> .	
	9. Generating a report on nearby ecosystems with a photographic record.	

### Suggested Readings

1. The Evolution of Plants, K.J Willis & J C Mc Elwain, Oxford University Press, ISBN 0-19-567604-1.
2. Life. The Science of Biology, Twelfth edition.
3. Biology. Kenneth A. Mason & Jonathan B. Losos, ISBN 978-1-260-16961-4, (bound edition).

### Resource materials:

1. Macro Photography, The Universe at our Feet, Don Komarcheka, 2021.
2. A Short Guide to Writing about Biology, *Ninth Edition*, Jan A. Pechenik, ISBN 978-0-321-98425-8 (student edition).
3. College Botany, Volume II, 2011, Hirendra Chandra Gangulee, Asok Kumar Kar.

### Course Outcomes:

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand, explain, evaluate, and effectively interpret basic concepts about plant lineages	R,U	PSO-1,2
CO-2	Apply knowledge to analyze and to distinguish among the major plant lineages.	R, U, E	PSO-1,2
CO-3	Understand basic concepts of photography and apply them to create scientifically useful photographic data.	R, E, Ap,	PSO-7
CO-4	Understand basic needs to effectively initiate, execute and report on the scientific process.	U,Ap,C	PSO-8
CO-5	Work and communicate effectively in a group on enquiry-based tasks and in a practical environment.	Ap, C	PSO-8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Plant World 1**

**Credits: 3:0:1 (Lecture:Tutorial: Practical).**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
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1	1	1	U, An	F, C	L,T	
2	2	2	R, U, E	F,C	L,T	
3	3	2	R, U, E	F,C	L,T	
4	4	7,8,9	R,Ap,An	F,P	T	P
5	5	1,2,6	R,U	F	L,T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive.

#### Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO7	PO8	PO9	PO10
<b>CO 1</b>	3	-	-	-	-	-				
<b>CO 2</b>	-	3	-	-	-	-				
<b>CO 3</b>	-	3	-	-	-	-				
<b>CO 4</b>	-	-	-	-	-	-	3	3	3	2
<b>CO 5</b>	1	1	-	-	-	-				

#### Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar.
- Midterm Exam.
- Programming Assignments.
- Final Exam.

#### Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓	✓	✓





## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK2DSCBOT101</b>				
Course Title	<b>PLANT WORLD II</b>				
Type of Course	<b>DSC</b>				
Semester	<b>II</b>				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	UK1DSCBOT101				
Course Summary	The purpose of this course is to demonstrate that Plant Science students will have met all learning outcomes in the major course, prior to passing to the next semester by observing, critically evaluating and documenting relevant in-class and co-curricular activities. Preparatory work will include observing and learning from a diversity of activities, including theoretical sessions, field observations and laboratory sessions. Career pathways and higher research options will be introduced enabling students to choose pathways to attain their goals.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
I	How plants colonised land?		04
	1	Evolution of Tracheary elements, Vascular systems, Stelar evolution, Pollen types, Pollen morphology, Wind pollination and Insect pollination, Seed habit.	
II	Tracheophytes: Pteridophytes (Non Seed plants)		04
	2	<i>Psilotum</i> , <i>Nephrolepis</i> , <i>Azolla</i> : Morphology of Gametophyte and Sporophyte, Structure of Cones.	
III	Tracheophytes: Gymnosperms & Angiosperms (Seed plants)		20
	Gymnosperms		
	3	<i>Pinus</i> : Morphology of Sporophyte and Gametophyte (Pollen grain & Ovule) , Structure of Cones.	
	Angiosperms		
	4	Flowering plant morphology: Root types: Tap root, Fibrous root, Aerial root, Prop root, Stilt root, Velamen root, Pneumatophore, Haustoria. Shoot morphology: Nodes, Internodes, Terminal bud, Axillary bud, Sympodial/Monopodial growth. Stem shapes (Cylindrical, Succulent, Flattened, Winged). Bark: Definition and Types, Emergences (prickles, thorns, tendrils), Pulvinus, Scars.	

		Leaf types: Simple, Compound, Leaf shape: Leaf apex, leaf margins, leaf base. Bsic structure of a flower, Inflorescence types: Study of basic types, Racemose, Cymose (Sub types not required).	
	5	Basic structure of a fruit: Types: Simple, Aggregate, Multiple Pseudocarps. Dicot and monocot embryo, Seed structure and methods of seed dispersal.	
	6	Preservation methods: Preservation using dry & wet methods. Herbarium and use of Formaldehyde.	
IV	Role of Tracheophytes in Nature		02
	7	Ecological & Economic importance of Pteridophytes, Gymnosperms, Angiosperms.	
V	Future prospects and Career openings in Plant Sciences		15
	8	Teachers, Garden managers, Plantation Managers, Entrepreneurs, Photographic specialists, Botanical artists, Researchers, Herbarium curators, Bonsai artists, Sustainability managers, Germplasm conservors, Organic farmers, Environmental experts in NGOs, Environmental Impact assessment experts, Biodiversity conservation experts, Plant breeders, Biodiversity activists, Aquascaping experts.	
	Research Institutes		
	9	Students should be familiarised with the work going on in Institutes: Inside Kerala: CSIR Institutes: NIIST, ICAR institutes -CTCRI, CMFRI, KSCSTE: JNTBGRI, KFRI, CWRDM, RGCB, MBGIPS. <b>Pan INDIA:</b> CFTRI-Mysore, IARI-PUSA, NBPGR-New Delhi, BSI, IISC-Bangalore, TIFR-Hyderabad, DRDO, BARC-Trombay, NBRI-Lucknow, IIHR-Mysuru. IISR-Kozhikode, ICAR-SBI, Coimbatore, UAS Bangalore. <b>Private sector:</b> Mahyco Private Ltd., Biocon, Pharmaceutical firms, Coffee, Tea, Cadbury Plantations, Indo-American hybrid seeds.	

<b>Practicals</b>		
	<ol style="list-style-type: none"> <li>1. Familiarisation of various stelar types: protostele, actinostele, siphonostele, solenostele (<i>Marselia</i> rhizome), dictyostele ( <i>Pteris</i> petiole), atactostele (Grass stem).</li> <li>2. Structure of vascular bundles- Collateral, Conjoint (open, closed, concentric, bicollateral) and radial.</li> <li>3. Maceration of Eupatorium stem to separate and identify Tracheids, Parenchyma, and Vessel members.</li> <li>4. Measurement of any one vascular element, using a micrometer.</li> <li>5. Field visits to collect different leaf types &amp; different inflorescence types. Preparation and submission (herbarium) of leaf types and inflorescences.</li> <li>6. Collection and submission of various seed types. Observing, Recording their surface peculiarities.</li> <li>7. Pollen surface ornamentation study of 5 plant using light microscopy.</li> <li>8. Pollen germination study and Pollen viability testing using acetocarmine.</li> </ol>	<b>30</b>

	9. Preparation of an e-portfolio, detailing the activities performed during the course and submitting for evaluation.	
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## Suggested Reading

1. The Evolution of Plants, K.J Willis & J C Mc Elwain, Oxford University Press, ISBN 0-19-567604-1.
2. Plant Form. An Illustrated Guide to Flowering Plant Morphology, Adrian D.Bell, Oxford University Press, ISBN 0-19-854279-8.
3. Taylor A. Steeves & Vipeen K. Sawhney 2017.Essentials of Developmental Plant Anatomy, Oxford University Press.
4. A Short Guide to Writing about Biology, *Ninth Edition*, Jan A. Pechenik, ISBN 978-0-321-98425-8 (Student Edition).
5. Plant Anatomy, Third Edition. A.Fahn, Pergamon Press. ISBN 0-08-028030-7.
6. Life. The Science of Biology, Twelfth edition.
7. Hirendra Chandra Gangulee, Asok Kumar Kar. 2011, College Botany, Volume II,
8. Web sites of research institutions mentioned in the syllabus.

## Course Outcomes

No.	Upon completion of the course, the graduate will be able to,	Cognitive Level	PSO addressed
CO-1	Recognize and appreciate nature, both on campus and at nearby sites.	U	PSO-1,3
CO-2	Summarize key ideas in the plant sciences.	R, U	PSO-2,7,8
CO-3	Understand and evaluate the vast career pathways and opportunities across the agricultural and plant science disciplines.	U,E	PSO-1,10
CO-4	Acquire a broad grasp of current knowledge pathways across the Plant Science discipline.	U, An	PSO-1,3
CO-5	Reflect on how field experiences provide new insights into the plant sciences, and how it can contribute to career pathways and career goals.	E,Ap,An	PSO-4
CO-6	By discovering and critically analysing information, interpreting data and gaining a conceptual grasp of common biological principles, learn to execute the scientific method.	U,Ap,An	PSO-6,7,8,9,10

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Plant World II**

**Credits: 3:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,3	R, U	F, C	L, T	P
2	2	2,7,8	R, U	F, C	L, T	P
3	3	1,10	U, E	F, C, P	L, T	
4	4	1,3	R, U,E	F, C	L,T	
5	5	4,10	E, Ap, An	F, C, P	T	P
6	6	6,7,8,9,10	U, Ap, An	C, P, M	T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

**Mapping of COs with PSOs and POs :**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO7	PO8	PO9	PO10
<b>CO 1</b>	3	-	3	-	-	-				
<b>CO 2</b>	2	-	-	-	-	-	3	2		
<b>CO 3</b>	2	-	1	-	-	-				3
<b>CO 4</b>	3	-	3	-	-	-				
<b>CO 5</b>	-	-	-	3	-	-				1
<b>CO 6</b>	-	-	-	-	1	2	3	3	3	3

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	



**University of Kerala**

Discipline	<b>BOTANY</b>				
Course Code	<b>UK3DSCBOT201</b>				
Course Title	<b>HISTOLOGY AND REPRODUCTIVE BOTANY</b>				
Type of Course	<b>DSC</b>				
Semester	<b>III</b>				
Academic Level	<b>200 - 299</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	Basic understanding of plant biology at the higher secondary level.				
Course Summary	This course provides basic knowledge of plant internal architecture, cellular composition, and reproduction. This will also help them to understand how different plant tissue evolve and modify their structure and functions with respect to their environment.				

