UNIVERSITY OF KERALA

THIRUVANANTHAPURAM

FOUR YEAR UNDERGRADUATE PROGRAMME SYLLABUS

UoK - FYUGP

(2024 Admission Onwards)

Faculty:	:	**Science**
BoS:	:	**Botany**
Subject:	:	**Botany**

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 19th to 23th 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 1st to 2nd and 9th 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 16th to 18th 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

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

Panel of Experts for Scrutiny Process

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

Experts participated in syllabus restructuring (Other than BoS)

Sl. No.	Name	Official Address
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 JoseA 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	**Critical thinking** ➢ analyze information objectively and make a reasoned judgment ➢ draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions ➢ identify logical flaws in the arguments of others ➢ evaluate data, facts, observable phenomena, and research findings to draw valid and relevant results that are domain-specific
PO-2	**Complex problem-solving** ➢ solve different kinds of problems in familiar and no-familiar contexts and apply the learning to real-life situations ➢ analyze a problem, generate and implement a solution and to assess the success of the plan

	➢ understand how the solution will affect both the people involved and the surrounding environment
PO-3	**Creativity** ➢ produce or develop original work, theories and techniques ➢ think in multiple ways for making connections between seemingly unrelated concepts or phenomena ➢ add a unique perspective or improve existing ideas or solutions ➢ generate, develop and express original ideas that are useful or have values
PO-4	**Communication skills** ➢ convey or share ideas or feelings effectively ➢ use words in delivering the intended message with utmost clarity ➢ engage the audience effectively ➢ be a good listener who are able to understand, respond and empathize with the speaker ➢ confidently share views and express himself/herself
PO-5	**Leadership qualities** ➢ work effectively and lead respectfully with diverse teams ➢ build a team working towards a common goal ➢ motivate a group of people and make them achieve the best possible solution. ➢ help and support others in their difficult times to tide over the adverse situations with courage
PO-6	**Learning 'how to learn' skills** ➢ 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 ➢ work independently, identify appropriate resources required for further learning ➢ acquire organizational skills and time management to set self-defined goals and targets with timelines ➢ inculcate a healthy attitude to be a lifelong learner
PO-7	**Digital and technological skills** ➢ use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources ➢ use appropriate software for analysis of data ➢ understand the pitfalls in the digital world and keep safe from them
PO-8	**Value inculcation**

	➢ 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 ➢ formulate a position/argument about an ethical issue from multiple perspectives ➢ 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 ➢ adopt an objective, unbiased, and truthful actions in all aspects of work

Programme Specific Outcomes (PSO)

No.	Upon completion of the programme the graduate will be able to	PO No.
PSO-1	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
PSO-2	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
PSO-3	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
PSO-4	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
PSO-5	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.	
PSO-6	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
PSO-7	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
PSO-8	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
PSO-9	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
PSO-10	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
PSO-11	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

03	UK4SECBOT203	Basics of Plant Tissue Culture	2	1	257
5th Semester					
01	UK5SECBOT301	Vegetable Gardening	3	0	260
02	UK5SECBOT302	Biofertilizers and Biopesticides	3	0	263
03	UK5SECBOT303	Urban Gardening and Landscaping	3	0	266
6th Semester					
01	UK6SECBOT301	Herbal Cosmetics	3	0	269
02	UK6SECBOT302	Indoor Gardening and Terrarium Techniques	3	0	272
03	UK6SECBOT303	Hydroponics and Aquaponics	3	0	275

INTERNSHIP AND PROJECTS				
01	UK8RPHBOT401	Research Project	Any One	12
02	UK8CIPBOT401	Capstone Internship Project		12
03	UK4INTBOT201	Summer Internship		02

List of Compulsory DSC Courses

Sl. No.	Course Code	Course Title	Semester	Credits	
				T	P
01	UK1DSCBOT101	Plant World I	I	3	1
02	UK2DSCBOT102	Plant World II	II	3	1
03	UK3DSCBOT201	Histology and Reproductive Botany	III	3	1
04	UK4DSCBOT201	Lower Cryptogams, Phytopathology and Microbiology	IV	3	1
05	UK4DSCBOT202	Archegoniates and Paleobotany	IV	3	1
06	UK5DSCBOT301	Angiosperm Morphology and Plant Systematics	V	3	1
07	UK5DSCBOT302	Plant Genetics	V	4	0
08	UK5DSCBOT303	Cell biology and Evolutionary Biology	V	4	0
09	UK6DSCBOT301	Plant Physiology	VI	3	1
10	UK6DSCBOT302	Environmental Science and Conservation Biology	VI	4	0
11	UK6DSCBOT303	Biochemistry and Molecular Biology	VI	4	0

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
02	UK1DSCBOT102	Introductory Botany		DSC	3	1	3	2	75
03	UK1DSCBOT103	Fundamentals and Scope of Botany		DSC	3	1	3	2	75
04	UK1DSCBOT104	Plants in Daily Life		DSC	3	1	3	2	75
05	UK1DSCBOT105	Morphology of Flowering Plants		DSC	3	1	3	2	75
06	UK1MDCBOT101	Landscaping and Gardening	Any One	MDC	3	0	3	0	45
07	UK1MDCBOT102	Floriculture		MDC	3	0	3	0	45
08	UK1MDCBOT103	Botany in Forensic Science		MDC	2	1	2	2	60

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
02	UK2DSCBOT102	Anatomy of Flowering Plants		DSC	3	1	3	2	75
03	UK2DSCBOT103	Reproductive Botany and Microtechnique		DSC	3	1	3	2	75
04	UK2DSCBOT104	Phycology, Mycology and Plant Pathology		DSC	3	1	3	2	75
05	UK2DSCBOT105	Biomolecules		DSC	3	1	3	2	75
06	UK2MDCBOT101	Plants and Human Welfare.	Any One	MDC	2	1	2	2	60
07	UK2MDCBOT102	Ecotourism		MDC	3	0	3	0	45
08	UK2MDCBOT103	Organic Farming		MDC	3	0	3	0	45

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
02	UK3DSCBOT202	Floral Morphology, Systematic Botany and Ethnobotany		DSC	3	1	3	2	75
03	UK3DSCBOT203	Bryophytes, Pteridophytes and Gymnosperms		DSC	3	1	3	2	75
04	UK3DSCBOT204	Environmental Sciences		DSC	3	1	3	2	75
05	UK3DSCBOT205	Biophysics and Biostatistics		DSC	3	1	3	2	75
06	UK3DSEBOT201	Ethnobotany and IPR	Any One	DSE	4	0	4	0	60
07	UK3DSEBOT202	Forestry		DSE	4	0	4	0	60
08	UK3VACBOT201	Green initiatives for Sustainability	Any One	VAC	3	0	3	0	45
09	UK3VACBOT202	Bioethics and IPR		VAC	3	0	3	0	45

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
02	UK4DSCBOT202	Archegoniates and Paleobotany		DSC	3	1	3	2	75
03	UK4DSEBOT201	Herbal Technology	Any One	DSE	3	1	3	2	75
04	UK4DSEBOT202	Food Science and Quality Control		DSE	3	1	3	2	75
05	UK4VACBOT201	Entrepreneurship in Plant Science	Any Two	VAC	3	0	3	0	45
06	UK4VACBOT202	Biodegradable Waste Management.		VAC	3	0	3	0	45
07	UK4VACBOT203	Phytonutraceuticals		VAC	3	0	3	0	45
08	UK4VACBOT204	Disaster Management		VAC	3	0	3	0	45
09	UK4SECBOT201	Mushroom Cultivation	Any One	SEC	2	1	2	2	60
10	UK4SECBOT202	Organic Agriculture Practices		SEC	2	1	2	2	60
11	UK4SECBOT203	Basics of Plant Tissue Culture		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
03	UK5DSCBOT303	Cell Biology and Evolutionary Biology		DSC	4	0	4	0	60
04	UK5DSEBOT301	Analytical Techniques in Plant Science	Any Two	DSE	3	1	3	2	75
05	UK5DSEBOT302	Horticulture and Nursery Management		DSE	3	1	3	2	75
06	UK5DSEBOT303	Green Technology for Sustainable Development.		DSE	4	0	4	0	60
07	UK5DSEBOT304	Plant Biotechnology		DSE	4	0	4	0	60
08	UK5SECBOT301	Vegetable Gardening	Any One	SEC	3	0	3	0	45
09	UK5SECBOT302	Biofertilizers and Biopesticides		SEC	3	0	3	0	45
10	UK5SECBOT303	Urban Gardening and Landscaping		SEC	3	0	3	0	45

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
02	UK6DSCBOT302	Environmental Science and Conservation Biology		DSC	4	0	4	0	60
03	UK6DSCBOT303	Biochemistry and Molecular Biology		DSC	4	0	4	0	60
04	UK6DSEBOT301	Plant Propagation and Crop Improvement	Any Two	DSE	3	1	3	2	75
05	UK6DSEBOT302	Phytochemistry and Drug Discovery		DSE	3	1	3	2	75
06	UK6DSEBOT303	Modern Trends in Plant Systematics		DSE	4	0	4	0	60
07	UK6DSEBOT304	Climate Change and Disaster Management		DSE	4	0	4	0	60
08	UK6SECBOT301	Herbal Cosmetics	Any One	SEC	3	0	3	0	45
09	UK6SECBOT302	Indoor Gardening and Terrarium Techniques		SEC	3	0	3	0	45
10	UK6SECBOT303	Hydroponics and Aquaponics		SEC	3	0	3	0	45

Semester 7

Sl. No	Course Code	Course Title		Course Type	Credit		Hours/Week		Total Hours
					T	P	T	P	
01	UK7DSCBOT401	Methodology in Biological Research		DSC	3	1	3	2	75
02	UK7DSCBOT402	Plant Interaction and Defense Mechanism		DSC	3	1	3	2	75
03	UK7DSCBOT301	Genetic Engineering	**For Minor** Any Three	DSC	3	1	3	2	75
04	UK7DSCBOT302	Plant Metabolic Processes		DSC	3	1	3	2	75
05	UK7DSCBOT303	Hereditary Science.		DSC	3	1	3	2	75
06	UK7DSCBOT304	Biodiversity and Conservation		DSC	3	1	3	2	75
07	UK7DSEBOT401	Plant Metabolism	Any One	DSE	3	1	3	2	75
08	UK7DSEBOT402	Industrial Tissue Culture		DSE	3	1	3	2	75
09	UK7DSEBOT403	Aquatic Botany		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	
01	UK8DSCBOT401	Applied Aspects of Thallophytes	**For candidates who opt Capstone Courses** Any Three	DSC	3	1	3	2	75
02	UK8DSCBOT402	Applied Aspects of Archegoniates		DSC	3	1	3	2	75
03	UK8DSCBOT403	Bioinformatics		DSC	3	1	3	2	75
04	UK8DSCBOT404	Developmental Botany		DSC	3	1	3	2	75