**Detailed Syllabus:**

Module	Unit	Content	Hrs
<b>I</b>		<b>Introduction to tissues and tissue systems</b>	<b>07</b>
	1	Introduction and scope of Plant Anatomy; Structure of Plant Cell and Cell wall, Cell wall organization – Primary and secondary wall, pits, plasmodesmata (Brief account).	
	2	Non-living inclusions of the cell -Reserve food (carbohydrates, proteins, fats,and oil) Secretory products (coloring matter,nectar), excretory products (nitrogenous and non-nitrogenous including resins, tannins, latex, essential oils, gums, and mineral crystals-cystolith, raphides.	
	3	Structure and functions of Meristematic tissues; Classification of meristems; Theories on Apical organization - Apical cell theory, Histoge theory, Tunica-Corpus theory, and Korper Kappe theory. Organization of shoot and root apex in dicots and monocots	
<b>II</b>		<b>Permanent tissue system</b>	<b>06</b>
	4	Permanent tissues – Definition, classification – simple, complex, and secretory tissues (glandular tissue, laticifers).	
	5	Tissue systems- Epidermal tissue system, Ground tissue system and vascular tissue systems. Different types of vascular arrangements- collateral, bicollateral, concentric, and radial.	
	6	Stomata – structure and functions, types- anomocytic, anisocytic, paracytic, diacytic, graminaceous.	
<b>III</b>		<b>Primary and Secondary Structure</b>	<b>10</b>
	7	Primary structure – Root, stem and leaf (Dicot & Monocot)	
	8	Cambium (structure and function),	

	9	Secondary Growth: Normal Secondary growth in stem and root. Periderm formation – phellum, phellogen and phelloderm; lenticels.	
	10	Wood anatomy: Hard wood, soft wood; Growth ring, Ring porous and diffuse-porous wood; Sapwood and heartwood, Tyloses.	
	11	Anomalous secondary growth – Bignonia, Boerhaavia, Dracaena	
IV	<b>Reproductive Botany</b>		07
	12	Flower- as a reproductive organ, floral components, and their roles	
	13	Microsporangium: Structure of anther, microsporogenesis, Male gametogenesis. Pollen structure-wall layers, aperture, NPC system of classification, pollen allergy (Only Brief account)	
	14	Megasporangium: types of ovules; Megasporeogenesis – female gametophyte – structure of a typical embryo sac, types of embryo sacs, monosporic - Polygonum type, bisporic–Allium type and tetrasporic- Fritillaria type. Pollination- Types, agents of pollination, (Only Brief account)	
	15	Double fertilization; Endosperm: types – Cellular, Nuclear, and Helobial. Embryogeny- Structure of dicot and monocot embryo; seed formation. Polyembryony.	
V	<b>Comparative Plant Anatomy</b>		15
	16	Evolutionary trends in plant anatomy - Nodal anatomy	
	17	Anatomical adaptations of plants to different environments (Hydrophytes, Paracites, Xerophytes, Epiphytes)	
	18	Applications of anatomy in Plant systematics, Forensics, Pharmacognosy and Dendrochronology, Anatomics (Brief account)	

<b>Practicals</b>		
	<ol style="list-style-type: none"> <li>Non-living inclusions – Cystolith, Raphide, Sphaero-raphide (Druses).</li> <li>Starch grains (Eccentric, Concentric, compound, Aleurone grains)</li> <li>Simple permanent tissue- parenchyma, chlorenchyma, aerenchyma, collenchyma, sclerenchyma</li> <li>Primary structure- Dicot stem- Centella/ Chromolaena</li> <li>Monocot stem- Grass and Asparagus</li> <li>Dicot root- Pea/ Limnanthemum, Monocot root- Colocasia or any other monocot root</li> <li>Secondary structure – Stem (Normal type) – Vernonia.</li> <li>Root (Normal type)- Carica papaya, Aerial root- Tinospora and Ficus</li> <li>Epidermal structures- Stomata (Anomocytic, anisocytic, paracytic, diacytic)</li> <li>Anomalous secondary thickening – Bignonia, Boerhaavia, Dracaena</li> <li>Dissect a flower and document (photograph/illustration)</li> <li>Identification of C.S of the anther.</li> <li>Identification and documentation of anther dehiscence pattern in five locally available plants.</li> <li>Dissection of dicot embryo, familiar with different types of ovules</li> </ol>	30

### Suggested reading

- Beck, C. B. (2010). An Introduction to Plant Structure and Development-Plant Anatomy for the Twenty-First Century. Cambridge University Press, ISBN: 9781139486361.

2. Bonham, D. (2018). Plant Anatomy. Larsen & Keller education, ISBN: 9781635496468
3. Crang, R., Lyons-Sobaski, S., & Wise, R. (2018). Plant Anatomy A Concept-Based Approach to the Structure of Seed Plants. Springer International Publishing, ISBN: 9783319773155.
4. Cutler, D. F., Botha, T., & Stevenson, D.W. (2009). Plant Anatomy: An Applied Approach, Wiley, ISBN: 9781444300468.
5. Esau, K. (2006). Anatomy of seed plants, 2nd Edition, Wiley India Pvt. Limited, ISBN: 9788126508204
6. Evert, R.F., Eichhorn, S.E. (2006). Esau's Plant Anatomy Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function, and Development, Wiley, ISBN: 9780470047378
7. Foster, A. S. (2015). Practical plant anatomy. Creative Media Partners, LLC, ISBN: 9781341784507
8. Jain, A.P., & J. K. Maheshwari J. K. (2001). Recent researches in plant anatomy and morphology, Scientific Publishers, ISBN: 9788172332693.
9. . Bhattacharya K., Majumdar M. R & Bhattacharya S. G. 2017. A text book of Palynology. New Central Book Agency (P) Ltd.
10. Johri B. M., Srivastava P. S. 2015. Reproductive Biology of Plants Springer - Verlag Berlin and Heidelberg GmbH & Co.
11. Ramawat K. G. Mérillon J. M and Shivanna K. R. 2014. Reproductive Biology of Plants. CRC Press.
12. Johri, B. M. 1984. Embryology of Angiosperms. Springer Verlag. Berlin.
13. Pandey, S. N. & Chadha, A. 2000. Embryology. Vikas Publishing House Pvt. Ltd. New Delhi.
14. Maheswari, P. 1980. Recent Advances in the Embryology of Angiosperms.

## Web links

1. <https://www.encyclopedia.com/social-sciences/applied-and-social-sciences-magazines/plantanatomy>
2. <https://agriculturistmusa.com/plant-embryology/>
3. [http://www.ppup.ac.in/download/econtent/pdf/JNL%20College%20\(%20Pallavi%20for%20Botany%20B.Sc%20Part%20II\)%20Topic-Plant%20embryology%20part%201.pdf](http://www.ppup.ac.in/download/econtent/pdf/JNL%20College%20(%20Pallavi%20for%20Botany%20B.Sc%20Part%20II)%20Topic-Plant%20embryology%20part%201.pdf)
4. [https://bio.libretexts.org/Bookshelves/Introductory\\_and\\_General\\_Biology/Book%3A\\_Biology\\_\(Kimball\)/16%3A\\_The\\_Anatomy\\_and\\_Physiology\\_of\\_Plants](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Biology_(Kimball)/16%3A_The_Anatomy_and_Physiology_of_Plants)

## Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students can understand the complexities of cell wall organization, microscopic and sub-microscopic	U	PSO-1,2



	structures		
CO-2	Students can distinguish various anatomical features of monocots and dicots (stem and root) with respect to permanent tissues and tissue systems	R, U	PSO-1,2
CO-3	Differentiate stelar patterns in the stem and root of vascular plants with normal and anomalous secondary growth	An	PSO-1,2
CO-4	Students should comprehend the processes involved in plant embryonic development, including fertilization, embryogenesis, and seed development.	C, E	PSO-2
CO-5	Students should be able to compare the embryonic development of different plant taxa	C	PSO-1,2
CO-6	Students should be able to apply their understanding of plant anatomy and embryology to address real-world problems in agriculture, horticulture, plant breeding, and conservation biology.	Ap	PSO-6,7

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

**Name of the Course: Histology and Reproductive Botany**

**Credits: 3:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	U	F, C	L, T	
2	2	1,2	R, U	F,C	L,T	P
3	3	1,2	An	F,C	L,T	P
4	4	2	C, E	F,C	L,T	P
5	5	1,2	C	p	L,T	
6	6	6,7	Ap	M	T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

#### **Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	



**University of Kerala**

Discipline	<b>BOTANY</b>				
Course Code	<b>UK4DSCBOT201</b>				
Course Title	<b>LOWER CRYPTOGRAMS, PHYTOPATHOLOGY AND MICROBIOLOGY</b>				
Type of Course	<b>DSC</b>				
Semester	<b>IV</b>				
Academic Level	<b>200 - 299</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 hours
Pre-requisites	UK3DSCBOT201				
Course Summary	To familiarize the students with lower cryptogams (algae, fungi, and lichens) and microbes; their diversity, structure, and life cycle; and their economic and ecological significance. Students will get an idea about plant diseases and their management.				

Module	Unit	Content	Hrs
<b>I</b>	<b>Phycology</b>		<b>11</b>
	1	General characteristics and classification of algae (Fritch,1935) up to class level- Thallus organization and Pigment composition- Economic importance of algae.	
	2	Significant features, thallus structure, and life cycle of algae in the following groups with special reference to the type mentioned: Cyanophyceae ( <i>Nostoc</i> ) Chlorophyceae ( <i>Oedogonium</i> ) Bacillariophyceae ( <i>Pinnularia</i> ) Phaeophyceae ( <i>Sargassum</i> ) Rhodophyceae( <i>Polysiphonia</i> )	
<b>II</b>	<b>Mycology</b>		<b>10</b>
	3	General characteristics and classification of Fungi(G.C. Alexopoulos, 1996); Economic importance of Fungi.	
	4	Significant features, thallus structure and life cycle of the genera mentioned in each group Zygomycetes - <i>Rhizopus</i> Ascomycetes - <i>Penicillium</i> Basidiomycetes – <i>Puccinia</i> , <i>Agaricus</i>	
<b>III</b>	<b>Lichenology</b>		<b>03</b>
	5	General account, ecological and economic importance; types of Lichen - Crustose, Foliose and Fruticose.	
	6	Morphology, anatomy, and reproduction of <i>Usnea</i>	
<b>IV</b>	<b>Plant pathology</b>		<b>06</b>

	7	Definition and Classification of plant diseases based on causative organisms and symptoms, Host-parasite interaction, disease triangle, and phytoalexins.	
	8	Study of the following diseases with emphasis on symptoms, disease cycle, and control measures - Leaf mosaic of Tapioca, Citrus Canker, Blast disease of Paddy	
	9	Brief account of the following Fungicides- Bordeaux mixture, Lime sulphur, Tobacco decoction, Neem cake & oil.	
<b>V</b>	<b>Microbiology</b>		<b>15</b>
	10	History –Contributions of Robert Hook, Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch.	
	11	Bacteria: Morphology and classification- Ultrastructure, reproduction- Gram staining- Economic importance. Mycoplasma & Actinomycetes(General account)	
	12	Virus: Structure and reproduction in general. Bacteriophages: Structure and reproduction (Lytic and Lysogenic cycle)- Harmful activities of viruses.	
	13	Applied microbiology -Nitrogen fixation, Bio-fertilizers, Pasteurization, types (canning, drying), soil microorganisms – bacteria (cyanobacteria and actinobacteria), algae, fungi, and viruses (brief account only), Role of microbes in soil fertility:the rhizosphere-Phyllosphere.	

<b>Practicals</b>		
	<ol style="list-style-type: none"> <li>1. Gram staining of bacteria.</li> <li>2. Make micro preparations of vegetative and reproductive structures of the algal and fungal types mentioned in the syllabus.</li> <li>3. Identify the algal specimens up to the generic level and make labeled sketches of the specimens observed</li> <li>4. Identification of Different Lichens mentioned in the syllabus.</li> <li>5. Identify the causal organism and symptoms of Leaf mosaic of Tapioca, Citrus Canker, and Blast disease of Paddy.</li> <li>6. Prepare the fungicides- Bordeaux mixture &amp; Tobacco decoction</li> <li>7. Algal and fungal sample collection from different localities.</li> </ol>	<b>30</b>

### Suggested Reading

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M.1996. Introductory Mycology.
2. John Wiley & Sons. Inc., New York, 868.
3. Ganguli, H.C. and Kar. AK. 2001 College Botany and Vol.II Books and Allied Press Ltd Kolkata. India
4. Lee, R.E.2008. Phycology, Cambridge University Press, Cambridge. 4th edition.
5. Pelczar et al.2011. Microbiology, 8th edition, Tata McGraw-Hill Co, New Delhi.
6. Smith, G. M.1972.Cryptogamic Botany. Vol. 1 & 2. Tata McGraw Hill Publishing Co. Ltd.
7. Vasista P.R.2017.Botany for Degree student, Algae, S. Chand Publication, New Delhi

## References

1. Vasishta, B.R., Sinha, A. K., and Kumar, A. 2016. Botany for Degree Students,
2. Gupta, V. K. and Paul, T. S., (2004), Fungi & Plant diseases. Kalyani Publishers, New Delhi
3. Misra A and Agrawal P.R (1978) Lichens, New Delhi: Oxford and IBH.
4. Sharma, P. D., (2004), The Fungi, 2nd Edition , Rasthogi publication
5. Prescott, L.M., Harley J.P., Klein D. A. (2010). Microbiology, McGraw-Hill, India.
6. Campbell, R., (1987). Plant Microbiology. ELBS Edward Arnold, London
7. Agrios, G.N., (2005). Plant pathology. Elsevier.

## Web links

1. <https://www.britannica.com/science/algae/Ecological-and-commercial-importance>
2. <https://naturalhistory.si.edu/research/botany/research/algae/algae-classification>
3. <https://organismalbio.biosci.gatech.edu/biodiversity/fungi-2/>
4. <https://www.britannica.com/science/lichen>
5. <https://www.worldatlas.com/articles/what-is-the-economic-importance-of-algae.html>

## Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understanding the scope and contributions of Scientists to Botany students.	R,U	
CO-2	Understand the fundamental structure of microbes, Algae, Fungi, and lichens .	R,U	PSO-1
CO-3	Understand the ecological roles of algae, fungi, and lichens in various ecosystems	R,U	PSO-5
CO-4	Analyze the economic significance of microorganisms, algae, and fungi.	An, E	PSO-1, 2
CO-5	Apply Algology study to develop ways to clean up wastewater naturally by using algae.	Ap, E	PSO-5,6
CO-6	Apply knowledge of plant pathology to diagnose, prevent, and mitigate plant diseases in agricultural, horticultural, and natural ecosystems	Ap.An	PSO-4, 7
CO-7	Emphasizes the applications of microbiology to address environmental problems and provide microbial remedial measures	Ap ,C	PSO-7, 8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Lower Cryptogams, Phytopathology and Microbiology**

**Credits: 3:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1	R, U	F, C	L, T	
2	2	1	R, U	F, C	L, T	
3	3	5	R, U	F, C	L, T	P
4	4	1, 2	An, E	C, P	L, T	P
5	5	5,6	Ap, C	C, P	L, T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3		✓		✓
CO 4	✓	✓		
CO 5	✓			





## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK5DSCBOT301</b>				
Course Title	<b>ANGIOSPERM MORPHOLOGY AND PLANT SYSTEMATICS</b>				
Type of Course	<b>DSC</b>				
Semester	<b>V</b>				
Academic Level	<b>300 - 399</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	<b>UK1DSCBOT101, UK2DSCBOT101</b>				
Course Summary	The course emphasizes the identification and classification of plants based on morphological traits. Understand various angiosperm families their morphology, distinctive features, and biology.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
<b>I</b>	<b>Morphology of Flowering Plants</b>		<b>08</b>
	1	A brief account of vegetative parts of a plant - Plant habit, stem, root, leaf- morphotypes, phyllotaxy, venation.	
	2	Flower as a modified shoot: Detailed structure of floral parts-arrangements, relative position, cohesion, and adhesion of floral parts; Flower- symmetry- aestivation and placentation; Floral diagram and floral formula.	
	3	Types of inflorescence with examples- Racemose (simple raceme, spike, catkin, spadix, umbel, corymb, capitulum and panicle), Cymose (simple cyme, monochasial - helicoid and scorpioid, dichasial, polychasial) & special types - Cyathium, Verticillaster, Hypanthodium, Coenanthium and Thyrsus)	
	4	Types of fruits – Simple fruits-Fleshy& Dry – Dehiscent, Indehiscent, and Schizocarpic fruits)-Aggregate-and Multiple fruits with examples.;Seeds – Albuminous and exalbuminous-Dispersal of fruits and seeds.	
<b>II</b>	<b>Nomenclature and Systems of angiosperm classification</b>		<b>06</b>
	5	Basic rules of Binomial Nomenclature - International Code of Nomenclature for algae, fungi, and plants (ICN): Outline- Rule of priority and its limitations, Author citation -typification (Holotype, Isotype, Syntype, Paratype, and Lectotype), Effective and valid publication, Nomina rejected, Nomina conservenda.	
	6	Major systems of classification: Artificial (Linnaeus), Natural: (Bentham and Hooker (detailed account)), Phylogenetic- (Engler and Prantl)-APG-IV system (outline and its significance).	



<b>III</b>	<b>Taxonomic aids</b>		<b>04</b>
	7	Herbarium, techniques, preparation, International (Kew, K) – National (Central National Herbarium, CAL), BSI-Coimbatore(MH),JNTBGRI(TBGT), Virtual herbarium (concept and example only)- Botanical gardens and its role- important Botanic gardens: RBG, Kew; Acharya Jagadeesh Chandrabose Indian Botanic Garden-Culcutta, JNTBGRI, Thiruvananthapuram- Botanical Survey of India- Structure and organization.	
	8	Taxonomic Literature: Floras, Monographs, Revisions and Journals- Taxonomic keys: Bracketed and Indented keys (Brief account).	
<b>IV</b>	<b>Systematic study of Angiosperm families</b>		<b>12</b>
	9	A detailed study (Systematic position, distribution, common members, diagnostic features, vegetative, floral characters, and economic importance of the following families: 1. <i>Annonaceae</i> , 2. <i>Malvaceae</i> 3. <i>Rutaceae</i> , 4. <i>Leguminosae</i> with sub-families 5. <i>Rubiaceae</i> 6. <i>Asteraceae</i> 7. <i>Sapotaceae</i> 8. <i>Asclepiadaceae</i> 9. <i>Solanaceae</i> 10. <i>Acanthaceae</i> 11. <i>Lamiaceae</i> 12. <i>Euphorbiaceae</i> 13. <i>Orchidaceae</i> 14. <i>Liliaceae</i> 15. <i>Poaceae</i>	
<b>V</b>	<b>Modern techniques in plant systematics</b>		<b>15</b>
	10	Numerical Taxonomy, Chemotaxonomy, Cytotaxonomy, Molecular taxonomy – concepts and brief account.	
	11	Biosystematics-Principles and methodology(Brief account)- Phylogenetic systematics: principle, Methodology, and applications- brief account	

<b>Practicals</b>		
	1. Prepare a photo album of leaves and Inflorescences. 2. Identify evidence from nature for considering the flower as a modified shoot and submit the same in the form of geo-tagged photographs or herbarium sheets. 3. Conduct regular field visits to familiarise with the local flora and submit e-reports with photographs. 4. Conduct a field trip outside the Kerala -Herbarium of samples should be made from the trip, along with photographic evidence and a report should also be submitted during practical examination.	<b>30</b>

	<ol style="list-style-type: none"> <li>5. Visit to a recognized Herbarium- Report of the same with photographic evidence should be submitted for the practical examination.</li> <li>6. Students should work with at least two members from each family mentioned in the syllabus and record- description of the same in technical terms should be done in the practical record.</li> <li>7. Submission of not less than 15 properly identified Herbarium sheets with author citation, should be done during the practical examination.</li> <li>8. Online resources and websites: Index Herbarium, IPNI, The Tree Of Life Web Project (To), Plants of The World (POWO), The world flora online (WFO), RBGE Living collections should be accessed and familiarised. E-Flora Kerala.</li> </ol>	
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## Suggested Reading

1. Simpson, Michael G.(2019) Plant systematics. Academic press.
2. Singh, Gurcharan.(2019) Plant systematics: an integrated approach. CRC Press.
3. Bell, Adrian D., and Alan Bryan.(2008) Plant form: an illustrated guide to flowering plant morphology. Timber Press.
4. Eames, A.J. (1961). Morphology of Angiosperms. McGraw Hill, New York
5. Harris, J.G & M.W. Harris (1994). Plant Identification Terminology -An illustrated Glossary, Spring Lake Publishing, Spring Lake, Utah.
6. Sinha R K (2010) Practical Taxonomy of Angiosperms. IK International Publishing Pvt Ltd.
7. Naik, V.N. Taxonomy of Angiosperms. TATA McGraw Hill, New Delhi.

## Web link

1. <https://www.botanicalartandartists.com/plant-evolution-and-taxonomy.html>
2. <https://open.lib.umn.edu/horticulture/chapter/2-1-plant-taxonomy/>
3. <https://botanicalsociety.org.za/the-science-of-names-an-introduction-to-plant-taxonomy/>
4. <https://www.employees.csbsju.edu/ssaupe/biol308/Lecture/introduction.htm>
5. <https://botany.org/home/resources/plant-talking-points/what-is-economic-botany.html>

## Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students possess the capability to recognize and distinguish different categories of foliage, flowers, inflorescence, and fruits.	R, U	PSO-1,2
CO-2	Compare the morphological characters of plants belonging to different families. Construct the floral diagram and floral formula subsequent to the observation of a studied plant.	R, U	
CO-3	Execute field collections of plant specimens, scientific	An, C	

	herbarium preparations, and maintenance.		
CO-4	Learn about various modern taxonomies, software and tools and their application in plant systematics and the techniques for the preparation of virtual herbaria and macrophotography.	Ap, An, C	PSO-8,9
CO-5	Utilize the knowledge of plant systematics for the benefit of science and society.	Ap, E, C	PSO-1,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Angiosperm Morphology and Plant Systematics**

**Credits: 3:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	1	1.2	R, U	F, C	L.T	
CO-2	2		R, U	F, C	L.T	P
CO-3	3		An, C	F, C	L.T	P
CO-4	4	8,9	U, An, C	P	L.T	P
CO-5	5	1,6	Ap, E, C	P	L.T	

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓	✓	✓



## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK5DSCBOT302</b>				
Course Title	<b>PLANT GENETICS</b>				
Type of Course	<b>DSC</b>				
Semester	<b>V</b>				
Academic Level	<b>300 – 399</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	4 Hours	-		4 Hours
Pre-requisites	Students have a knowledge about cytology which is the basic objective of genetics				
Course Summary	Course offers a comprehensive knowledge about the characters and its inheritance. The students gain the knowledge of history of genetics and its advancements.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
<b>I</b>	<b>Heredity and Variation</b>		<b>10</b>
	1	Definition, Mendelian genetics-An account of Mendelian experiments and selection of characters, Reason behind Mendel's success, Monohybrid and Dihybrid crosses, Back cross- test cross, Mendelian ratios, Mendelian principles and laws- Principle of unit characters, Principle of dominance, Law of segregation and Law of independent assortment. <b>Learning Activity:-</b> Work out the problems related with monohybrid and dihybrid crosses and Test crosses.	
<b>II</b>	<b>Modified Mendelian ratios</b>		<b>15</b>
	2	Incomplete Dominance- Flower colour in <i>Mirabilis jalapa</i> ; co-dominance- MN blood group in man; gene interactions (non-allelic interactions)- Complementary gene action- flower colour in <i>Lathyrus odoratus</i> ; Epistasis- dominant (fruit colour in <i>Cucurbita pepo</i> ) and recessive (coat colour in mice); Collaboratory gene action- comb patterns in domestic fowls; Duplicate gene action- seed shape in <i>Capsella bursa pastoris</i> ; Duplicate gene with cumulative effect- fruit shape in <i>Cucurbita pepo</i> , Inhibitory gene action- leaf colour in <i>Oryza sativa</i> . <b>Learning Activity:-</b> Work out the problems related with different allelic and non-allelic interactions.	
	3	Multiple allelism- ABO blood group in man, self-sterility in <i>Nicotiana tobacco</i> ; Rh factor.	