Discipline Specific Core Courses

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK1DSCBOT101**				
Course Title	**PLANT WORLD I**				
Type of Course	**DSC**				
Semester	**I**				
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	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
I		**Origin, Diversity & Evolution of Life**	**02**
	1	**Are Plants Alive?** Circadian movements, Cyclosis, Tropic movements, Sensing the environment (photo, chemo), respiration, photosynthesis, secretion, allelopathy, and reproduction. (Brief account.)	
	2	**Where do they survive?** Terrestrial biomes, aquatic biomes, tundra biomes.	
II		**Diversity of Plants: Prokaryotic world**	**08**
	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.	
III		**Eukaryotic world**	**15**
	7	Algae: **Spirogyra**, **Pinnularia, Nitella** Microscopic study of thallus structure.	
	8	Fungi: **Yeast**, **Pleurotus**, Microscopic study of thallus morphology.	
	9	Lichens: Concept of Symbiosis, Various forms of Lichens- Crustose, Foliose and Fruticose.	
	10	Bryophyta: Thallus morphology of *Riccia, Bryum.*	
IV		**Recording Plant Life**	**05**

	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	**Influence of plants on the environment**		**15**
	14	**Specialties of the plant specimens/ecosystems are listed below:** 1. **Conservation successes**: *Judean date palm, Nymphaea thermarum.* 2. **Botanical novelties**: *Victoria amazonica, Welwitschia, Podocarpus wallichianus, Cycas annaikalensis , Wollemia nobilis, Wolffia arriza, Rafflesia arnoldii, Amorphophallus titanum*. 3. **Alluring assasins**: *Amanita muscaria, Abrus precatorius, Thevetia neerifolia, Cerbera odollum, Strychnos nux-vomica.* 4. **Foreign exchange earners**: *Morels of Kashmir*, *Crocus sativus*, Marayoor Sandalwood, *Tectona grandis*. 5. **Invasive alien**: *Eichornia crassipes, Mikania micrantha.* 6. **Metal Prospectors**: *Equisetum arvensis.* 7. **Pharma factories**: *Trichopus zeylanicus, Vinca rosea, Ephedra foliata, Artemesia, Rauwolfia serpentina, Atropa belladona.* 8. **Adaptation kings**: Myristica swamps, Mangrove vegetation, Insectivorous plants, *Cephaleuros, Parmelia, Ficus religiosa var. krishnae,* Peat bogs. 9. **Early warning systems**: Lichens. 10. **Kerala's own**: Rice cultivation below sea level, Pokkali rice, Sacred Groves, Marayoor jaggery, *Cassytha filiformis,* 11. **Timeless giants**: *Giant redwoods, Bristlecone pines.*	

Practicals		
	1. Familiarisation with simple and compound microscopes, Identifying the various parts, and measurement of microscopic structures using micrometry. 2. Observing algal filaments using a microscope to detect cyclosis movements. 3. Setting up & Demonstrating experiments to show the Evolution of oxygen (Photosynthesis) and CO_2 during respiration. (Discuss given the Process of Scientific Enquiry). 4. Field visits to familiarise diverse environments, and collection of samples. 5. Documentation of collected samples, and preparation of semi-permanent slides of bacteria and algae.	**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 *in vivo*. 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)

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**
CO 1	3	-	-	-	-	-				
CO 2	-	3	-	-	-	-				
CO 3	-	3	-	-	-	-				
CO 4	-	-	-	-	-	-	3	3	3	2
CO 5	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	**BOTANY**				
Course Code	**UK1DSCBOT102**				
Course Title	**INTRODUCTORY BOTANY**				
Type of Course	**DSC**				
Semester	**I**				
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	Basic understanding of plant biology at the higher secondary level				
Course Summary	Students can study plants and their biology, including how they grow and adapt to their environment.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**An Introduction to the Science of Botany**	**07**
	1	What is Botany? Characteristics of Plants, Levels of biological organization from atom-Molecules - Macromolecule- Organelle - Cell-Tissue- Tissue Systems – Organ - Organism - Population- Community- Ecosystem- Biosphere (Brief account).	
	2	Characteristic features of plant Kingdom - Eukaryotic cell- the important character of the plant cell (Cellulose -cell wall & plastids)- single to multicellular structure - sexual & asexual reproduction- Autotrophic synthesize food by Photosynthesis; Plant kingdom- Classification- Cryptogamae and Phanerogamae.	
II		**Why Study Plants?**	**08**
	3	Plants are the foundation of ecosystem-primary producers - Supplying Food and Energy)- Maintains Climatic Conditions - (production of oxygen-removing the carbon dioxide from the surroundings). Biogeochemical Cycles- Aesthetics for Humans- Natural habitat for most organisms.	
	4	Plants around us- Crops (Wheat, Mango) Poisonous (Cerebera, Datura), Weeds (*Ageratum sp., Alternanthera sp*) Carnivorous Plants (Dionaea, Nepenthus), Ornamental plants (Orchids, Rose), Wild ornamental plants (*Osbeckia Sp.* Memecylon), Invasive plants (*Sphagneticola trilobata, Mimosa diplotricha),* Misteleto (*Loranthus*), Parasitic plants (*Cuscuta*).	
	5	Plants Defense– **(**against herbivorous and animals)- Structural defense – Barrios-cuticle, wax, bark; Adaptations- thorns, prickles, shrinkage (Mimosa), latex, trichomes, crystalliferous cells, and silica cells.)-Biochemical defense (alkaloids, phenolics, terpenes, and flavonoids) (Brief study)	

III	**Plant Morphology**		**08**
	6	Roots- types (Tap root, fibrous and adventitious). Stem - types (aerial and underground). Leaf - parts of the leaf; phyllotaxy,types v e n a t i o n . Inflorescence types – Cymose, Racemose, and Special (Cyathium and Hypanthodium). Flower - (Parts, Symmetries, Aestivation Types). Fruit – Simple (Fleshy, Dry) Aggregate, Multiple (Syconous, Sorosis) with two examples. Seed and its Structure (Brief study only).	
IV	**Botanical Skills and Techniques**		**07**
	7	Familiarization with Microscopes (Simple and Compound Microscope), and photomicrography. Plant Collection and Preservation: Dry Preservation – Herbarium). Killing and fixing. Purpose and Importance of FAA. Whole mounts and sections – Hand Sectioning – TS and LS. Staining plant tissues: purpose; stains – Safranine, Crystal violet. ***Learning Activity:*** *Identify and collect any five flowering plants and Prepare herbarium.*	
V	**Scope of Botany**		**15**
	9	**Importance and Scope**: Mushroom cultivation, Agriculture, Horticulture - Garden and Nursery Management, Floriculture- cut flower), Integrated Farming, Micro and macro propagation, Bio-pesticides industry, Dye industry, Perfumery industry, Cloth industry, pharmaceutical industry, Cosmetic industry, and Microgreens.	
	10	Teaching and Research, Technical and field level openings, pharmaceutical sector, Agriculture sector, NGOs, BSI, and Entrepreneurship. *Activity: Invited talk by Eminent Botanists to make awareness among students about Career and Entrepreneurial Prospects and Opportunities in Botany*.	

Practicals		
	Field Activities (Mandatory) 1. Conduct a laboratory visit and submit reports with the support of Geo-tagged photographs. 2. Prepare a report and presentation on Botanists who made significant contributions to Plant science. 3. Collection/ photograph of different shoots with respect to phyllotaxy, shapes, types, leaf margins, leaf apex, and leaf venation. 4. Collection/photographs of different types of inflorescences. 5. Collection/photographs of different types of Fruits.	**30**

Suggested Reading

1. Acquciah, G. (2004). *Horticulture: Principles and Practices (II Edn)*. Prentice Hall. India
2. Brown, W.(2021). *The Forgotten Botanist: Sara Plummer Lemmon's Life of Science and Art*. Bison Books. ISBN: 9781496222817 (ISBN10: 1496222814
3. Davis, P. H., & Heywood, V. H.(1963). *Principles of Angiosperm Taxonomy*. Oliver &

Boyd, London.
4. Eames A. J.(1961). *Morphology of Angiosperms*. McGraw Hill, New York.
5. Gangulee, S. C., Das, K. S., Dutta, C. D., & Kar, A. K.(1968). *College Botany Vol. I, II, and III*. Central Education Enterprises.
6. Gifford, E. M., & Foster, A. S.(1988). *Morphology and Evolution of Vascular Plants*.
7. Pallabhi, V., & Gautham, N.(2005). Biophysics. Narosa Publishing House, New Delhi.

References

1. Mason K. A., Jonathan B. L., & Susan R. S. (2013). *Biology (IX Edn)*. McGraw Hill.
2. Narayana, P. S., & Pullaiah, T.(2010). *Eminent Indian Botanists: Past and Present Biographies and Contributions*. Regency Publications, Ansari Road, New Delhi- 110002
3. Pandey, R. K., & Ghosh, S. K.(1996). *A Handbook on Mushroom Cultivation*. Emkey Publications
4. Prasad, M. K., & Krishna, P. M.(1986). *Outlines of microtechnique*. Emkay Publishers, New Delhi.
5. Purohit, S. S. (2005). *Plant Tissue Culture*. Student Edition.
6. Rema, L. P.(2006). *Applied Biotechnology*. MJP Publishers.
7. Sharma, R. R.(2005). *Propagation of Horticultural Crops*. Kalyani Publishers.
8. Sharma, V. K. (1991). *Techniques in microscopy and cell biology*. Tata McGraw-Hill, New Delhi.
9. Singh, G. (2012). *Plant Systematics. Theory and Practice. 3rd edition*. Oxford & IBH Pvt. Ltd., New Delhi.
10. Taylor, T. N. (1981). *Paleobotany: An Introduction to Fossil Plant Biology*. McGraw Hill, New York.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the Level of biological organization of communities and ecosystems and acquire the knowledge of characteristic features of the plant kingdom.	U	PSO-1,2
CO-2	Understand the relevance of the plants in the ecosystem, will develop the ability to identify the diversity of plants around us and the defense mechanism in plants.	R, U	PSO-1,2
CO-3	Understand the morphological features of plants	R, U	PSO-1
CO-4	Develop basic skills required to study Botany in detail and gain a foundational understanding of the basic instruments and techniques used in Botanical studies.	U, Ap	PSO-1, 4

CO-5	The learner will develop evolving abilities and opportunities in diverse themes in botany and gain insights into the potential of personal prosperity and career opportunities in plant science.	U, Cr	PSO-4, 6

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

Name of the Course: Introductory 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	R, U	F,C	LT	
2	2	1,2	R, U	F, C	LT	
3	3	1	R, U	F, C	L,T	
4	4	1,4	U, Ap	C, P	P	P
5	5	1,6	U, Cr	P,M	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		✓		✓
CO 5		✓	✓	✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK1DSCBOT103**				
Course Title	**FUNDAMENTALS AND SCOPE OF BOTANY**				
Type of Course	**DSC**				
Semester	**I**				
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	Basic understanding of plant biology at the higher secondary level.				
Course Summary	Students can study plants and their biology, including how they grow and adapt to their environment. The history of Botany and also different branches within botany focus on specific areas of plant biology.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Botany: An Introduction**	**06**
	1	History of botany, the basic concept of botany, Evolutionary history of plants on geological time scale; Fossil evidence for plant evolution.	
	2	The Lush Green Domain: A Brief description of various branches in Botany (Phycology, Lichenology, Mycology, Bryology, Pteridology, Taxonomy, Ethnobotany, Horticulture, Molecular Biology, Physiology, cytology, Genetics, Pharmacognosy, Plant Pathology, Palynology)	
II		**Predecessors in Plant Science**	**04**
	3	International: Theophrastus (Father of Botany), Charles Darwin, G.J. Mendel, Carl Linnaeus, Louis Pasteur, Rosalind Franklin, Watson and Crick. N.I.Vavilov, Norman Borlaug, George Bentham & Joseph Dalton Hooker.	
	4	Indian Botanists: M. O. P. Iyengar, S.R. Kashyap, P. K. K. Nair, Birbal Sahni, P. Maheswari, M.S. Swaminathan, Janaki Ammal, Jagadish Chandra Bose.	
III		**Plant Morphology**	**11**
		Roots- types (Tap root, fibrous and adventitious). Stem – types (aerial and underground). Leaf – parts of the leaf; phyllotaxy –	