	4	Quantitative characters- General characteristics, polygenic inheritance- Skin colour in man, ear size in <i>Zea mays</i> .	
III	<b>Role of chromosomes</b>		10
	5	Chromosome theory of inheritance; Coupling and repulsion; Linkage- significance and types (complete and incomplete); Cis and trans heterozygote; Morgan's theory of linkage; crossing over- mechanism, types and significance. Interference and coincidence, Crossover value; Gene mapping; two point and three point test crosses. <b>Learning Activity:-</b> Work out the problems related with two point and three point test crosses	
IV	<b>Sex determination and inheritance patterns</b>		10
	6	Sex determination in organisms- Chromosome basis of sex determination (XX-XY, XX-XO types), sex determination in higher plants- <i>Melandrium album</i> ; Genic balance theory.	
	7	Sex linked inheritance- X linked (Haemophilia and eye colour in <i>Drosophila</i> ), Y linked (Hypertrichosis pinnae) and XY linked (Bobbed bristles in <i>Drosophila</i> )	
	8	Extra chromosomal inheritance- Maternal effect, Plastid inheritance in <i>Mirabilis jalapa</i> , inheritance of kappa particles in <i>Paramecium</i> .	
V	<b>Applying genetics: Analysis, disorders, and population genetics</b>		15
	9	Karyotype and Pedigree analysis; Inborn errors of metabolism- alkaptonuria, phenylketonuria and albinism; Syndromes- Klinefelter's syndrome, Turner's syndrome and Down syndrome. Population genetics- systems of mating and their genetic effect; Hardy Weinberg law and its applications; threatening of gene frequency- migration, mutation, genetic drift, genetic polymorphism and selection.	

## Suggested Reading

1. Snustad, P.D and Simmons, M.J. (2012) Principles of genetics VI<sup>th</sup> Edn. John Wiley and Sons, Inc.
2. William, S. Klug. Michael, R. Cummings. Charlotte, A. Spencer and Michael, A. Palladino. (2012) Concepts of genetics. Pearson Education, Inc.
3. Gardner. Simmons, M.J and Snustad, P.D. (2006) Principles of Genetics, John Willey and Sons.
4. Strickberger, M.W. (1985) Genetics. Mac Millan India, New Delhi.
5. Goodenough, U. (1984) Genetics. Holt Saunders, New York.
6. Gupta, P.K. (2022) Genetics. Rastogi publications, ISBN: 9788193775707
7. Robert J Brooker. Concepts of Genetics. ISBN13:9781260709629
8. Verma, P.S and Agarwal, V.K. (2005) Cell biology, genetics, molecular biology, evolution and ecology. Chand Publications.

## Weblink

1. <https://learn.genetics.utah.edu/content/basics/>
2. <https://education.nationalgeographic.org/resource/resource-library-cell-biology>

## Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students Recognize and understand the basic concepts of genetics, Mendelian experiments and conclusions.	R, U	PSO-2
CO-2	Learn about the various allelic and non-allelic interactions.	R, U	
CO-3	Compare the qualitative and quantitative characters and their Inheritance.	U, An, E	
CO-4	Develop skills in students to integrate the heredity and variation with chromosomes.	U, An,	PSO-4
CO-5	Learn about the sex determination in organisms, inheritance of Body characters through sex chromosomes and cytoplasm.	R, U, An	

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Plant Genetics**

**Credits: 4:0:0 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	2	R, U	F, C	L,T	
2	2		R, U	F, C	L,T	
3	3		U, An, E	F, C	L,T	
4	4	4	U, An,	F, C	L,T	
5	5		R, U, An	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3		✓	✓	✓
CO 4	✓	✓		✓
CO 5		✓	✓	✓



## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK6DSCBOT301</b>				
Course Title	<b>PLANT PHYSIOLOGY</b>				
Type of Course	<b>DSC</b>				
Semester	<b>VI</b>				
Academic Level	<b>300 – 399</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	UK5DSCBOT303				
Course Summary	The course, plant physiology explores all the vital activities of the plant kingdom which include photosynthesis, respiration, nutrient assimilation, hormone action, and stress responses. This integrated approach prepares students for advanced studies and research in plant sciences, with applications in agriculture, horticulture, environmental conservation, and biotechnology.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
<b>I</b>	<b>Water absorption and mineral nutrition</b>		<b>07</b>
	1	Mechanism of water absorption: Physical forces- Imbibition, diffusion, and osmosis; water potential; Active absorption: Osmotic and non-osmotic theory; Passive absorption; Ascent of sap: Root pressure theory, Cohesion of water molecule and transpiration pull theory.	
	2	Transpiration- Types, Mechanism: opening and closing of stomata: Starch - sugar interconversion theory, potassium ion transport mechanism, the role of ABA, factors affecting transpiration and anti-transpirants.	
	3	Essential elements: Macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, passive absorption: Ion exchange, Donnan equilibrium and Active: Carrier -concept, cytochrome pump theory	
<b>II</b>	<b>Carbon Assimilation</b>		<b>07</b>
	4	Photosynthesis: Photosynthetic Pigments, Solar spectrum- action and absorption spectra, Red drop, Emerson enhancement effect. Photosystem I and II-Photolysis of water, Water Oxidising clock-Hill reaction, Cyclic and non-cyclic photophosphorylation, Electron	



		transport, Q cycle and mechanism of ATP synthesis. Rubisco, Carbon assimilation: Calvin cycle, Hatch Slack Pathway, CAM pathway and Photorespiration. Bacterial photosynthesis and chemosynthesis (Brief account only). Factors affecting photosynthesis - Law of limiting factor.	
III	<b>Transport and Break down of Molecules</b>		08
	5	Phloem transport- Composition of phloem sap, Girdling experiment; Pressure flow model; Phloem loading and unloading. P-Proteins.	
	6	Respiration: Significance and general equation, respiratory substrates. Glycolysis- anaerobic respiration (Alcoholic and lactic acid fermentation) Krebs' cycle-Electron transport system and Oxidative phosphorylation (ATP Synthesis): Glyoxylate cycle and its significance, Energy relation of respiration, R.Q, and its significance. Factors affecting respiration.	
IV	<b>Physiological Response of Plants</b>		08
	7	Plant Growth: Definition, different phases of growth, Sigmoid curve, Measurement of growth; Growth regulators: Physiological effect and practical applications - Auxins, Gibberellins, Cytokinins, Absciscic acid, and Ethylene (Brief account); Senescence, Programmed Cell Death and abscission.	
	8	Biological clock, Circadian Rhythms, and Stress Physiology: Abiotic (water and salt)- Biotic (pathogens), Phytoalexins.	
	9	Physiology of flowering: Phytochromes, Photoperiodism, and Vernalization (brief account)	
	10	Germination and dormancy of seeds (Brief account)	
V	<b>Plant Physiology for Human Beings</b>		15
	11	Nitrogen metabolism: Source of nitrogen - Biological nitrogen fixation- symbiotic and symbiotic. Nitrogen fixation by blue-green algae - rotation of crops. Nif genes – Leghaemoglobin, Nitrate, and ammonia assimilation.	
	12	Plant movements, Physiology of Fruit ripening	
	13	Growth Regulators and Biostimulants: Upcoming Opportunities.	

<b>Practicals</b>		
	<p><b>Study of the following experiments (1-7) and set up any of the experiments by students.</b></p> <ol style="list-style-type: none"> <li>Demonstration of osmosis using Osmoscope. (Thistle funnel/papaya petiole experiment)</li> <li>Incipient Plasmolysis using Rheo peel.</li> <li>Determination of water absorption and transpiration ratio.</li> <li>Calculation of the stomatal index and comparison of the stomatal frequency of any three mesophytes.</li> <li>Observe and record deficiency symptoms of plants grown in nutrient-deficient solutions (N, P, Mg, K) over a period of time.</li> </ol>	30

	6. Observe and record the effect of growth regulators (Auxin/Cytokinin/Gibberlin) on germinating seedlings. 7. Measurement of transpiration rate using Ganong's potometer 8. Demonstration of Oxygen evolution during Photosynthesis (Hydrilla Experiment). 9. Demonstration of the evolution of CO <sub>2</sub> during aerobic respiration by conical flask method. 10. Measurement of photosynthesis using Wilmott's bubbler under different light conditions. 11. Alcoholic fermentation using Kuhn's fermentation vessel.	
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## Suggested Readings

1. Devlin R M & Witham F H (1986). Plant Physiology 4th Edition, C B S publishers.
2. Dey & Harborne (2016). Plant Biochemistry, Academic Press
3. Inam A, Sahay S, Akhtar A (2016). Experiments in Plant Physiology, Biochemistry and Ecology, Jaya Publishing House, N Delhi
4. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
5. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

## References

1. Kochhar P. L. & Krishnamoorthy H. N. (1964). Plant Physiology. Atmaram & Sons-Delhi, Lucknow
2. Kumar & Purohit (1996). Plant Physiology - Fundamentals and Applications Agrobotanical Publications
3. Malik C. P. & Srivastava A. K. (2005). Textbook of Plant Physiology, Kalyani Publishers- New Delhi.
4. Noggle G R & Fritz G J (1983). Introductory Plant physiology 2nd Edition, Prentice Hall of India.
5. Pandey S.N. & Sinha B. K. (1996) Plant physiology 3rd Edition, Vikas publishing

## Weblink

1. <https://www.vedantu.com/biology/plant-physiology>
2. <https://www.lifeasible.com/custom-solutions/plant/analytical-services/plant-physiology-analysis/>
3. <https://learn.careers360.com/biology/plant-physiology-chapter/>

## Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will gain a comprehensive understanding of the physiological processes and pathways that govern	R,U	PSO-1,2

	the functioning of living organisms.		
CO-2	Students will develop the ability to design, conduct, and analyze experiments in physiology, using modern laboratory techniques and instrumentation.	R, U	PSO-3,4
CO-3	Students will apply their knowledge of physiology to understand the pathophysiological basis of diseases.	Ap, An,E	
CO-4	Students will understand of the physiological processes and pathways that govern the functioning of living organisms.	Ap, An,E	PSO-4,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Plant Physiology**

**Credits: 3:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	R,U	F, C	L	
2	2	3,4	R, U	F, C	L	
3	3		Ap, An,E	F, C	L	
4	4	4,6	Ap, An,E	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

#### **Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

#### **Mapping of COs to Assessment Rubrics :**

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓



## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK7DSCBOT304</b>				
Course Title	<b>BIODIVERSITY AND CONSERVATION</b>				
Type of Course	<b>DSC (For Minors)</b>				
Semester	<b>VII</b>				
Academic Level	<b>300 - 399</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	Students from any stream who had an immense interest in environment protection and conservation of biodiversity				
Course Summary	The course enables the students to understand the significance of biodiversity conservation in the current scenario and to analyse the threats in the depletion of biodiversity. It provides the skill to evaluate the measures for conserving the biodiversity for ecosystem balance. Also it allows to understand the concepts and acquire the skills in using geospatial techniques like remote sensing and GIS in the assessment of biodiversity to interpret the biodiversity status of a region.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
I	Principles and concepts in Biodiversity Conservation		08
	1	Biodiversity – definition, Types of biodiversity, Measuring biodiversity, Mapping of biodiversity - Extremes of low and high diversity, Geospatial techniques in biodiversity assessment – Remote sensing & GIS – Principles and applications (Brief account).	
	2	Mega biodiversity centres, Biodiversity hotspots. Threats to biodiversity - Human impacts & invasive species. Species extinctions.	
II	Conservation strategies		07
	3	Conservation of biodiversity- General measures for conservation and sustainable use.	
	4	Conservation strategies: In-situ conservation -Ex-situ conservation, eco-restoration,-Sustainable use of components of biological diversity	
	5	Biosphere reserves, wildlife sanctuaries, national parks in India (with special reference to Kerala), Wetlands – Ramsar sites, <i>Myristica</i> swamp, management and protection.	
III	Green resources for sustainable utilization of biodiversity		08
	6	Plants as a source of renewable energy.	