	5	Alternate, Opposite, Whorled; Leaf types-simple, compound, Leaf venation-Parallel, and Reticulate. Inflorescence types – Cymose (Monochasial and Dichasial), Racemose (Raceme, Spike, Spadix, Catkin, Capitulum), and Special (Cyathium and Hypanthodium).	
	6	Flower – Parts, Symmetries, Aestivation Types. Fruit – Simple (Fleshy, Dry) Aggregate, Multiple (Syconous, Sorosis) with two examples. Seed and its Structure (Brief study).	
IV	**Botanical Skills and Techniques**		**09**
	7	Familiarization with Microscopes (Simple and Compound Microscope), and photomicrography; Plant Collection and Preservation: Dry Preservation – Herbarium; Killing and Fixing agents – Carnoy's formula, FAA. Whole mounts and sections – Free Hand Sectioning. Staining plant tissues: purpose; stains – Safranine, Acetocarmine. ***Learning Activity:*** *1. Identify and collect any five flowering plants and Prepare herbarium.* 2. *Prepare semi-permanent slide /whole mount.*	
V	**Prospects and Scope of Botany**		**15**
	9	Importance and scope: Mushroom cultivation. Agriculture and its branches (Horticulture and Floriculture). Integrated Farming. Micro and macro propagation. Fertilizers and bio-pesticides industry. Dye industry. Perfumery industry. Cloth industry. Pharmaceutical industry. Cosmetic industry. Garden and Nursery Management, Microgreens.	
	10	Teaching and Research, Technical and field level openings, pharmaceutical sector, Agriculture sector, NGOs, BSI, and Entrepreneurship. ***Learning Activity:*** *Invited talk by Eminent Botanists to make awareness among students about Career and Entrepreneurial Prospects and Opportunities in Botany*.	

Practicals		
	Field Activities (Mandatory) 1. Conduct a laboratory Visit and submit reports with the support of Geo-tagged photographs. 2. Prepare a report and presentation on Botanists who made significant contributions to plant science. 3. Collection/ photograph of different shoots with respect to phyllotaxy, shapes, types, Leaf margins, leaf apex, leaf venation. 4. Collection/photographs of different types of inflorescences 5. Collection/photographs of different types of Fruits.	**30**

Suggested Readings

1. Arnold, C. A. 1947. Introduction to Paleobotany. Tata McGraw Hill, New Delhi.
2. 2.Beck, W. S., Karel, F. L., & George, G. S. 1991. LIFE: An Introduction to Biology (IIIEdn). Harper Collins Publishers.
3. Pallabhi, V.& Gautham, N. 2005. Biophysics. Narosa Publishing House, New Delhi.
4. Sewart, W. N. 1983. Paleobotany and the Evolution of Plants. Cambridge Uni. Press, London.
5. Simpson, M. G. 2010. Plant Systematics (II Edn). Academic press.

References

1. Davis, P. H., & Heywood, V. H., 1963. *Principles of Angiosperm Taxonomy*. Oliver & Boyd, London.
2. Eames A. J., 1961. *Morphology of Angiosperms*. McGraw Hill, New York.
3. Gangulee, S. C., Das, K. S., Dutta, C. D., & Kar, A. K., 1968. *College Botany Vol. I, II, and III*. Central Education Enterprises.
4. Pandey, R. K., & Ghosh, S. K., 1996. *A Handbook on Mushroom Cultivation*. Emkey Publications
5. Prasad, M. K., & Krishna, P. M., 1986. *Outlines of microtechnique*. Emkay Publishers, New Delhi.
6. Sharma, V. K., 1991. *Techniques in microscopy and cell biology*. Tata McGraw-Hill, New Delhi.
7. Singh, G., 2012. *Plant Systematics. Theory and Practice. 3rd edition*. Oxford & IBH Pvt. Ltd., New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basic concepts of Botany and its origin	U	PSO-1,2
CO-2	Help the learner gain an understanding of the cardinal branches in Botany hence paving the way towards the conception of an elemental awareness of the areas.	R, U	PSO-1
CO-3	Identify and acknowledge the Eminent Botanical Contributors, and recognize the importance of their contributions.	R, U	
CO-4	Analyze the morphological features of plants. Develop basic skills required to study Botany in detail and gain a foundational understanding of the basic instruments and techniques used in Botanical studies.	R, U, An	PSO-1, 4

CO-5	The learner will develop evolving abilities and opportunities in diverse themes in botany and gain insights into the potential of personal prosperity and career opportunities in plant science.	U, Ap	PSO- 3,4,6

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

Name of the Course: Fundamentals and Scope of 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	R, U	F, C	L,T	
2	2	1,2	R, U	F, C	L,T	
3	3	1	R, U	F, C	L,T	
4	4	1,4	R, U, An		T	P
5	5	3,4,6	U, Ap		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		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK1DSCBOT104**				
Course Title	**PLANTS IN DAILY LIFE**				
Type of Course	**DSC**				
Semester	**I**				
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	No Pre-requisites				
Course Summary	The course 'Plants in Daily Life' explores the diverse roles plants play in our everyday lives, such as nutrition, medicine, industry, and culture. Students learn about the botanical characteristics, innovative uses, and practical applications of various plant species. The course emphasizes the importance of sustainable practices and the conservation of plant resources for future generations.				

Module	Unit	Content	Hrs
I		**Plant services to humans in everyday life**	**06**
	1	Introduction to the science of Botany, plant resources in everyday life.	
	2	Role of plants: Air purifier (Photosynthesis); Plants used in rituals/festivals; pollution removal (Phytoremediation), Pollution indicator (lichens), and nutrient source (litter, manure).	
	3	Herbal basket: Following plants to be studied with respect to botanical source, part of the plant used, and medicinal uses: *Ocimum sanctum, Adhatoda vasica, Zingiber officinale, Curcuma longa, Aloe vera, Andrographis paniculata, Cymbopogon citratus, Coleus aromaticus, Acorus calamus, Boerhaavia diffusa, Oldenlandia corymbosa.*	
II		**Plant resources and utilization-I**	**04**
	4	Botany and utility of the following plants: a. Cereals: Rice, Wheat, Maize b. Millets: Ragi, Jowar, and Bajra c. Legumes: Bengal gram, Green gram, Black gram d. Cash crops: Cashew, Sugarcane, and Cocoa e. Non-alcoholic beverages: Tea, Coffee	

		f. Alcoholic beverage: Toddy (Coconut tree), Palm vine (Palm) g. Vegetable Crops: Cabbage, Brinjal	
III	**Plant resources and utilization-II**		**06**
	5	Fibers: Cotton, Coir, Banana (Separation, storing, and drying of fibers from Banana leaf sheath). (in brief). Psychoactive drugs from Hemp and poppy and their mode of action. (in brief).	
IV	**Utilization of plants in value-added products**		**14**
	6	Herbal Cosmetics- Introduction, scope and advantages over Synthetic Cosmetics- Cosmaceuticals.	
	7	Plants used in Skincare - Aloe, Cucumber, Facewash- Rosewater, Hair wash - Hibiscus and Amla, Face creams - Papaya, Turmeric, Hair dyes - Henna, Indigofera, Hair growth- Eclipta.	
	8	Herbal infusions – Clitoria, Hibiscus, Tulsi, Guava leaf	
	9	Preparation of natural dyes from Marigold, Hibiscus. (Brief account only).	
	10	Plants used for Aromatherapy – Essential oils from Citrus, Sandal, and Lavender.	
V	**Modern applications and innovations**		**15**
	11	Innovative uses of plants in fields such as a) Biofuels- plant sources-bio-diesel production process - converting plant materials into biofuels (brief account) b) Phytoremediation- Use of plants to remediate polluted environments - contaminated soil and water bodies. c) Case studies of successful phytoremediation projects targeting different types of pollutants (brief account)	

Practicals		
	1. Study and identification of plants mentioned in the floral basket category 2. Visit to tea and coffee processing unit and report the same 3. Collect and properly preserve the economically used plants or plant products 4. Identify the plants of economic importance within the Campus and preparation of a report 5. To conduct an exhibition of the economically used plants or plant products. 6. Demonstration on Preparation of herbal dye 7. Demonstration on the preparation of herbal infusion	**30**

Suggested Reading

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones &Bartlett Publishers,

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the role of plants in human welfare.	U, An	PSO-1,2
CO-2	Course familiarizes with the use of various plans used by humans for food, fiber, beverages, and medicine.	R, U	PSO-1
CO-3	Gain knowledge about various plants of economic use.	R, U	PSO-2
CO-4	Create awareness on the conservation of medicinal plants and the use of natural plant products as alternatives to synthetic products	R, U, C	PSO-I,4
CO-5	Identify various plant-based industries and their economic significance	R, U, An	PSO-1,8

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

Name of the Course: Plants in Daily Life

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, T	
2	2	1	R, U	F, C	L, T	
3	3	2	R, U	F, C	L, T	
4	4	1,4.8	R, U, C	F, C,Ap	L, T	P
5	5	1.2.4	R, U, An	F, P, M	L	P

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

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	2										
CO 2		1										

CO 3		2										
CO 4	1			4						4		6
CO 5						6						

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	**BOTANY**				
Course Code	**UK1DSCBOT105**				
Course Title	**MORPHOLOGY OF FLOWERING PLANTS**				
Type of Course	**DSC**				
Semester	**I**				
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	No pre-requisites				
Course Summary	Plant morphology is a field of study dealing with the external structure of plant organs. Morphology forms the basis of taxonomic descriptions and generally constitutes the most important data in taxonomy. Hence, studying the morphology of angiosperms is a very basic course to learn more about these important plant groups.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Angiosperm structure**	**05**
	1	General Angiosperm structure- introduction; Plant habit, habitat, and life span	
II		**Morphology of the Vegetative parts**	**07**
	2	Root- types, modifications (storage, aerial, pneumatophores, prop, stilt, buttress).	
	3	Stem- types, modifications (underground, aerial, subaerial with examples), branching pattern (monopodial and sympodial).	
	4	Leaves: parts, stipules, phyllotaxy, morpho types, leaf shape, margin, base, apex (basic types only needed), and leaf surface features – hairiness - tomentose, glabrous, scabrous, strigose, hispid, venation (reticulate and parallel). Modifications- leaf tendrils, spines, scales, pitcher, phyllode	
		Morphology of the Reproductive parts	**10**
III	5	Inflorescence- racemose (simple raceme, spike, catkin, spadix, corymb, umbel, and head), cymose (simple cyme, monochasial cyme-helicoid & scorpioid, dichasial and polychasial), and specialized types (cyathium, verticillaster, thyrsus and hypanthodium) with examples.	
	6	Flower as a modified shoot - Detailed structure of flower parts- calyx, corolla, androecium, and gynoecium - arrangements, relative position, cohesion, and adhesion of floral parts;	

	7	Flower symmetry, cycly, merosity, aestivation (valvate, twisted, imbricate-ascending, descending, quincuncial), and placentation (axial, marginal, free-central, parietal, basal, pendulous, superficial).	
IV	**Fruits and seeds**		**08**
	8	Fruits - simple, aggregate, and multiple with examples; Seeds- dicot and monocot, albuminous and exalbuminous, aril, caruncle - hypogeal and epigeal germination, dispersal of fruits and seeds.	
V	**Importance of Morphology**		**15**
	9	Importance of Morphology in Identification, Nomenclature, and Morphology in Classification; Descriptive and Interpretative Morphology; Description of a plant in technical terms- Floral Diagram- Floral Formula -Art of scientific botanical illustration.	