	7	Agriculture and conservation of resources – nitrification inhibitors, windmills for irrigation, solar energy for drawing groundwater, biogas for cooking, and slurry left to be used as fertilizers.	
	8	Urbanization and conservation – planning for environmentally compatible human settlements and strategy for sustainable industrial development.	
<b>IV</b>	<b>Environmental awareness and the role of organizations</b>		<b>07</b>
	9	Environmental awareness - Role of governments and NGOs, media, World Environment Day, WWF, UNEP, IBP	
	19	Wild life preservation act (1972), Indian forest conservation act (1980), Environment protection act (1986), Biodiversity act (2002) and rules (2004).	
	11	Role of organizations in biodiversity conservation – NBPGR, IARI, CIMAP, JNTBGRI, KFRI, KSBB- PBR (People's biodiversity register). Convention on biological diversity (CBD), Role of IUCN - Red data book (color codes), Threatened categories of plants, MAB, iCUBE (International Consortium of Universities for the Study of Biodiversity and Environment).	
<b>V</b>	<b>Trends of conservation and biodiversity</b>		<b>15</b>
	12	Sustainable goals of UNEP, Green technologies for the conservation of biodiversity. CITES, EIA.	
	13	Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves)- Ecotourism – principles, types, advantages, examples.	
	14	Urbanization and Conservation – Planning for environmentally- compatible human settlements- afforestation – social forestry, agroforestry.	
	15	Conservation and energy – Causes of energy crisis, Conventional and Non-conventional energy sources.	

<b>Practicals</b>		
	<ol style="list-style-type: none"> <li>Field trip to ecologically significant sites (National parks/ Mangrove site/ ramsar site/ <i>Myristica</i> swamp) and submit a detailed report with geotagged photos for evaluation.</li> <li>Plant and maintain at least three plants of IUCN category in the campus.</li> <li>Participation in community awareness programmes in the conservation of biodiversity in the locality and create an audio-visual document of the same.</li> </ol>	<b>30</b>

### Suggested Readings

1. Sher A A & Primack RB. 2019. An introduction to Conservation Biology. Oxford University Press, Newyork. Wiley and Sons, New York.
2. Shobh Nath Singh 2015. Non-Conventional Energy Resources. 1st Edition. Pearson.
3. Mahendra Chaturvedi 2010. Biodiversity and Conservation, 1st Edition D.P.S. Publishing House

4. Van Dyke F. 2008. Conservation Biology, foundation, concept, applications, Springer.
5. Hunter ML Jr. and JP Gibbs. 2007. Fundamentals of conservation biology, 3rd edition. Blackwell Publishing, Oxford, United Kingdom, 497pp.
6. MacDonald & Katrina Service. 2007. Key Topics in Conservation Biology, Blackwell Publishing.
7. Bharucha & Jayalaxmi Rai (2002) The Biodiversity of India. Erach Grantha Corporation.
8. Andrew S Pullin. 2002. Conservation Biology, Cambridge University Press.
9. Fiedler PI & Kareiva PM. 1998. Conservation Biology for the coming decade. Chapman and Hall.

## Weblink

1. <https://www.britannica.com/science/ecology>
2. <https://plato.stanford.edu/entries/ecology>

## Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the significance of biodiversity conservation in the current scenario.	U	PSO -1,4
CO-2	Analyse the threats in the depletion of biodiversity.	An	PSO -1,4
CO-3	Evaluate the measures for protection of biodiversity and conserving the biodiversity of our region for ecosystem balance.	E	PSO -1
CO-4	Understand the concepts and acquire the skills in using geospatial techniques like remote sensing and GIS in the assessment of biodiversity.	U, Ap	PSO -5,2
CO-5	Interpret the biodiversity status of a region and suggest the remedial measures for protection of the same.	An, Ap	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Biodiversity and Conservation**

**Credits: 3:0:1 (Lecture:Tutorial: Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,4	U	C		P

2	2	1,4	An	F	L	
3	3	1	E	P	L	
4	4	5,2	U, Ap	P		P
5	5	2	An, Ap	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

#### **Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

#### **Mapping of COs to Assessment Rubrics :**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓	✓	✓

# **Discipline Specific Elective Courses**





## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK3DSEBOT201</b>				
Course Title	<b>ETHNOBOTANY AND IPR</b>				
Type of Course	<b>DSE</b>				
Semester	<b>III</b>				
Academic Level	<b>200 - 299</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	04 Hours	-		04 Hours
Pre-requisites	No Pre-requisites				
Course Summary	Appreciate the need to conserve the floristic and cultural diversity of the region. Rescue and document Ethnobotanicals for sustainable use of plant resources. Understand the need for development of new drugs for the safe and more rational use of herbal preparations. Recognition of intellectual property rights and its benefit to people and society who share their knowledge and wisdom.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
<b>I</b>		<b>Ethnobotany</b>	<b>10</b>
	1	Ethnobotany: Introduction, concept, scope, and objectives. Ethnic groups in Kerala - Kurichiya, Cholanaikan, Kani, Ulladan.	
	2	Traditional and indigenous knowledge and its importance. Traditional systems of medicine in India- Ayurveda, Siddha, Unani & Homeopathy. Role of ethnomedicine and its scope in modern times.	
	3	Role of Ethnobotany in conservation and sustainable development. Plants used by ethnic groups as food, medicines beverages, fodder, fiber, resins, oils, and fragrances ( two plants from each category).	
	4	NTFP (Non-Timber Forest Produces), animal products, minerals, and artifacts, used by Tribal and Folk Communities of Kerala.	
<b>II</b>		<b>Methods and Techniques used in Ethnobotany</b>	<b>10</b>
	5	Ethnobotanical data collection- Audio, Video recording, Photographs, Interview-Methods, Questionnaire, and Datasheet, Consent forms, Field book and Herbarium preparation, Preparation of Data Sheet and Data Base (Excel/MS Access); Peoples Biodiversity Register (PBR).	
	6	Centres of Ethnobotanical studies in India, AICRP E-All India Coordinated Research Project on Ethnobiology,	

	7	FRLHT- Foundation for the Revitalisation of Local Health Traditions. Contributions of AICRPE and FRLHT to ethnobiology of India.	
<b>III</b>	<b>Introduction to Intellectual Property Rights</b>		<b>10</b>
	8	Origin Development and Objectives and its different forms. Farmer's Rights, Animal and Plant breeders' rights.	
	9	Intellectual Property Rights – Types- Patents, Copyright, Trademark, Industrial Design, Geographical Indications, Sui generis rights, Protection of Plant Varieties and Farmer's Rights, Indigenous Traditional Knowledge. Patent system in India.	
<b>IV</b>	<b>Procedures of Patenting</b>		<b>15</b>
	10	Basic requirements of patentability, Discovery and Invention, patentable subject matters, novelty, utility, and the Public Domain; Product and process.	
	11	Patent Laws in Indian and International Perspective. Indian Patent Act 1970 (Patent Amendment Acts-1999, 2002 and 2005).	
	12	Patent filing procedures: Time frame and cost; Status of the patent applications filed; Precautions while patenting–disclosure/non-disclosure	
	13	Financial assistance for patenting-introduction to existing schemes, Patent licensing, and agreement, Patent infringement-meaning, scope, litigation, Patent Case study: Basmati Case, Neem Controversy, Turmeric Case	
<b>V</b>	<b>International Agreements and Treaties Related to IPR</b>		<b>15</b>
	14	General Agreement on Trade and Tariff (GATT), Trade-Related Aspects of Intellectual Property Rights (TRIPS)	
	15	WTO agreement- Indian Position on WTO Regime, Establishment of WIPO – Mission and Activities, Budapest treaty	

## Suggested Reading

1. Cunningham, A. B. 2001. Applied Ethnobotany. Earthscan Publishers Ltd. London & Sterling,
2. Jain, S. K. 1995. A manual of Ethnobotany. Scientific Publishers, Jodhpur.
3. Acharya, N.K. 2001. Text Book on Intellectual Property Rights: (Copyright, Trademark, Patent Design, Geographical Indications, Protection of New Plant Varieties & Farmers Rights and Protection of Biodiversity
4. Faulks, P.J. (1958). An introduction to Ethnobotany, Moredale Publ. London.
5. Jain, S. K. 1981. Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi

## References

1. Elizabeth Verkey. 2015. Intellectual Property law and Practice (Eastern Book Company)
2. Taraporevala V J 2013. Law of Intellectual Property (2nd Edition) Thomson Reuters,
3. Irini A. Stamatoudi & Paul L.C.. Torremans. 2000. Copyright in the New Digital

### **Course Outcomes**

<b>No.</b>	<b>Upon completion of the course the graduate will be able to</b>	<b>Cognitive Level</b>	<b>PSO addressed</b>
CO-1	Students will identify ethnobotanically significant plants during ethnobotanical field surveys.	R	PSO-1
CO-2	Students recognize regionally and locally important plants and practice field collection and identification methods.	R, Ap	PSO-8
CO-3	Students will explore the general principles of ethnobotany, including its history and importance in traditional and modern culture.	U	PSO-2
CO-4	Students will appreciate the need to conserve floristic and cultural diversity of the region.	An	PSO-5
CO-5	Students will understand and recognise the concept of IPR and different subject matter of IPR like trademark, copyright, trade secret, Patent and geographical indication. and its benefit to people and society who share their knowledge and wisdom.	R, U	PSO-4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Ethnobotany & IPR**

**Credits: 4:0:0 (Lecture:Tutorial:Practical:)**

<b>CO No.</b>	<b>CO</b>	<b>PO/PSO</b>	<b>Cognitive Level</b>	<b>Knowledge Category</b>	<b>Lecture (L)/Tutorial (T)</b>	<b>Practical (P)</b>
CO-1	1	1	R,U	F, C	L	
CO-2	2	8	R, Ap	C	L	
CO-3	3	2	U	F, C, M	L	
CO-4	4	5	An	F, C	L	
CO-5	5	4	R, U	F, C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

#### **Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓			✓
CO 5	✓			✓



## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK5DSEBOT301</b>				
Course Title	<b>ANALYTICAL TECHNIQUES IN PLANT SCIENCE</b>				
Type of Course	<b>DSE</b>				
Semester	<b>V</b>				
Academic Level	<b>300 - 399</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	Basics about physical principals and biomolecules				
Course Summary	This is a course designed to develop various skills in the analytical techniques used in plant science. Students will get a basic understanding of the principles and applications and practical knowledge in a few of the methods listed. The technical skill intended may be useful for doing the research project prescribed for Semester VI and VII or for developing a research career or as a prerequisite for industry related jobs.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
<b>I</b>	<b>Imaging and related techniques</b>		<b>05</b>
	1	Principles of microscopy- Light microscopy- Fluorescence microscopy; Confocal microscopy- SEM and TEM -Transmission and Scanning electron microscopy – sample preparation for electron microscopy.	
<b>II</b>	<b>Cell Fractionation and Chromatography</b>		<b>09</b>
	2	Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl <sub>2</sub> gradient analytical centrifugation, ultracentrifugation.	
	3	Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion exchange chromatography; Affinity chromatography- HPTLC, Gas chromatography, GCMS-Head space analysis, HPLC, LC-MS.	
<b>III</b>	<b>Spectrometry</b>		<b>10</b>
	4	Introduction-Principle- application in biological research Electromagnetic spectrum- Colorimetry-UV/visible spectrophotometry-fluorescence spectroscopy, IR spectroscopy, NMR, X-ray diffraction, and Circular dichroism/Optical Rotatory Dispersion.	
<b>IV</b>	<b>Electrophoresis</b>		<b>06</b>
	5	Vertical and horizontal, paper electrophoresis, capillary electrophoresis- SDS-PAGE, 2D gel electrophoresis, pulsed-field gel electrophoresis, and isoelectric focusing. UV-trans illuminator, gel documentation system.	

V	Elemental Analysis	
	6	Flame photometry, Atomic emission spectroscopy, Atomic absorption spectroscopy, X-ray fluorescence spectroscopy, Energy dispersive x-ray spectroscopy.

Practicals		
	1. Pigment separation using TLC/Paper chromatography/Column chromatography 2. Spectrophotometric quantification of Chlorophyll pigment. 3. Agarose gel electrophoresis of DNA and UV detection. (Demonstration) 4. FTIR-Spectral analysis of any plant sample. (Demonstration) 5. SDS-PAGE (Demonstration) 6. Visit to a research lab and submit a report.	30

### Suggested Readings

1. Daniel M. (2011). Basic Biophysics for Biologists. CBS Publishers, New Delhi.
2. David Sheehan (2009) Physical Biochemistry-Principles and Applications. Wiley- Blackwell.
3. Ian Campbell (2012) Biophysical techniques. Cambridge University Press.
4. Elizabeth M. Slayter and Henry S. Slayter (1992) Light and Electron microscopy. Cambridge University Press
5. Narayanan P (2010) Essentials of Biophysics. New Age International Publishers, New Delhi.
6. Roy RN (1999) A Text Book of Biophysics. New Central Book Agency (P) Ltd., Calcutta.
7. Prakash S. Bisen and Anjana Sharma (2012) Introduction to instrumentation in life sciences. CRC Press.

### Weblink

1. <https://www.vedantu.com/chemistry/electrophoresis-technique-used-for-dna-analysis>
2. <https://www.britannica.com/science/chromatography/Elution-chromatography>
3. [https://chem.libretexts.org/Bookshelves/Analytical\\_Chemistry/Analytical\\_Chemistry\\_2.1\(Harvey\)/10%3A\\_Spectroscopic\\_Method](https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Analytical_Chemistry_2.1(Harvey)/10%3A_Spectroscopic_Method)

### Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the principles of various types of microscopes used in biology and distinguish their application according to the aims of designed experiments.	U, An	PSO-4,6
CO-2	Understand the principle of colorimetry and spectrophotometry and can use the technique for detection and quantification of various biomolecules.	U, Ap	PSO-4,6

CO-3	Understand the principles of fluorescence, IR, NMR and CD and recognises the context where the techniques can be used for analysing different biomolecules	U, An	PSO-4,6
CO-4	Prepare different solutions and buffers used in biology and apply various fractionation techniques for extraction of different biomolecules.	U, Ap	PSO-4,7
CO-5	Understand the principles of precipitation, filtration, dialysis and centrifugation and recognises their usage in the separation of biomolecules.	U, Ap	PSO-6,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course:**

**Credits: 3:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	4,6	U	F,C	L,T	
2	2	4,6	U, Ap	F,C	L,T	P
3.	3	4,6	U	P	L,T	
4.	4	4,7	U	P		P
5.	5	6,7	U, Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2		✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5		✓		✓



## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK6DSEBOT302</b>				
Course Title	<b>PHYTOCHEMISTRY AND DRUG DEVELOPMENT</b>				
Type of Course	<b>DSE</b>				
Semester	<b>VI</b>				
Academic Level	<b>300 - 399</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	Basic knowledge of biology, including cell structure and biomolecules				
Course Summary	The discipline Provides information on different pathways of primary and secondary metabolism in plants and naturally occurring secondary metabolites such as Alkaloids, terpenoids, phenolics, flavonoids, and tannins, that are important in medicinal plants. The chemical structures, natural distribution, biological function, and therapeutic activities of these compounds are used in the pharmaceutical industry for drug discovery and standardization				

### Detailed Syllabus

Module	Unit	Content	Hrs
<b>I</b>	<b>Phytochemistry</b>		<b>10</b>
	1	Introduction- Phytochemicals, Primary and secondary metabolites, sources, classification, and Function (General account only).	
	2	Phytochemicals: Alkaloids, terpenoids, phenolics, flavonoids, and tannins. Role of phytochemicals in the plant defense mechanism.	
	3	Functions of phytochemicals in the living organism - antioxidants, antimicrobial agents, wound healing, antihypertension, stimulation of the immune system, anti-inflammatory functions (brief study only)	
	4	Brief study of basic metabolic pathways and formation of different secondary metabolites through these pathways- Shikimic acid pathway, and Amino acid pathway.	
	5	Biosources - therapeutic uses, and commercial applications of the following secondary metabolites: (brief study only). Alkaloids: Rauwolfia, Belladonna, Opium; Flavonoids: Tea, Ruta Tannins: Catechu, Pterocarpus; Resins: Asafoetida, Myrrh,	
<b>II</b>	<b>Extraction, Separation, and Structural Analysis of Phytochemicals</b>		<b>09</b>
	6	Extraction: Solvent extraction- Polar and non-polar solvents-Cold extraction- Hot extraction (Soxhlet & Clevenger).	
	7	Separation: Chromatography-Paper Chromatography- Thin LayerChromatography-Column Chromatography- High-	



		Performance	
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		Liquid Chromatography (HPLC, GC-MS, LC-MS (Brief account-discuss with a representative graph/data).	
	8	Characterization: Ultraviolet and visible spectrophotometry (UV-Vis), Brief account of Infrared Spectroscopy (IR), Mass Spectrometry (MS), Nuclear Magnetic Resonance spectroscopy (NMR).	
III	<b>Drug Development</b>		06
	9	General introduction to drug discovery research, Examples of few drug discovery in old days and recent times.	
	10	Bioactivity Screening and mechanism of action using various assays: (Brief account of Cell culture assays, Reporter gene assays, Enzyme activity assay).	
IV	<b>Standardization of Phytoformulations</b>		05
	11	Standardization and Quality Control: Isolate, Purify and characterize using various methods. Establish reference standards, validation protocols, and quality control measures for herbal medicines and natural product formulations (WHO guidelines).	
	12	Biotechnological Approaches: Plant Tissue Culture, Genetic Engineering and Bioreactor Systems-cell cultures for the sustainable production of high-value phytochemicals.	
	13	Drug Delivery and Formulation Development: Techniques such as Nanoformulation, Solid dispersion, Complexation, Polymer-based delivery.	
	14	Clinical Evaluation and Translation: Study Protocol Development, Ethical Approval and Regulatory Compliance, Study Implementation and Monitoring, Safety Monitoring and Adverse Event Reporting.	
V	<b>Sustainable Phytochemical Innovation: Case Studies and Practical Applications</b>		15
	15	Case studies of innovative products like Jeevani, Good Manufacturing Practices (GMP) and Intellectual Property Rights (IPR), Market research. Challenges and considerations in large-scale production. Visit a Pharmaceutical Industry or Research Facility. Interaction with industry professionals.	

<b>Practicals</b>		
	<ol style="list-style-type: none"> <li>1. Qualitative test for reducing sugar : Benedict's test. Molisch's test, Lugol's Iodine test.</li> <li>2. Test for proteins : Biuret test. Xanthoprotein test, Translucent Oil drop test, Solubility Test.</li> <li>3. Preparation of buffers. Phosphate, carbonate, Tris HCl.</li> <li>4. Estimation of reducing sugars.</li> <li>5. Extraction and estimation of soluble proteins by Lowry's/ Bradford method.</li> <li>6. Subject any one of the given plant to Soxhlet extraction/ hydrodistillation/Cold extraction -<i>Curcuma longa</i> rhizome powder,</li> </ol>	30

	<i>Piper nigrum</i> fruits powder, <i>Syzygium aromaticum</i> , <i>Cinnamomum malabatrum</i> (avoid the plants which need conservation) 7. Test the presence of the following: Terpenoids/Steroids by Lieberman- Burchard test, Flavonoids by Shinodas test, Coumarins by Borntragers test and Alkaloids by Mayers test or Dragendorfs test 8. Demonstrate the separation of a phytochemical mixture using TLC or Column chromatography.	
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### Suggested readings

1. David L. Nelson and Michael M. Cox (2020)Lehninger Principles of Biochemistry by, 8th Edition).
2. Lubert Stryer (2019) 8th Edition)Biochemistry" by
3. Victor W. Rodwell, David Bender, et al. (2020).Harper's Illustrated Biochemistry.
4. Kurt Hostettmann and Marianne Hostettmann (2016)Textbook of Phytochemistry.
5. Kelsey Springer (2019).Natural Products: Phytochemistry, Botany, and Metabolism of Alkaloids, Phenolics, and Terpenes.
6. Paul M. Dewick (2009).Medicinal Natural Products: A Biosynthetic Approach.

### References

1. Raymond G. Hill (2018).Drug Discovery and Development: Technology in Transition.
2. William Charles Evans (2009).Introduction to Pharmacognosy.
3. James E. Robbers, Marilyn K. Speedie, and Varro E. Tyler.(2005).Handbook of Pharmacognosy and Phytochemistry
4. Mark S. Meskin, Wayne R. Bidlack, et al. (2004).Phytochemicals: Mechanisms of Action.

### Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify important phytochemicals and their applications in human welfare	U	PSO-4
CO-2	Recognize the diverse approaches to healthcare, including classical, modern, and oral/non-codified systems	R, U	PSO-4,6
CO-3	Analyze chromatographic data to separate and identify phytochemical compounds	An	PSO-7,8
CO-4	Evaluate bioactivity screening methods and their mechanisms of action using various assays	E	PSO-8
CO-5	Apply pharmacokinetic and pharmacodynamic tests to assess the behavior of phytochemicals in the body	Ap	PSO-7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Phytochemistry and Drug Discovery**

**Credits: 3:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	4	U	F,C	L.T	
2	2	4,6	R, U	F,C	L.T	
3	3	7,8	An	F,C	L.T	
4	4	8	E	F,C,P		P
5	5	7	Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

#### Assessment Rubrics:

1. Quiz / Assignment/ Quiz/ Discussion / Seminar
2. Midterm Exam
3. Programming Assignments
4. Final Exam

#### Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓		✓



**University of Kerala**

Discipline	<b>BOTANY</b>				
Course Code	<b>UK7DSEBOT402</b>				
Course Title	<b>INDUSTRIAL TISSUE CULTURE</b>				
Type of Course	<b>DSE</b>				
Semester	<b>VII</b>				
Academic Level	<b>400 – 499</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	Students should have basics knowledge about plant biology and tissue culture.				
Course Summary	The course will make the student capable to become an entrepreneur. It deals with the opportunities of plant tissue culture especially ‘micropropagation’ as a business in the Indian context. It addresses areas of how one can start the tissue culture lab – the requirements like infrastructure, steps in micropropagation and problems faced at industrial level operations. It also deals with the certification system for quality assurance, virus indexing, logistics and marketing of tissue cultured plants. Also, the course will give an outline on costing of TC plants, cost benefit analysis and cost reduction measures.				