Practicals		
	1. Study of morphological characters of root, stem, and leaves. 2. Study the morphological features of flowers, inflorescence, fruits, and seeds. 3. Prepare a photo album of leaf forms. 4. Prepare herbarium sheets for various types of inflorescences. 5. Identify evidence for considering the flower as a modified shoot from nature and submit the same in the form of a photo album using geo-tagged photos or herbarium. 6. Identify the cohesion and adhesion types of androecium from actual plant parts. 7. Collect flowers belonging to various merosity and record. 8. Study of various types of aestivation and placentation (ovary CS). 9. Conduct a field survey (minimum 5) to identify the morphotypes studied. 10. Create a floral formula for at least 10 named flowers and record the same. 11. Create a floral diagram for at least five named flowers and record the same.	**30**

Suggested reading

1. Simpson, Michael G. (2019) Plant systematics. Academic Press.
2. Singh, Gurcharan. (2019). Plant systematics: an integrated approach. CRC Press.
3. Sharma, OP. (2009).Plant taxonomy. Tata McGraw-Hill Education Private Limited.
4. Bell, Adrian D., and Alan Bryan. (2008). Plant form: an illustrated guide to flowering plant morphology. Timber Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed

CO-1	Ability to identify the vegetative parts of angiosperms and understand their variation.	R, U	PSO-1
CO-2	Ability to identify different types of inflorescences, flowers and fruits, their arrangement and relative position.	R, U	PSO-1
CO-3	Remember the taxonomical terminology and acquire the skills to describe flowering plants in technical terms.	R, U,	PSO-1
CO-4	Acquire the skills to depict the structure of a flower through floral diagrams and floral formula	R, U, C	PSO-3

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

Name of the Course: Morphology of Flowering Plants

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	LT	
2	2	1	R, U	F, C	LT	
3	3	1	R, U,	F, C	LT	P
4	4	3	R, U, C	F, An	LT	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	**BOTANY**				
Course Code	**UK2DSCBOT101**				
Course Title	**PLANT WORLD II**				
Type of Course	**DSC**				
Semester	**II**				
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	*Psilotum, Nephrolepis, Azolla*: Morphology of Gametophyte and Sporophyte, Structure of Cones.	
III		**Tracheophytes: Gymnosperms & Angiosperms (Seed plants)**	**20**
		Gymnosperms	
	3	*Pinus*: 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**		
	7	Ecological & Economic importance of Pteridophytes, Gymnosperms, Angiosperms.	**02**
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. **Pan INDIA**: 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. **Private sector**: Mahyco Private Ltd., Biocon, Pharmaceutical firms, Coffee, Tea, Cadbury Plantations, Indo-American hybrid seeds.	

Practicals		
	1. Familiarisation of various stelar types: protostele, actinostele, siphonostele, solenostele (*Marselia* rhizome), dictyostele (*Pteris* petiole), atactostele (Grass stem). 2. Structure of vascular bundles- Collateral, Conjoint (open, closed, concentric, bicollateral) and radial. 3. Maceration of Eupatorium stem to separate and identify Tracheids, Parenchyma, and Vessel members. 4. Measurement of any one vascular element, using a micrometer. 5. Field visits to collect different leaf types & different inflorescence types. Preparation and submission (herbarium) of leaf types and inflorescences. 6. Collection and submission of various seed types. Observing, Recording their surface peculiarities. 7. Pollen surface ornamentation study of 5 plant using light microscopy. 8. Pollen germination study and Pollen viability testing using acetocarmine.	**30**

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

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 & Vipen 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
CO 1	3	-	3	-	-	-				
CO 2	2	-	-	-	-	-	3	2		
CO 3	2	-	1	-	-	-				3
CO 4	3	-	3	-	-	-				
CO 5	-	-	-	3	-	-				1
CO 6	-	-	-	-	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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK2DSCBOT102**				
Course Title	**ANATOMY OF FLOWERING PLANTS**				
Type of Course	**DSC**				
Semester	**II**				
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	Basic understanding of plant tissues at the higher secondary level				
Course Summary	The course provides a foundational understanding of plant structure, from the cellular level to the organizational complexity of tissues and organs, and also provides students with a comprehensive understanding about wood formation.				

Detailed Syllabus:

Module	Unit	Content	Hrs.
I		**Objectives and scope of plant anatomy**	**05**
	1	Definition, objectives, and scope of plant anatomy; Fundamental parts of flowering plant (Brief account only).	
	2	Basic study requirements: Stains (Saffranin), mounting media (Water, Glycerol), and compound microscope (Brief account only).	
	3	Cell wall organization – Gross structure- Primary and secondary wall, pits- plasmodesmata; Cell wall material (cellulose, cutin, lignin, suberin).	
	4	Non- living inclusions of the cell - Reserve food (carbohydrates, proteins), Secretory products (enzymes, nectar), Excretory products -nitrogenous (alkaloids) and non-nitrogenous including gum, resin, essential oils, latex, and mineral crystals-(Cystolith, Raphides).	
II		**Plant Tissues**	**08**
	5	Tissues - Meristems: Definition, Classification based on origin, position, plane of cell division, and functions.	
	6	Apical meristem- Theories on the apical organization of shoot apex- Apical cell theory, Histogen theory, Tunica - Corpus theory. Theories on the organization of root apex- Apical cell theory, Histogen theory, and Korper-Kappe theory	
	7	Permanent tissues – Definition, classification – simple, complex, and secretory tissues (schizogenous- lysigenous cavities, glandular hairs, nectary, laticifers).	
III		**Tissue Systems**	**5**

	8	Tissue systems- Definition & Types - Epidermal tissue system, Ground tissue system, and Vascular tissue system; Stomata – structure and functions, types (anomocytic, anisocytic, paracytic, diacytic, graminaceous); Different types of vascular arrangements (Conjoint, radial, open, closed, collateral, bicollateral, concentric (amphivasal & Amphicribral).	
IV	**Internal structure of plant body -I**		
	9	Primary structure – Root, stem and leaf (Dicot & Monocot)	
	10	Secondary growth – Dicot root and stem; vascular cambium (structure, types, and function); growth rings; dendrochronology. Wood - heart wood and sap wood; hardwood and softwood; ring-porous wood and diffuse-porous wood; tyloses; periderm formation; Bark and lenticels.	**12**
	11	Adaptive (anomalous) secondary growth in stem–*Boerhaavia, Bignonia,*	
V	**Internal structure of plant body -II**		
	12	Anatomy of petiole; Abscission layer.	
	13	Nodal anatomy (brief account only).	**15**
	14	Role of cambium in wound healing and grafting.	
	15	Adaptive Anatomy:– Hydrophytes ,Xerophytes, Epiphytes.	

Practicals		
	1. Observe and record: Non-living inclusions -Cystolith, Raphide; Starch grains - eccentric, concentric, compound; Aleurone grains. 2. Observe and record: Simple permanent tissues- parenchyma, chlorenchyma, aerenchyma, collenchyma, sclerenchyma. 3. Make micro preparation : 4. Study of stomata through peal method: types of stomata -anomocytic, anisocytic, paracytic, diacytic. *5.* primary structure: Root: monocot (*Colocasia),* dicot (Pea /*Limnanthemum*)*;* Stem: Dicot - *(Centella*), Monocot - Grass; Leaf- Dicot (Ixora); monocot (grass). *6.* secondary structure - Stem (Normal type) – *Vernonia,* Root – *Tinospora / Papaya* . *7.* Anomalous secondary thickening of Stem - *Boerhaavia, Bignonia.* 8. Adaptive anatomy: xerophytes (*Nerium*-leaf), hydrophytes (Hydrilla - stem), epiphytes (*Vanda* -velamen root).	**30**

Suggested reading

1. Bhattacharya H., Ghosh. 2017. A Textbook of Botany, Vol I – IV, NCBA, Kolkata
2. Dickison, W.C. 2000. Integrative Plant Anatomy. Harcourt Academic Press, USA.
3. Evert, R.F. 2006. Esau's Plant Anatomy: Meristems, Cells, and Tissues of the
4. Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc Fahn,
5. Mauseth, J.D. 1988. Plant Anatomy. The Benjammin/Cummings Publisher, USA.

Reference

1. Mitra, J.N. D. Mitra, D., S.K. Chowdhuri, S.K. 2017. Studies in Botany. Vol. 1 and 2, Moulik Library, Kolkata.
2. Pandey, B.P. 2001. Plant Anatomy, S. Chand Publishing, New Delhi.
3. Vasistha, P.C. 2000. Plant Anatomy, Pradeep Publications, Jalandha..

Web links

1. https://www.encyclopedia.com/social-sciences/applied-and-social-sciences-magazines/plant-anatomy.
2. 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	Understand the basic concepts, fundamentals, and scope of plant anatomy	U	PSO-2
CO-2	Develop a critical understanding of the concept of organization of shoot and root apex.	R, U	PSO-2,4
CO - 3	Develop skills for microscopic specimen preparation and examine the internal anatomy of plant systems and organs	U,An	PSO-2,4
CO - 4	Understand the composition, internal structure & architecture of plants	R, U, An,	PSO-4
CO - 5	Understand, analyse, and identify the modification of internal structure with respect to environmental adaptations	U, An	PSO-4,7

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

Name of the Course : Anatomy of Flowering plants:

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

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

4	4	4	R, U, An	C, P		P
5	5	4,7	U, An	C, 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	**BOTANY**				
Course Code	**UK2DSCBOT103**				
Course Title	**REPRODUCTIVE BOTANY AND MICROTECHNIQUE**				
Type of Course	**DSC**				
Semester	**II**				
Academic Level	**200 - 299**				
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 high secondary school level.				
Course Summary	Reproductive Botany covers the study of plant reproduction, pollination, fertilization, and seed development. Microtechnique involves microscopic methods for studying plant structures and processes.				

Module	Unit	Content	Hrs
I		**Structural organization of flower**	**12**
	1	Anther and Palynology: Development, structure and functions of anther wall- microsporogenesis- structure of pollen grain, pollen wall, MGU (male germ unit); NPC system; Palynology and scope (a brief account)	
II	2	Ovule- development, structure, types- Megasporogenesis – (tenuinucellate and crassinucellate), monosporic, bisporic, and tetrasporic; megagametogenesis - organization and ultrastructure of mature embryo sac.	
III		**Pollination**	**10**
	3	Pollination types - Self-pollination- Cross-pollination- significance and adaptations - entomophily, anemophily,hydrophily & zoophily (birds, squirrels, bats, and snails – one example for each). Advantages & disadvantages of self & cross-pollinations. Contrivances to cross pollination: dicliny, self sterility, dichogamy, heterostyly, and herkogamy with one example each	
IV		**Fertilization**	**08**
	4	Pollen germination- entry of pollen tube - double fertilization and its significance- structure of dicot and monocot embryo; Endosperm- types and functions- Polyembryony (brief account)	
V		**Microtechnique**	**15**

	5	Introduction to microtechnique: killing and fixing Dehydration - agents used - ethyl alcohol.	
	6	Sectioning: hand sections, serial section; Microtome - rotary, sledge (application only).	
	7	Staining technique: principle of staining; stains – Saffranin, hematoxylin, fast green, acetocarmine; vital stains & mordants with examples. Types of staining - single staining, double staining.	
	8	Mounting and mounting media -semi-permanent (glycerine), permanent (DPX, Canada balsam).	
	9	Types of micropreparations-Wholemount, maceration, smear, squash.	

Practical		
	1. Dissect and display parts of different types of flowers. 2. Identification of c.s. of anther, embryo sac, and embryo 3. Identify the different types of ovules 4. Familiarize, with micropreparation, use of stains, fixatives, and mounting media. 5. Preparation of smears and squash (demonstration only) 6. Demonstration of microtome sectioning 7. Preparation of single stained hand sections (permanent demonstration only)	**30**

Suggested Reading

1. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
2. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms,
4. Vikas PublishingHouse. Delhi. 5th edition.
5. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH
6. Publishing Co. Pvt.Ltd. Delhi.

Web links

1. https://agriculturistmusa.com/plant-e mbryology/
2. http://www.ppup.ac.in/download/econtent/pdf/JNL%20College%20(%20Pallavi%20for%20Botany%20B.Sc%20Part%20II)%20Topic-Plant%20embryology%20part%201.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Familiarize the techniques for the preservation and processing of tissues	U	PSO-1,2,4

CO-2	Apply practical experience in microtechnique and histochemistry in laboratories	R, U, Ap	PSO-4
Co-3	Understand the morphology and development of reproductive parts	U	PSO-1,2
C0-4	Creates awareness about different types of pollination	C	

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

Name of the Course: Reproductive Botany and Microtechnique

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,P	L,T	
2	2	4	R, U, Ap	F, C,P		P
3	3	1,2	U	F,C	L,T	
4	4	1	C		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		✓		✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK2DSCBOT104**				
Course Title	**PHYCOLOGY, MYCOLOGY AND PLANT PATHOLOGY**				
Type of Course	**DSC**				
Semester	**II**				
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	No Pre-requisites				
Course Summary	The course includes a general account of thallophytes such as algae, fungi, lichens, and mycorrhiza. Each group discusses its classification, distinguishing characters, and economic importance. Type forms in each group give a detailed account of morphology, life cycle, and economic importance. Various agents of plant diseases, its management and control also covered in the course.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Algae**	**10**
	1	Classification of Algae by Fritsch (1935), General account of algal forms- - Thallus organization- Economic Importance.	
	2	Habit, thallus structure, pigments, reproduction, and economic importance of the following classes Chlorophyceae – Oedogonium Phaeophyceae – Sargassum Rhodophyceae –Polysiphonia Myxophyceae- Nostoc	
II		**Fungi**	**10**
	3	Classification (Ainsworth,1973) -General Characters of fungi	
	4	Brief account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina.	
	9	Structure and Life Cycle of Rhizopus and Puccinia.	
	10	Economic importance of Fungi	
III		**Association in Fungi**	**03**
	11 12	Lichens- Thallus structure and reproduction- economic and ecological importance- forms (Crustose, foliose, fruticose); Mycorrhiza- Ectomycorrhiza-VAM-importance; Association between Ant and Fungi	
IV		**PlantPathology**	**07**
	13	General Principles of Plant Disease Management and Therapy (brief account only)	

	14	Disease control- chemical-physical-biological and cultural methods-(Brief account only)	
	15	Causal organism, symptoms, transmission, and control measures of Citrus Canker, Tapioca Mosaic Disease, and Blast disease of Paddy.	
V	**Applications of Algae and Fungi**		**15**
	16	Industrial application of Algae- pharmaceuticals, cosmetics, food, nutraceuticals, biofuel, bioplastics, animal feed.	
	17	Industrial application of Fungi- Alcohol, organic acid, Enzymes, antibiotics, pharmaceuticals	
	18	Agricultural applications- biofertilizers, biocontrol of diseases and pests.	

Practicals		
	1. Analysis of algal flora in a water body (natural/artificial) 2. Field visit for studying marine algal forms 3. Field observation and preparation of photo album- 4. Structure of plant body and reproductive structures of Nostoc, Oedogonium, Sargassum, Polysiphonia, Rhizopus and Puccinia. 5. Conduct a field survey to identify and document plant diseases	**30**

Suggested Reading

1. Sharma, O. P. 2017. Textbook of Algae. Tata Mc Graw Hill Publ. Comp. Ltd.New Delhi
2. Singh V, Pandey PC and Jam D.K .1998. A Text Book of Botany for Under Graduate Students, Rastogi Publications.
3. Vashishta, Singh & Singh (2011). Algae, Botany for Degree students, S Chand and Publishers
4. Vasishta B R and A K Sinha (2011). Botany for Degree Students Fungi . S Chandand Co Pvt Ltd.
5. Michael Carlile, Sarah C. Watkinson, Graham W. Gooday,2001. The Fungi, Academic Press
6. Singh R.S. 2017. Introduction to Principles of Plant Pathology. 5th Edition. Medtech Publisher.
7. Mehrotra R.S. 2017. Plant Pathology. 3rd Edition. McGraw Hill Education
8. Dube H.C. 2014. Modern Plant Pathology.3rd Edition, Agribios, New Delhi

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Acquires knowledge of various algal forms, their classification, and economic importance. Analyze various forms of algae in nearby water bodies and express interest in the conservation of algal forms.	U, R	PSO-1,2

CO-2	Differentiates different classes of algae, its pigment system, and life cycle. Skill in morphological identification of type specimens.	U, An	PSO-1,2
CO-3	Recognize fungal forms in the surroundings on different seasons, and compare the variation in morphology, habitat, and reproductive peculiarities among fungi. Explore various ecosystems for fungal forms. Gains skill in isolation and staining of fungal forms.	K, U, An	PSO-1,5
CO-4	Attain the ability to isolate symbiotic forms from higher plants. Understand the importance of lichens in ecosystem conservation.	U, An	PSO-1,5
CO-5	Gains knowledge about various plant pathogens . Learn different methods to manage and control plant diseases.	U, Ap	PSO-1,2

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

Name of the Course: Phycology, mycology and Plant Pathology

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, R	F,C	L,T	
2	2	1,2	U, An	F,C	L,T	
3	3	1,5	K, U, An	F,C,P	L,T	P
4	4	1,5	U, An	C,P	L,T	P
5	5	1,2	U, Ap	F,C	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		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK2DSCBOT105**				
Course Title	**BIOMOLECULES**				
Type of Course	**DSC**				
Semester	**II**				
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	No Pre-requisites				
Course Summary	Biomolecules are components that interact in complex ways to form the basis of life. The molecular components include water, carbohydrates, lipids, amino acids, proteins, and nucleic acids. Studying the types, structure, and significance of these molecules will make you understand the role of biomolecules in metabolism and how the molecules are involved in the biochemical activities of living things.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Biomolecules**	**06**
	1	Water- properties-weak interactions in aqueous systems-hydrogen bonding-Van der Waals forces-hydrophobic interactions	
	2	Ionization of water-pH-weak acids and weak bases-Henderson–Hasselbalch equation	
	3	Buffers in the biological system- phosphate buffer-bicarbonate/carbonic acid system	
II		**Carbohydrates**	**07**
	4	Monosaccharides- Glucose-Fructose-aldoses- ketoses-isomerism-cyclic structures-pyranoses-furanoses	
	5	Disaccharides-- glycosidic bonds-sucrose- lactose-reducing and non-reducing sugars-Oligosaccharides	
	6	Polysaccharides- Homo and Hetero polysaccharides-Structural polysaccharides - cellulose, peptidoglycans; storage polysaccharides -Inulin and starch; biological importance of carbohydrates	
III		**Proteins**	**08**
	7	General structure-zwitter ion-isomerism	
	8	Classifications of aminoacids, D-aminoacids- biologically active aminoacids	
	9	Peptides-peptide bond-oligopeptide-polypeptide.	

	10	Proteins- structure-primary-secondary-super secondary-motifs and domains (brief account)-tertiary-quaternary-structure-functions of proteins.	
IV	**Lipids and Nucleic acids**		**09**
	11	Classification of lipids-Fatty acids- saturated/unsaturated-mono/poly-triacyl glycerols	
	12	Membrane phospholipids- glycerophospholipids- sphingolipids-lipid bilayer- Steroids-cholesterol	
	13	Nucleic acids- nucleoside-nucleotide, Polynucleotides-phosphodiester bond, DNA - types (B-DNA, A&Z DNA (brief account); RNA- mRNA, rRNA, t-RNA, minor RNAs (brief account), significance of nucleic acids.	
V	**Secondary Metabolites**		**15**
	14	Introduction, Classification, Major secondary metabolites in plants.	
	15	Phenolics, lignins, flavonoids, tannins, terpenes, saponins, carotenoids and alkaloids	
	16	Function and significance of secondary metabolites.	

Practicals		
	1. Measurement of pH 2. buffer preparation (Phosphate buffer) 3. Tests for carbohydrates- Iodine, Molisch's test, Benedict's, Fehling's test. 4. Qualitative test for proteins- biurette test 5. Separation of aminoacids using paper chromatography (demonstration). 6. Isolation of DNA from a plant source (Demonstration).	**30**

Suggested Reading

1. Lehninger, Principles of Biochemistry, Eighth Edition,2022.
2. Lubert Stryer, Biochemistry, 2022.
3. Dey, P.M..Harborne, Plant Biochemistry, 1997
4. Conn, E.E, Stumpf,P.K., Bruening,G. and Doi, R.H., Outlines of Biochemistry 5th edition, Wiley India Ltd., N.Delhi.
5. Primrose, S.B., 1987, Modern Biotechnology, Black Well Scientific Publications, Oxford
6. Jain, J.L., Jain, S., and Jain, N., Fundamentals of Biochemistry, S.Chand& Company.