Module	Unit	Content	Hrs
<b>I</b>		<b>Introduction to plant Tissue culture</b>	<b>06</b>
	1	Tissue culture – as a biotechnological tool – clonal propagation – advantages- organogenesis- Somatic embryogenesis- Synthetic seeds- somaclonal variations.	
	2	History of commercial plant tissue culture in India.	
	3	Major Commercial tissue culture ventures in India and their annual production capacity	
<b>II</b>		<b>Laboratory organization and Instrumentation</b>	<b>06</b>
	4	Model layout of a commercial tissue culture laboratory- Glassware wash area, chemical storage, media preparation, sterilization and media storage room, air showers, air curtains, foot bath, inoculation room, culture room, observation/data collection area.	
	5	Instrumentation: Purpose, maintenance and management of - Laminar air flow cabinet, Electronic balance, Autoclave, Water purification system, pH meter, Orbital shaker, Magnetic stirrer, microscope, Refrigerator, deep freezer, growth chamber, Tools for aseptic operations – forceps, Scalpel holder, surgical blade, Glass bead sterilizer.	
<b>III</b>		<b>Tissue culture media</b>	<b>06</b>

	6	MS media: composition, preparation of stocks- Optimal pH and its significance in media; Plant Growth regulators - role in photomorphogenesis,-Combination of PGR for synergistic action Carbon source: Sucrose – different grades used in commercial labs. Gelling agent: Agar Agar – different grades used in commercial labs; gelrite, Phytigel, and other low-cost alternatives. Additives:– Antioxidants, Organic supplements – Inositol, amino acids, coconut water, yeast extract; Adsorbents: PVP, activated charcoal.	
	7	Preparation of MS Media, Methods of sterilization of equipment and culture media.	
IV	<b>Micropropagation</b>		12
	8	Micropropagation- Stages of Micropropagation. Advantages and applications over conventional propagation.	
	9	Culture Initiation : Explant selection, disease indexing, surface sterilization and explant preparation, and inoculation.	
	10	Shoot multiplication – Multiplication ratio, Duration of multiplication cycles, Necessity of limiting multiplication cycles,	
	11	Rooting and Hardening of TC plants: primary and secondary – Green house – poly house – Shade house- Shade nets – pots for tissue cultured plants – Media for hardening – management practices for tissue cultured plants	
	12	Commercial micropropagation of – Trees – Teak; Crops – Banana, Coccinia; Flower crops – Orchids, Anthuriums	
V	<b>Commercial Operations</b>		15
	13	Commercial Operations – Production planning. Problems in operations – Availability of trained manpower - Training, Efficiency enhancement in aseptic operations. Contamination of cultures affecting supply targets – micro-arthropods mediated contamination, measures to reduce contamination. Quality Control in tissue culture labs.	
	14	Certification system for tissue cultured plants. Virus indexing of tissue cultured plants – Importance - ELISA, PCR based indexing (brief account) with examples.	
	15	Logistics of TC plant distribution – hardening centres – transportation of TC plants – in agar – ex agar – primary and secondary hardened plants.	
	16	Marketing of tissue cultured plants. Farmer's acceptance of tissue culture plants - Lab to land awareness.	
	17	Costing of TC plants. Cost benefit analysis – Cost reduction measures – power, water, Chemicals and other items, Manpower.	

<b>Practicals</b>		
	1. MS Media Preparation and Sterilization. 2. Surface Sterilization, explant preparation, inoculation, and incubation. 3. Micropropagation, multiplication, rooting hardening of any commercially important plants a. Ornamental plants (Orchids/ Anthuriums/ any available sps) OR b. Fruits/ Vegetables (Banana/ Papaya or any other species)	30

	4. Visit to a commercial tissue culture firm and submit a report. 5. Preparation of a project proposal for the establishment of a commercial tissue culture lab	
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## Suggested Readings

1. APAARI (2019) Banana Tissue Culture in India – A Success Story. Asia Pacific Association of Agricultural Research Institutions, Bangkok, Thailand. xvi+43 p.
2. Patil SM, Kumari VBC, Sumana K, Sujay S, Tejaswini M, Shirahatti PS, Ramu R (2021) Sustainable development of plant tissue culture industry: The Indian scenario. Journal of Applied Biology & Biotechnology Vol. 9(2), pp. 18-27.
3. Srivastava DK, Thakur AK, Kumar P (Eds.) (2021) Agricultural Biotechnology: Latest Research and Trends. Springer Nature Singapore Pte Ltd.
4. Prasad S and Pareek LK (eds.)(1996) Impact of Plant Biotechnology in Horticulture. Agro Botanical Publishers (India)
5. Bajaj YPS (ed) (1997) HighTech and Micropropagation (Biotechnology in Agriculture and Forestry Vol. 39) Springer
6. Biotech consortium India limited (2005) Summary report on market survey on tissue cultured plants DBT – Government of India (2006): National certification system for tissue culture raised plants.
7. Dutta G S, Ibaraki Y (Ed.) (2010): Plant Tissue Culture Engineering (Focus on Biotechnology) Springer
8. George E.F., Michael A. Hall, Geert-Jan De Klerk (2007): Plant Propagation by Tissue Culture: Volume 1. The Background. Springer
9. International Atomic Energy Agency (2004) - Low cost options for tissue culture technology in developing countries. Proceedings of a Technical Meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and held in Vienna, 26–30 August 2002
10. Jain SM and Ishii K (ed.) (2003) Micropropagation woody trees and fruits. Kluwer Academic publishers
11. Michael A. Dirr , Charles W. Heuser Jr. (2006) : The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture,
12. Neumann KH, Kumar A, Imani J (2009) Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application (Principles and Practice)) Springer.
13. Razdan MK (2003) Plant Tissue Culture 2nd Ed. Science Publishers Inc, USA
14. Robert N. Trigiano, Dennis J. Gray (Eds.) (2010): Plant Tissue Culture, Development, and Biotechnology, CRC Press

## Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the principles of plant tissue culture - Students will demonstrate knowledge of the basic principles and concepts underlying plant tissue culture, including Media requirements explant selection, and nutrient requirements.	U	PSO-8

CO-2	Perform aseptic techniques - Students will be able to effectively sterilize plant material, culture vessels, and media, and maintain sterile conditions throughout the tissue culture process.	Ap, U	PSO-9
CO-3	The students will be exposed to industrial level operations, analyze problems, and evaluate the reasons for the success and failure of plant tissue culture industries	An	PSO-4
CO-4	The students will analyse the need for certification of tissue-cultured products.	U, An	PSO-7
CO-5	The students will be able to do the costing of tissue culture products and can do a cost-benefit analysis of an industry	Ap, An	PSO-10
CO-6	The course will make the student capable of becoming and entrepreneur	Ap, C	PSO 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Industrial Tissue Culture**

**Credits: 3:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	8	U	F	L	-
2	2	9	Ap, U	FC	L	P
3	3	4	An	M	L	-
4	4	7	U, An	FCM	L	-
5	5	10	Ap, An	CM	L T	-
6	6	4	Ap, C	CM	L T	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam



**Mapping of COs to Assessment Rubrics :**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

# **Multidisciplinary Courses**



## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK2MDCBOT101</b>				
Course Title	<b>PLANTS AND HUMAN WELFARE</b>				
Type of Course	<b>MDC</b>				
Semester	<b>II</b>				
Academic Level	<b>100 - 199</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	03	02 Hours	-	02 Hours	04 Hours
Pre-requisites	Basic understanding of plant biology at the high/secondary school level.				
Course Summary	This course explores the relationship between plants and human society, covering topics such as medicinal plants, food crops, and economic significance, as well as their importance in maintaining biodiversity and ecosystem services.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
<b>I</b>	<b>Plant relation to humans</b>		<b>02</b>
	1	Origin of Cultivated Plants: Vavilov's Concept of Centers of Origin of cultivated crop plants -Introduction, Domestication, the evolution of new crop varieties of rice, wheat, and potato.	
	2	Role of plants: Air purifier (Photosynthesis); plants used in rituals/festivals; pollution removal (Phytoremediation and its types), pollution indicator (lichens), and nutrient source (litter manure).	
<b>II</b>	<b>Food crops</b>		<b>08</b>
	3	Cereals: Wheat & Rice (With special reference to indigenous rice varieties- Pokkali, Navara and Jeerakasala rice) a. Millets: Ragi, Jowar, and Bajra-( Brief account of nutritional importance) b. Legumes: Chick pea, Pigeon pea. c. Vegetable Crops: Cabbage, Brinjal, Carrot. d. Fruits: Apple, Orange. e. Narcotics: Poppy, Cannabis. f. Masticatory: Areca nut, Tobacco.	
	4	<b>Cash crops</b> - Beverages- Tea ( Morphology uses and processing). Natural Rubber - (Morphology, Tapping and processing)	

	5	<b>Plants in Medicine-</b> Plant-based medicinal systems – Ayurveda, Siddha, unani and folk medicine (brief account). <b>Herbal basket:</b> Following plants to be studied for botanical source, part of the plant used, and medicinal uses: <i>Ocimum sanctum</i> , <i>Adhatoda</i> , <i>Ginger</i> , <i>Curcuma longa</i> , <i>Aloe</i> , <i>Andrographis</i> <i>Coleus</i> , <i>Acorus</i> , <i>Boerhavia</i> and <i>Oldenlandia</i> <b>Nature of active principles</b> of <i>Rauwolfia</i> , <i>Cinchona</i> , and <i>Vinca</i> .	
III	<b>Lower plants in Economic Botany</b>		04
	6	Algae- <i>Ulva</i> , <i>Codium</i> Food, <i>Chondrus</i> (Carrageenan- gelling agent) Fungi- <i>Agaricus</i> , <i>Lycoperdon</i> , <i>Morchella</i> . Lichen- <i>Parmelia</i> (spice), <i>Peltigera</i> (food).	
IV	<b>Plants Role in Human Prospects</b>		04
	7	Biofuel from Starchy crops- (Tapioca/Sweet potato)-Starch to sugars, sugar to alcohol and product recovery) Brief description only)	
V	<b>Management of Plant Biodiversity</b>		12
	8	Conservation of Plants in Protected Areas, <i>In situ</i> and <i>Ex-situ</i> Plant Conservation: Principles and practices- Conventional methods and Biotechnological methods. Concept of RET plants, Organizations associated with biodiversity-IUCN, UNEP, UNESCO, WWF, NBPGR, PBR: Biodiversity legislation and conservations, Biodiversity information management and communication.	

Practicals		
	1. Collect and properly preserve the economically used plants or plant products. 2. Study of exotic species- Identification and morphological characteristics. 3. Homestead Biodiversity documentation. 4. Submission of geotagged photos of plants of RET. 5. Identification of common plants used in daily life, including herbs, vegetables, and ornamentals. 6. Visit to local ecosystem to study the plants. 7. Visit to plantation crop research institute.	30

## Suggested Reading

1. Hill A.F (1952) Economic Botany, Tata-Mc-Graw Hill, New Delhi
2. Kochhar S.L.(1998). Economic Botany of Tropics, Macmillan India Publishers. New Delhi
3. Susil Kumar Mukharjee(2004). College Botany Vol-III. New Central Book agency, London
4. Vasanth Kumar P. (2014). Economic Botany. Sonali Publications New Delhi.

## Reference

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
2. Daubenmire, R.F. : Plants & Environment (2nd Edn.,) John Wiley & Sons., New York 22
3. Billings, W.B. (1965): Plants and the Ecosystem Wadsworth Publishing Co., Inc., Belmont.
4. Misra, R. (1968): The Ecology work Book Oxford & INH Publishing Co., Calcutta
5. S.K .Jain1995. Manual of Ethnobotany. Scientific publishers.
6. S. Sundar Rajan-2007. College Botany Vol-V, Part 1:Taxonomy and Economic Botany Himalaya Publishing House.
7. Erach Bharucha, 1998. Environmental Studies for UG Students. Universities Press, New Delhi.

## Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the role and scope of Plant Diversity for human welfare	U	PSO-1,2
CO-2	Apply the methods of conservation of Biodiversity	R, U, Ap	PSO-1,6
CO-3	Understand the role of plants in providing food, medicine and other resources essential for human survival	R,U	PSO-1,2
CO-4	Creates awareness on economic importance of various plant groups	U,C	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Plants and Human welfare.**

**Credits: 2:0:1 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	1		U	F	L	
CO-2	2		R, U, Ap	C	L	P
CO-3	3		R,U	C	L	
CO-4	4		U, C	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓



# **Value Addition Courses**





**University of Kerala**

Discipline	<b>BOTANY</b>				
Course Code	<b>UK4VACBOT203</b>				
Course Title	<b>PHYTONUTRACEUTICALS</b>				
Type of Course	<b>VAC</b>				
Semester	<b>IV</b>				
Academic Level	<b>200-299</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	03	03 Hours	-	-	03 Hours
Pre-requisites	No Pre-requisites				
Course Summary	The course is designed to address the rapidly growing field of nutraceuticals, covering a wide range of topics including their types, mechanisms of action, manufacturing processes, product development, clinical testing, and considerations regarding toxicity. The course will provide insight into additives crucial for enhancing shelf life, aiding processing, and improving sensory appeal within the processed food industry.				

**Detailed Syllabus:**

Module	Unit	Content	Hrs
<b>I</b>		<b>Introduction</b>	<b>09</b>
	1	Introduction to nutraceuticals: Phytochemicals, phytonutrients & Phyto remedies- definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX.	
	2	Plants as food and medicine.- microgreens, Single cell protein, millets, and antioxidants	
	3	Plants yielding nutraceuticals- Vegetables (Yams, carrot & tomato), Fruits (Apple, Banana, Orange & Papaya)	
	4	Medicinal plants ( <i>Aloe vera</i> , <i>Hemidesmus indicus</i> , <i>Moringa oleifera</i> , - <i>Piper</i> , <i>Zingiber</i> , <i>Allium</i> )	
<b>II</b>		<b>Role of Nutraceuticals</b>	<b>09</b>
	5	Concept of angiogenesis and the role of nutraceuticals/functional foods	
	6	Nutraceuticals for cardiovascular diseases, cancer, diabetes, cholesterol management, obesity, joint pain, immune enhancement, age-related muscular degeneration, endurance performance, and mood disorders – compounds and their mechanisms of action, dosage levels, contraindications.	
<b>III</b>		<b>Manufacturing of Nutraceuticals</b>	<b>09</b>

	7	Manufacturing methods of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols, etc. (Brief description only)	
	8	Formulation of functional foods containing nutraceuticals – Stability and analytical issues, labelling issues.	
<b>IV</b>	<b>Clinical testing of Nutraceuticals</b>		<b>09</b>
	9	Clinical testing methods of nutraceuticals and health foods (Brief description only)	
	10	Interactions of prescription drugs and nutraceuticals.	
	11	Adverse effects and toxicity of nutraceuticals.	
	12	Nutrigenomics -an introduction and its relation to nutraceuticals.	
<b>V</b>	<b>Functional ingredients of Nutraceuticals</b>		<b>09</b>
	13	Proteins, starch, and lipids as functional ingredients;	
	14	Isolation, modification, specifications, functional properties	
	15	Applications of food as nutraceuticals.	

### Suggested Readings

1. Branen AL, Davidson PM & Salminen S. 2001. Food Additives. 2nd Ed. Marcel Dekker.
2. Webb GP. 2006. Dietary Supplements and Functional Foods. Blackwell Publ.
3. Gibson GR & William CM. 2000. Functional Foods - Concept to Product.
4. Goldberg I. 1994. Functional Foods: Designer Foods, Pharma Foods
5. Morton ID & Macleod AJ .1990. Food Flavours. Part A, BC. Elsevier.

### References

1. Brigelius-Flohé, J & Joost HG. 2006. Nutritional Genomics: Impact on Health and Disease. Wiley VCH.
2. Cupp J and Tracy TS. 2003. Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press.
3. Losso JN. 2007. Anti-angiogenic Functional and Medicinal Foods. CRC Press.
4. Madhavi DL, Deshpande SS & Salunkhe DK. 1996. Food Antioxidants: Technological, Toxicological and Health Perspective. Marcel Dekker.
5. Neeser JR & German BJ. 2004. Bioprocesses and Biotechnology for Nutraceuticals. Chapman & Hall.
6. Robert EC. 2006. Handbook of Nutraceuticals and Functional Foods. 2nd Ed. Wildman.

### Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	This course will equip students to explain phytonutraceuticals and their use in daily life	R	PSO-1
CO-2	Students can evaluate the dual role of plants as sources of food and medicine.	R, U	PSO-3
CO-3	Students will analyze the role of nutraceuticals in managing various health conditions, including	An, Ap	

	cardiovascular diseases, cancer, diabetes, etc .		
CO-4	Equipping them with the knowledge and skills to navigate this dynamic and growing field in the pursuit of health and wellness	Ap	PSO-4
CO-5	Students will acquire knowledge about the manufacturing processes of selected nutraceuticals, such as lycopene, isoflavonoids, prebiotics, probiotics, glucosamine, and phytosterols.	C	

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Phyto-nutraceuticals**

**Credits: 3:0:0 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1		R, U	F, C	L, T	
2	2	3	An, Ap	F, C	L,T	
3	3		Ap	F, C	L, T	P
4	4	4	C	p	L, T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

#### **Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

#### **Mapping of COs to Assessment Rubrics :**

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓

# **Skill Enhancement Courses**



## University of Kerala

Discipline	<b>BOTANY</b>				
Course Code	<b>UK4SECBOT201</b>				
Course Title	<b>MUSHROOM CULTIVATION</b>				
Type of Course	<b>SEC</b>				
Semester	<b>IV</b>				
Academic Level	<b>200 - 299</b>				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	03	02 Hours	-	02 Hours	04 Hours
Pre-requisites	Basic understanding about structure of fungi.				
Course Summary	This SEC provides detailed tools and techniques about mushroom cultivation, its nutritional profile, various levels of management and its marketing so that students can earn through this acquired knowledge and skill.				

### Detailed Syllabus:

Module	Unit	Content	Hrs
<b>I</b>		<b>Introduction to Mushrooms</b>	<b>03</b>
	1	General characters and morphology of mushrooms	
	2	Scope and significance of mushroom cultivation	
	3	Identification of mushrooms - edible and poisonous.	
	4	Distinguishing characters of different types of Mushrooms such as button, oyster and milky mushrooms.	
<b>II</b>		<b>Nutritional Value of Mushrooms</b>	<b>04</b>
	5	Nutritional profile of mushrooms - Carbohydrates, proteins, amino acids, vitamins, minerals, fats and fibre.	
	6	Health benefits of Mushrooms-anti-tumour, antiviral and antibacterial effect, in therapeutic diet (brief study)	
	7	Common Indian mushrooms.	
<b>III</b>		<b>Cultivation Methods of Mushrooms</b>	<b>07</b>
	8	Pre requisites for Mushroom cultivation.	
	9	Preparation of Spawn - requirements, substrate selection, isolation of pure culture and nutrient media for pure culture. Maintenance and storage of spawn.	
	10	Cultivation of Oyster Mushroom ( <i>Pleurotus spp.</i> ) Specify	
	11	Cultivation of Milky Mushroom ( <i>Calocybe indica</i> )	
<b>IV</b>		<b>Pest and disease Management in Mushroom Culture</b>	<b>04</b>
	12	Common pests and pest management in	
	13	Commonly identified Diseases and its management	
	14	Disease prevention and control measures	
<b>V</b>		<b>Value Addition in Mushroom Culturing</b>	<b>12</b>

	15	Post-harvest processing of mushrooms- refrigeration / instant packing, freeze drying, dehydration, canning	
	16	Value-added products from mushrooms – soup powder, biscuits, chutney powder, pickles.	
	17	Marketing strategies for mushroom products	
	18	Major problems in mushroom cultivation and solutions. self-employment schemes, Government aids	

Practicals			
	1.	Hands-on training on mushroom mother spawn preparation	30
	2.	Hands on training on Bedding and Bagging	
	3.	Training in Oyster mushroom cultivation	
	4.	Visit to a mushroom cultivation unit/house	

### Suggested Readings:

1. Gupta S., Summuna B., Gupta M., Annepu S.K. (2018). Edible Mushrooms: Cultivation, Bioactive Molecules, and Health Benefits. In: Mérillon J M., Ramawat K. (eds) Bioactive Molecules in Food. Reference Series in Phytochemistry. Springer, Cham. [https://doi.org/10.1007/978-3-319-54528-8\\_86-1](https://doi.org/10.1007/978-3-319-54528-8_86-1)
2. John T Fletcher and Richard H. Gaze (2007). Mushroom Pest and Disease Control-A colour Hand Book, CRC PRESS.
3. Kaul T.N. (2002). Biology and conservation of mushrooms. Oxford and IBH publishing co. pvt. Ltd. New Delhi. ISBN 81-204-1513-2.
4. Kratika Sharma (2015). Mushroom: Cultivation and Processing. International Journal of Food Processing Technology, 5:9-12
5. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R. (1991). Oyster Mushroom. Department of Plant Pathology. Tamil Nadu, Agricultural University, Coimbatore.

### References

1. Nita Bhal. (2000). Handbook of Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
2. Pandey R.K, S.K Ghosh, (1996). A Hand Book on Mushroom Cultivation. Emkey publications.
3. Pathak, V.N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
4. Singh DP, Prabha R. (2017). Bioconversion of Agricultural Wastes into High Value Biocompost: A Route to Livelihood Generation for Farmers. Adv Recycling Waste Manag. 2: 1-5.
5. Stamets P and Chilton J. S. (1985). The mushroom cultivator, Richmond publishing company. U.K. ISBN 096-1079-80-0.
6. Tiwari Pankaj Kapoor, S.C. (1998). Mushroom cultivation. Mittal Publication, New Delhi.
7. Tripathy D.P. (2005). Mushroom cultivation. Oxford and IBH publishing co. pvt.Ltd.New Delhi. ISBN 8120416449

## **Course Outcomes**

<b>No.</b>	<b>Upon completion of the course the graduate will be able to</b>	<b>Cognitive Level</b>	<b>PSO addressed</b>
CO-1	Differentiate among various mushrooms such as edible, poisonous etc.	U	PSO-1, 7
CO-2	Evaluate nutritional content of different mushrooms	An	PSO-1, 9
CO-3	Categories various methods for mushroom culture	Ap	PSO-11
CO-4	Examine various pest and disease that attacks mushrooms	An	PSO-9
CO-5	Formulate a project proposal for large scale production of Mushrooms	C	PSO-11

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

**Name of the Course: Mushroom Cultivation**

**Credits: 2:0:1 (Lecture:Tutorial:Practical)**

<b>CO No.</b>	<b>CO</b>	<b>PO/PSO</b>	<b>Cognitive Level</b>	<b>Knowledge Category</b>	<b>Lecture (L)/Tutorial (T)</b>	<b>Practical (P)</b>
CO-1	1	PSO-1	U	F, C	L	
CO-2	2	PSO-1	An	F,C	L	
CO-3	3	PSO-12	Ap	P	L	P
CO-4	4	PSO-9	An	F, C	L	P
CO-5	5	PSO-13	C	P	T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

### **Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4				✓
CO 5		✓		✓