Web link

1. https://www.mcgill.ca/biochemistry/about-us/information/biochemistry
2. https://biochemistry.org/education/careers/becoming-a-bioscientist/what-is-biochemistry/
3. https://www.britannica.com/science/biochemistry
4. https://www.nanowerk.com/nanobiotechnology.ph

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the importance of water and buffers in the metabolism of living things. Gain skill in using pH meter and the preparation of buffers.	U, An	PSO-1,2
CO-2	Recall various carbohydrates present in plants. Differentiate the structure and significance of common mono, di and polysaccharides in plants. Learn to analyse the presence of carbohydrates in a given sample.	R, U, An	PSO-1,2
CO-3	Understands the structure and significance of proteins, amino acids, and peptides. Acquire skill in qualitative analysis of proteins and separation of amino acids through chromatography.	U, An	PSO-4
CO-4	Understand the role of fats, and sterols in our metabolism and diet. Describe the structure of nucleic acids and lipids. Attain skill in the isolation of DNA from plant samples.	U, An	PSO-4
CO-5	List out different classes of secondary metabolites and describe the importance of secondary metabolites in plant defense mechanisms and phytomedicines.	U	PSO-7

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

Name of the Course: Biomolecules

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, R	F, C, P	L, T	P
2	2	1,2	U, R	F, C, P	L, T	P
3	3	4	U, R	F, C, P	L, T	P
4	4	4	U, An	F, C, P	L, T	P
5	5	7	U, Ap	F, C	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	**BOTANY**				
Course Code	**UK3DSCBOT201**				
Course Title	**HISTOLOGY AND REPRODUCTIVE BOTANY**				
Type of Course	**DSC**				
Semester	**III**				
Academic Level	**200 - 299**				
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
I		**Introduction to tissues and tissue systems**	**07**
	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	
II		**Permanent tissue system**	**06**
	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.	
III		**Primary and Secondary Structure**	**10**
	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	**Reproductive Botany**		**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;Megasporogenesis – female gametophyte – structure of a typical embryosac, types of embryosacs, 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	**Comparative Plant Anatomy**		**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)	

Practicals		
	1. Non-living inclusions – Cystolith, Raphide, Sphaero- raphide (Druses). 2. Starch grains (Eccentric, Concentric, compound, Aleurone grains 3. Simple permanent tissue- parenchyma, chlorenchyma, aerenchyma, collenchyma, sclerenchyma 4. Primary structure- Dicot stem- Centella/ Chromolaena 5. Monocot stem- Grass and Asparagus 6. Dicot root- Pea/ Limnanthemum, Monocot root- Colocasia or any other monocot root 7. Secondary structure – Stem (Normal type) – Vernonia. 8. Root (Normal type)- Carica papaya, Aerial root- Tinospora and Ficus 9. Epidermal structures- Stomata (Anomocytic, anisocytic, paracytic, diacytic) 10. Anomalous secondary thickening – Bignonia, Boerhaavia, Dracaena 11. Dissect a flower and document (photograph/illustration) 12. Identification of C.S of the anther. 13. Identification and documentation of anther dehiscence pattern in five locally available plants. 14. Dissection of dicot embryo, familiar with different types of ovules	**30**

Suggested reading

1. 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
4. 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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK3DSCBOT202**				
Course Title	**FLORAL MORPHOLOGY, SYSTEMATIC BOTANY, AND ETHNO BOTANY**				
Type of Course	**DSC**				
Semester	**III**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	UK1DSCBOT105				
Course Summary	The course covers the external features of flowering plants and their systematic arrangement based on their similarities and evolutionary relationships and the economic importance of plant resources utilized for daily life.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Morphology of Flowering Plants**	**08**
	1	Detailed structure of floral parts- Calyx, Corolla, Androecium, and Gynoecium- arrangements, relative position, cohesion, and adhesion of floral parts. Flower-symmetry, aestivation (valvate, twisted, imbricate-ascending, descending, and quincuncial), and placentation (axial, marginal, free-central, parietal, basal, pendulous, and superficial).Floral diagram and floral formula.	
	2	Types of inflorescence with examples- Racemose (simple raceme, spike, catkin, spadix, umbel, corymb, capitulum, and panicle), Cymose (simple cyme, monochasial - dichasial) & special types Cyathium, Verticillaster, Hypanthodium,)	
	3	Types of fruits – Simple fruits (Fleshy, Dry – Dehiscent, Indehiscent), Aggregate, and Multiple fruits with examples. Seeds – Albuminous and exalbuminous.	
II		**System of Classification**	**06**
	4	Major systems of classification: Artificial (Linnaeus), Natural: (Bentham and Hooker (detailed account)), Phylogenetic- (Engler and Prantl). Brief reference of APG (IV) classification.	
	5	Basic rules of Binomial Nomenclature. Herbarium technique - Significance of herbaria and botanical gardens; important herbaria and botanical gardens inworld and India.	
III		**Systematic study of Angiosperm families**	**10**

	6	A detailed study (Systematic position, distribution, common members, diagnostic features, vegetative, floral characters, and economic importance of the following families: 1. *Malvaceae*, 2. *Leguminosae* (with sub-families), 3. *Asteraceae*, *4. Acanthaceae* 5. *Euphorbiaceae*, 6. *Arecaceae*.	
IV	**Ethnobotany**		**06**
	7	Introduction- concept, scope, and objectives- Ethnobotany of indigenous communities in Kerala-(Kani, Kurumbar, Kurichiya) Study of various methods to collect Ethno botanical data. (brief study only); Role in modern Medicine -Plants in ethnobotanical practices (along with their habitat and morphology) a) *Curculigo orchioides*, b) *Emilia sonchifolia* c) *Vitex negundo* d) *Gloriosa superba* e)) *Pongamia pinnata* h) *Biophytum sensitivum* Role of ethnobotany in modern medicine with special example *Rauvolfia seperntina*, *Trichopus zeylanicus* (Jeevani)	
V	**Modern techniques in plant systematics**		**15**
	8	Modern trends in taxonomy; Chemotaxonomy and Molecular taxonomy – concepts and brief account.	
	9	Biosystematics- Principles and methodology (Brief account).	
	10	Phylogenetic systematics: principle, methodology and applications- brief account	

Practicals		
	1. Prepare a photo album of different leaf forms and Inflorescence. 2. field visits - to familiarise with the local flora and submit e-reports with photographs. 3. Visit a recognized herbarium, and prepare a report on the same. 4. Work out at least one genus of each family mentioned in the syllabus make suitable diagrams, and describe them in technical terms. 5. Ethnobotanical documentation of medicinal plants in and around the campus. 6. Online resources and websites like Index Herbariorum, IPNI, The Tree of Life Web Project (ToL), Plants of The World (POWO), The World Flora Online (WFO), RBGE Living collections should be accessed and familiarised. E-Flora Kerala.	**30**

Suggested Readings

1. Simpson, Michael G.(2019). Plant systematics. Academic Press,
2. Singh, Gurcharan. (2019) Plant systematics: an integrated approach. CRC Press,.
3. Sharma, O.P. Plant taxonomy. Tata McGraw-Hill Education Private Limited.
4. Bell, Adrian D., and Alan Bryan. (2009.) Plant form: an illustrated guide to flowering plant morphology. Timber Press.

5. Bell, Adrian D., and Alan Bryan. (2008). Plant form: an illustrated guide to flowering plant morphology. Timber Press.
6. Jain, S.K .Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
7. Jain, S.K. (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
8. Jain, S.K. (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.

References

1. Sambamurthy A..S.S.(2005). Taxonomy of Angiosperms, i.K. International Pvt. Ltd, New Delhi.
2. 2.Bharati Bhattacharyya.(2009). Systematic Botany, Narosa Publishing House Pvt. Ltd., New Delhi.
3. Mondal A.K. (2009). Advanced Plant Taxonomy, New Central Book Agency Pvt. Ltd. KolKota
4. Sinha R K. (2010) .Practical Taxonomy of Angiosperms. IK International Publishing Pvt Ltd..
5. Chaudhuri, Rai, H. N., Guha, A., Roychowdhury, E. & Pal, D. C. 1980. Ethnobotanical uses ofHerbaria-Il. J. Econ. Tax. Bot. 1:163-168.
6. Chaudhuri, Rai, H. N., Banerjee, D. K. & Guha, A. 1977 . Ethnobotanical uses of herbaria. Bull. Bot. Surv. Indial9:256-261 .

Web links

1. https://kpu.pressbooks.pub/plant-identification/chapter/introduction-to-plant-morphology.
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/

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	Summarize taxonomic information from available resources. Comprehend the general principles of angiosperm systematics and plant nomenclature	R, U	PSO-1,2
CO-3	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.	U, An	PSO-1,2
CO-4	Students will able to understand the indigenous communities in Kerala and the ethnobotanical documentation of medicinal plants.	U,An, E, C	PSO-1,4

CO-5	Execute field collections of plant specimens, scientific herbarium preparations, and maintenance. Develop skills in the techniques for the preparation of virtual herbaria and macro photography	Ap, An, C	PSO-7,8

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

Name of the Course: Floral Morphology, Systematic Botany and Ethnobotany

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	T	
CO-2	2	1,2	R, U	F, C	T	P
CO-3	3	1,2	U, An, E	F, C	T	P
CO-4	4	1,4	Ap, An, E, C	F, C.P	T	P
CO-5	5	7,8	Ap, An, C	F, 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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK3DSCBOT203**				
Course Title	**BRYOPHYTES,PTERIDOPHYTES AND GYMNOSPERMS**				
Type of Course	**DSC**				
Semester	**III**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	UK2DSCBOT104				
Course Summary	To familiarize students with the characteristic features and evolutionary significance of Bryophytes, Pteridophytes and Gymnosperms. To generate awareness about the lifecycle of Bryophytes, Pteridophytes and Gymnosperms.To impart knowledge about ornamental ferns and gymnosperms				

Module	Unit	Content	Hrs
I		**Bryophytes**	**09**
	1	General characters, classification by Smith (1959)	
	2	Study of habit, thallus organization, vegetative and sexual reproduction, and alternation of generation of the following types (Developmental details are not required) *Riccia, Bryum.*	
II		**Pteridophytes**	**09**
	3	Introduction: General characters and classification (Bierhost - 1971); Study of habit, internal structure, reproduction, and life cycle of the following types (Developmental details not required). *Selaginella* and *Pteris* Fossil Pteridophytes- *Rhynia* stem T.S	
	4	Stelar evolution in Pteridophytes	
III		**Gymnosperms**	**10**
	5	Introduction –General characters and classification (Sporne- 1965)	
	6	Study of the habit, anatomy, reproduction, and life cycle of the following types (Developmental details are not required) *Cycas* and *Pinus* Fossil gymnosperms--*Lyginopteris*	
IV		**Economic importance**	**2**
	7	Economic, ecological, medicinal, horticultural, culinary, and research of bryophytes, pteridophytes and Gymnosperms.	
V		**Evolutionary trends**	**15**

	9	Archegoniate Evolutionary aspects- Transition to land habit, Conservation studies.	
	10	Polyembryony in Gymnosperms, Apogamy and Apospory.	
	11	Heterospory and seed habit in Pteridophytes.	

Practicals		
	1. Riccia- Habit- Anatomy of thallus 2. Bryum- Habit, Anatomy of thallus 3. Selaginella – Habit, T.S of stem and rhizophore. 4. Pteris - Habit, Anatomy of Rachis and Sporophyll, Prothallus 5. Cycas- T.S of leaf, Micro, and megasporophyll 6. Pinus-T.S. of the needle, morphology of male and female cone. 7. Permanent slide/ images of Fossils – Rhynia, Lyginopteris 8. Identify and submit geotagged photographs of archegoniates.	**30**

Suggested Reading

1. Watson, E. V. 1974. The structure and life of Bryophytes, B. I. Publications, New Delhi.
1. Pandey, B. P. 2006. College Botany, Vol. II: Pteridophyta, Gymnosperms and Paleobotany. S. Chand & Company Ltd, New Delhi.
2. Sporne, K. R. 1965. Morphology of Gymnosperms. Hutchinson Co., Ltd., London.
3. Vashishta, P. C., A. K. Sinha and Anil Kumar. 2006. Botany - Pteridophyta (Vascular Cryptogams). . Chand & Company Ltd, New Delh

References

1. Pandey, B. P. 2007. Botany for Degree Students: Diversity of Microbes, Cryptogams, Cell Biology and Genetics. S. Chand & Company Ltd, New Delhi.
2. Thakur, A. K. and S. K. Bassi. 2008. A Textbook of Botany: Diversity of Microbes and Cryptogams. S. Chand & Company Ltd, New Delhi.
3. Vashishta, B. R., A. K. Sinha and Adarsha Kumar. 2008. Botany for Degree Students: Bryophyta. S. Chand & Company Ltd, New Delhi.
4. Vashishta, P. C., A. K. Sinha and Anil Kumar. 2006. Botany for Degree Students: Gymnosperms. Chand & Company Ltd, New Delhi

Web links

1. https://www.vedantu.com/biology/pteridophytes
2. https://plantlet.org/classification-of-pteridophytes/
3. https://www.thoughtco.com/what-are-gymnosperms-4164250

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the general characters of Archegoniates and formation of fossils	R,U	PSO-1,2

CO-2	Classify archegoniate to different plant groups	R,U,	PSO-1,2
CO-3	Compare the structure of gametophyte and sporophyte of Archegoniates	U, An	PSO-1,2,
CO-4	Assess the economic and ecological significance of Archegoniates	U, An	PSO- 4,6
CO-5	Investigate aesthetic applications of archegoniates	U,Ap	PSO-7

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

Name of the Course: Bryophytes, Pteridophytes and Gymnosperms
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,T	
2	2	1,2	R,U,	F, C	L,T	
3	3	1,2,	R,U,An	F, C	L,T	
4	4	4,6	U, An	F, p		P
5	5	4,6	U,Ap	F, C		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	**BOTANY**				
Course Code	**UK3DSCBOT204**				
Course Title	**ENVIRONMENTAL SCIENCES**				
Type of Course	**DSC**				
Semester	**III**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	No Pre-requisites				
Course Summary	This course equips the students to identify Natural resources and key features of ecosystems and understand the interrelationships between organisms within an ecosystem. Explains sustainable development of nature through biodiversity conservation. This course equips the students with knowledge about pollution, its causes and methods for prevention and control.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Natural Resources and Conservation**	**06**
	1	Renewable and Non-renewable resources, natural resources - Land, Water, Forests -, Energy, Plants & Wildlife.	
	2	Degradation of natural resources (Land, water, flora and fauna), Causes – habitat fragmentation, invasive species, population explosion, over-exploitation, deforestation, agriculture mismanagement, desertification, overgrazing, soil erosion, mining, urbanization and industrialization, depletion of water resources	
	3	Conservation of Natural resources and sustainable lifestyles. Afforestation, regeneration of wasteland, rainwater harvesting, use of renewable resources, tidal and wind; biodiesel, biofuels. (brief account only)	
II		**Ecosystem Ecology**	**12**
	4	Definition, Biotic and abiotic components- Food chains, Food web & ecological Pyramids -Energy flow in an ecosystem–GPP, NPP	
	5	Biogeochemical cycles– Nitrogen, Phosphorus – biomagnification, eutrophication	
	6	Ecological succession-Definition, primary and secondary succession, climax concept - hydrosere, xerosere	
	7	Types of ecosystems (structure & functions) - Forest, Grassland, Desert, Aquatic – Marine, Freshwater, Estuaries, Mangrove forest, Salt marshes,	

III	**Interactions and Adaptations**		**06**
	8	Species interactions : Herbivory – Mechanical, Chemical defense, Competition – introduced species, Mutualism – Pollination syndromes, Dispersive mutualism, Defensive mutualism, Symbiosis (Lichens,Mycorrhizae), Parasitism – holoparasites, hemiparasites Commensalism, carnivory	
	9	Morphological, anatomical & physiological adaptations of – Hydrophytes, Xerophytes, Halophytes, Epiphytes, Parasites	
IV	**Biodiversity Conservation**		**06**
	10	Definition- genetic, species and ecosystem diversity, keystone species, indicator species, umbrella species	
	11	Hot spots – in India, Endemism – Western Ghats, IUCN, Red list – categories, Red data Book	
	12	Biodiversity Conservation: In-situ (National parks, Wildlife sanctuaries, Biosphere reserves) and Ex-situ conservation (botanical gardens, seed bank), World Heritage Sites in India, Ramsar convention	
	13	Major biodiversity conservation Movements in India - Chipko movement, Silent Valley Movement, Narmada BachaoAndolan	
V	**Environmental Pollution**		**15**
	14	Definition, causes and types – Air, Water, Soil, Noise, Thermal , Radioactive, Light. Case study : DDT	
	15	Global warming, Climate change, Ozone layer depletion,	
	16	Environmental policy in India	

Practicals		
	1. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes, Halophytes, Epiphytes and Parasites. 2. Conduct a study tour to minimum 2 ecosystems 3. One day visit to ecologically significant location (National parks/ Botanical garden) 4. Identify and prepare a list of IUCN categorized tree/plants list in the campus or the nearest region 5. Conduct a debate/discussion on current environmental issues 6. Visit a local polluted site and report major pollutants	**30**

Suggetsted Reading

1. Kumar, H. D. 2000. Modern Concepts of Ecology. Vikas Publishing House, New Delhi
2. Ahluwalia VK &Sunitha Malhotra (2009). Environmental science, Ane Books PvtLtd.
3. Krishnamoorthy K V (2012)An Advanced text book of Biodiversity Conservation,
4. Kumaresan B. (2009). Plant Ecology & Phytogeography– Rastrogi Publications :
5. Misra S P and Pandey S N. (2009). Essential Environmental studies, Ane Books Pvt.Ltd
6. Odum Eugene P (2018)– Fundamentals of Ecology, 5 thEdn. Philladephia&Saunders,
7. Principles and Practise, Oxford& IBH publishers Co Pvt. Ltd

References

1. Prithipal Singh, (2007). An Introduction to Biodiversity. Ane Books Pvt.Ltd
2. .Sharma, P. D. 2004. Environmental Biology, Himalaya Publications.
3. Stiling, P. 2012. Ecology: Global Insights and Investigations, McGraw- Hill Companies, NewYork.
4. Chapman, J. and Reiss, M. (2000). Environmental Biology. Cambridge University Press
5. AravindKumar.(2009).Pollution and Biodiversity, Biosocial aspects, , DayaPublishingHouse
6. 14. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.

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	Define and explain natural resources. Discuss the factors affecting the availability of natural resources, their conservation and management.	R, U	PSO-1,2
CO-2	Assess the dynamics and types of ecosystems.Identify key features of ecosystems and understand the interrelationships between organisms within a simple ecosystem.	R, U,C	PSO-5
CO-3	Interpret and compare the species interactions and adaptations	U,E	PSO-5
CO-4	Analyze various threats to our biodiversity and able to suggest measures for conservation Strategies.	R,U,Ap	PSO-5
CO -5	Students are able to take part in the message of sustainable use of resources and conservation of biodiversity to the public and young generation	R,U,E	PSO-5,6,7

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

Name of the Course: Environmental sciences
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,T	

2	2	5	R, U,C	F,C	L,T	
3	3	5	U,E	F,C	L,T	P
4	4	5	R,U,Ap	C.P	L,T	
5	5	5,6,7	R,U,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	**BOTANY**				
Course Code	**UK3DSCBOT205**				
Course Title	**BIOPHYSICS AND BIOSTATISTICS**				
Type of Course	**DSC**				
Semester	**III**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	No Pre-requisites				
Course Summary	Students will be able to understand the concept of bioenergetic, biophysical properties, tools, and techniques in biophysics. Students will be able to carry out data collection and statistical representation of data. Develops skills to interpret scientific data using basic statistical methods.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Bioenergetics & Biophysical properties**	05
	1	Concepts of free energy, Thermodynamic principles in Biology. Entropy, Oxidation-reduction, redox potential.	
	2	Energy requirements in cell metabolism, role and structure of mitochondria, high energy phosphate bond, electron transfer phenomenon, and biological transfer.	
II		**Tools and Techniques in Biophysics I**	10
	3	Principles and applications of light and electron microscopy - Scanning and Transmission electron microscopy.	
	4	Principles and applications of Spectrophotometer (UV-visible)	
	5	Chromatography: Principle and types -Adsorption and partition chromatography. Thin layer chromatography, column chromatography, gas chromatography, HPLC.	
III		**Tools and Techniques in Biophysics -II**	07
	6	Electrophoresis: Horizontal and vertical gel electrophoresis, PAGE and AGE.	
	7	Centrifugation- Basic principles of centrifugation, RCF (relative centrifugal force), sedimentation coefficient, Ultracentrifugation, Density gradient, and Differential centrifugation.	
	8	pH meter- Principles and applications, Buffers-their functions in biological systems.	
IV		**Biostatistics - Data Collection and Handling**	08

	9	Nature and types of data - Typical examples, Collection, classification, and tabulation of data.	
	10	Diagrammatic and graphic representation. Line diagram, Bar diagram, Pie diagram, Histogram, Frequency curve, frequency polygon, Ogives.	
	11	Statistical terms and symbols. Measures of central tendencies for discrete data (mean, median, mode).	
	12	Measures of dispersion (range, mean deviation, variance, standard deviation, standard error)	
V	**Statistical treatment of data**		**15**
	13	Samples and sampling techniques – simple random sampling, systematic sampling, and stratified sampling., Errors.	
	14	Significance tests (chi-square test & t test). Correlation and regression analysis	

Practicals		
	1. Separation of plant pigments by paper chromatography/TLC. 2. Preparation of buffer 3. Measurement of pH 4. Construct the absorption spectrum of any sample. 5. Familiarise students to equipment like Centrifuge 6. Spectrophotometer, pH meter,Electrophoresis. 7. Workout problems on frequency distribution 8. Represent data using bar diagram and histogram 9. Measures of central tendencies (Mean, Median, Mode) 10. Workout problems on measures of dispersion (range, mean, deviation, variance, standarddeviation, standard error) 11. Workout problems on chi-square test.	**30**

Suggested Reading

1. Banerjee, P.K. (2006). Introduction to Biostatistics. S. Chand and Company Ltd., Ram Nagar, New Delhi
2. Balaji, K., Raghavaiah, A.V.S. & Jayaveera, K.N. Biostatistics. I.K. International Pub. House.
3. Essential Biophysics, Narayanan, New Age Publ
4. Williams, B. L. and Wilson, K. (1983). A Biologist's Guide to Principles Techniques of Practical Biochemistry

References

1. Methods in Molecular Biophysics, Igor N S, N Zaccai & J Zaccai, (2007), Cambridge
2. Principle of Biochemistry, D Voet, J Voet and CW Pratt, 3rd Ed,
3. Advanced Methods in Protein Microsequencing, Witmann Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley

Weblink

1. https://www.britannica.com/science/chromatography/Elution-chromatography

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will be able to identify the major aspects in bioenergetics and thermodynamics of living system	R, U	PSO-3
CO-2	Students learn the fundamentals of instruments and techniques used in Biology	R, U	PSO-5
CO-3	Students will be able to conduct experiments using analytical instruments	Ap, E	PSO-7,8,9
CO-4	Students apply the statistical methods for data analysis and will be able to validate experimental hypothesis	An, AP, E	PSO-8

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

Name of the Course: Biophysics and Biostatistics

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	3	R, U	F, C	L,T	
CO-2	2	5	R, U	F, C	L,T	P
CO-3	3	8, 9	Ap, E	P		p
CO-4	4	8	An, AP, E	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	✓	✓		✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK4DSCBOT201**				
Course Title	**LOWER CRYPTOGAMS, PHYTOPATHOLOGY AND MICROBIOLOGY**				
Type of Course	**DSC**				
Semester	**IV**				
Academic Level	**200 - 299**				
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
I		**Phycology**	**11**
	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 (*Nostoc)* Chlorophyceae (*Oedogonium*) Bacillariophyceae (*Pinnularia*) Phaeophyceae (*Sargassum*) Rhodophyceae(*Polysiphonia*)	
II		**Mycology**	**10**
	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 -*Rhizopus* Ascomycetes - *Penicillium* Basidiomycetes – *Puccinia, Agaricus*	
III		**Lichenology**	**03**
	5	General account, ecological and economic importance; types of Lichen - Crustose, Foliose and Fruticose.	
	6	Morphology, anatomy, and reproduction of *Usnea*	
IV		**Plant pathology**	**06**

	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.	
V	**Microbiology**		**15**
	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.	

Practicals		
	1. Gram staining of bacteria. 2. Make micro preparations of vegetative and reproductive structures of the algal and fungal types mentioned in the syllabus. 3. Identify the algal specimens up to the generic level and make labeled sketches of the specimens observed 4. Identification of Different Lichens mentioned in the syllabus. 5. Identify the causal organism and symptoms of Leaf mosaic of Tapioca, Citrus Canker, and Blast disease of Paddy. 6. Prepare the fungicides- Bordeaux mixture &Tobacco decoction 7. Algal and fungal sample collection from different localities.	**30**

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.ll Books and Allied Press LId Kolkta. 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	**BOTANY**				
Course Code	**UK4DSCBOT202**				
Course Title	**ARCHEGONIATES AND PALEOBOTANY**				
Type of Course	**DSC**				
Semester	**IV**				
Academic Level	**200 - 299**				
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 students with the characteristic features and evolutionary significance of archegoniates. To impart knowledge about fossil formation and its significance To give a basic outlook towards the ecological and economic significance of Archegoniate.				

Detailed Syllabus:

Module	Unit	Content	Hrs
		Bryophytes	
I	1	**Bryophytes**- General characters and classification by Proskauer (1957)	**08**
	2	Study of habit, thallus organization, vegetative and sexual reproduction and alternation of generation of the following types (Developmental details are not required) *Riccia, Polytrichum*	
	3	Economic Importance of Bryophytes.	**08**
		Pteridophytes	
II	4	Introduction: General characters. Classification as proposed by Smith(1959)	
	5	Study of the habitat, habit, internal structure, reproduction and life cycle of the following types (Developmental details not required). *Selaginella* and *Pteris*	
	6	Economic importance of Pteridophytes	
		Gymnosperms	
III	7	Introduction –General characters and classification by Sporne,(1965).	**10**
	8	Study of the habit, anatomy, reproduction and life cycle of the following types (Developmental details are not required) *Cycas*, *Pinus* and *Gnetum*	
	9	Economic importance of Gymnosperms	
		Paleobotany	
IV	10	Fossil formation, types of fossils.	**04**
	11	Fossil Pteridophytes- *Rhynia*,	

		Fossil gymnosperms-*Lyginopteris*	
V	**Identification, collection and preservation of archegoniates**		**15**
	12	Archegoniates,-Features, Transition to land habit, Collection and preservation methods, Conservation studies	
	13	Alternation of generations, lifecycle Patterns, eusporangiate and leptosporangiate sporangia	
	14	Field Visit to collect bryophytes, pteridophytes and gymnosperm specimens and submit a detailed report with geotagged photos for evaluation.	

Practicals		
	1. *Riccia*- Internal structure of thallus 2. *Polytrichum*- Morphology - archegonial cluster, Antheridial cluster, SporophyteV.S 3. *Selaginella* – T.S of stem and rhizophore, T.S of Strobilus, *4. Pteris* - T.S of Rachis, T.S of Sporophyll, Prothallus 5. *Cycas*- T.S of leaf, coralloid root (morphology). Micro and megasporophyll 6. *Pinus*- spur shoot, T.S. of needle, male and female cone. 7. *Gnetum*- T.S of stem and leaf, male and female cone (morphology) 8. Permanent slide/ images of Fossils – *Rhynia*, *Lyginopteris*	**30**

Suggested Reading

1. Pandey B.P.2010. College Botany Vol II, Chand Publications, New Delhi
2. PariharN.S.2015. An Introduction to Embryophyta- Pteridophytes Surjeet Publications
3. Rashid.A.2012. An introduction to Bryophytes, Vikas Publishers N Delhi
4. Chopra RN and Kumra P K.2005.Biology of Bryophytes –New age international Publ.
5. Cutler. J. M. - and Chamberlain C.J.958.Morphology of Gymnosperms -Central Book Depot ,Allahabad
6. Gupta V .K. and Varshneya U.D.1967. An Introduction to Gymnosperms–Kedarnath,
7. Pandey.B.P.1972.College Botany Vol I, Chand Publications, New Delhi

References

1. Sambamurthy A.V.2005.A textbook of Bryophytes, Pteridophytes, Gymnosperms
1. and Palaeobotany I K International PVT LTD.
2. Sharma A K and Rajeswari Sharma.2010. Palaeobotany and Gymnosperms
3. Sharma OP.2016.Gymnosperms. Pragathi Prakashan. Meerut
4. Smith G.M.1955.Cryptogamic Botany – Vol.II – Mc Graw Hill Co. NewDelhi
5. Sporne K.R.1966. Morphology of Pteridophytes - Hutchin UniversityLibrary, London

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed

CO-1	Explain the general characters of Archegoniates and formation of fossils	R,U	PSO-1,2
CO-2	Classify archegoniates to different plant groups	U,Ap	PSO-1,2
CO-3	Compare the structure of gametophyte and sporophyte of Archegoniates	U, An	PSO-1,2
CO-4	Assess the economic and ecological significance of Archegoniates	U, An	PSO-4, 6
CO-5	Investigate the diversity of archegoniates	Ap, An, E	PSO-1

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

Name of the Course: Archegoniates and Paleobotany
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, T	
2	2	1, 2	R, U	F, C	L, T	
3	3	1, 2	R, U	F, C	L, T	
4	4	4, 6	R, U	F, C	L, T	P
5	5	1, 2	R, An	F, C	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		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK5DSCBOT301**				
Course Title	**MORPHOLOGY AND PLANT SYSTEMATICS**				
Type of Course	**DSC**				
Semester	**V**				
Academic Level	**300 - 399**				
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, UK2DSCBOT101**				
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
I		**Morphology of Flowering Plants**	**08**
	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.	
II		**Nomenclature and Systems of angiosperm classification**	**06**
	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).	

III	**Taxonomic aids**		**04**
	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).	
IV	**Systematic study of Angiosperm families**		**12**
	9	A detailed study (Systematic position, distribution, common members, diagnostic features, vegetative, floral characters, and economic importance of the following families: 1. *Annonaceae,* 2. *Malvaceae* 3. *Rutaceae,* 4. *Leguminosae with sub-families* 5. *Rubiaceae* 6. *Asteraceae* 7. *Sapotaceae* 8. *Asclepiadaceae* 9. *Solanaceae* 10. *Acanthaceae* 11. *Lamiaceae* 12. *Euphorbiaceae* 13. *Orchidaceae* 14. *Liliaceae* 15. *Poaceae*	
V	**Modern techniques in plant systematics**		**15**
	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	

Practicals		
	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.	**30**

	5. Visit to a recognized Herbarium- Report of the same with photographic evidence should be submitted for the practical examination. 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. 7. Submission of not less than 15 properly identified Herbarium sheets with author citation, should be done during the practical examination. 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.	

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	**BOTANY**				
Course Code	**UK5DSCBOT302**				
Course Title	**PLANT GENETICS**				
Type of Course	**DSC**				
Semester	**V**				
Academic Level	**300 – 399**				
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
I		**Heredity and Variation**	**10**
	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. ***Learning Activity:-*** Work out the problems related with monohybrid and dihybrid crosses and Test crosses.	
II		**Modified Mendelian ratios**	**15**
	2	Incomplete Dominance- Flower colour in *Mirabilis jalapa* ; co-dominance- MN blood group in man; gene interactions (non-allelic interactions)- Complementary gene action- flower colour in *Lathyrus odoratus*; Epistasis- dominant (fruit colour in *Cucurbita pepo*) and recessive (coat colour in mice); Collaboratory gene action- comb patterns in domestic fowls; Duplicate gene action- seed shape in *Capsella bursa pastoris*; Duplicate gene with cumulative effect- fruit shape in *Cucurbita pepo*, Inhibitory gene action- leaf colour in *Oryza sativa*. ***Learning Activity:-*** *Work out the problems related with different allelic and non-allelic interactions.*	
	3	Multiple allelism- ABO blood group in man, self-sterility in *Nicotiana tobacco*; Rh factor.	

	4	Quantitative characters- General characteristics, polygenic inheritance- Skin colour in man, ear size in *Zea mays*.	
III	**Role of chromosomes**		**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. ***Learning Activity:-*** *Work out the problems related with two point and three point test crosses*	
IV	**Sex determination and inheritance patterns**		**10**
	6	Sex determination in organisms- Chromosome basis of sex determination (XX-XY, XX-XO types), sex determination in higher plants- *Melandrium album*; Genic balance theory.	
	7	Sex linked inheritance- X linked (Haemophilia and eye colour in Drosophila), Y linked (Hypertrichosis pinnae) and XY linked (Bobbed bristles in Drosophila)	
	8	Extra chromosomal inheritance- Maternal effect, Plastid inheritance in *Mirabilis jalapa*, inheritance of kappa particles in Paramecium.	
V	**Applying genetics: Analysis, disorders, and population genetics**		**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 VIth 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 Publocations.

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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK5DSCBOT303**				
Course Title	**CELL BIOLOGY AND EVOLUTIONARY BIOLOGY**				
Type of Course	**DSC**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	04 Hours	-	-	04 Hours
Pre-requisites	UK3DSCBOT201				
`Course Summary	This course gives the basic idea of the cell and its ultrastructure which help to establish the relationship between the structure and function of the different cell organelles/compartments. Cellular communication gives an idea about how cells communicate to function as an organism and interact with the environment. It also deals with the origin and evolution of life which explains the basic principles governing the adaptations to changes in environment.				

Module	Unit	Content	Hrs
I		**Cell ultrastructure**	**10**
	1	A brief account of the structural and functional organization of the cell and cell organelles - chloroplast, mitochondria and nucleus (detailed account)	
	2	Structure of chromosomes-Nucleosome model, structure, and function of the kinetochore, NOR, and other secondary constrictions, satellites, heterochromatic segments, and telomeres. ***Learning Activity:*** *- Study of Cell ultrastructure and cell organelles using 3D models*	
II		**Cell Division, Différentiation, and Cell Death**	**13**
	3	Cell Division- Stages in cell cycle, mitotic phases, mitotic apparatus, and cytokinesis. Meiosis – General description, synaptonemal complex, stages of meiosis I and II, molecular mechanism of crossing over. ***Learning Activity: -*** 1. *Identification of different stages of Mitosis using Onion root tips.* 2. *Demonstration of Meiosis using Allium cepa Chlorophytum flowers*	
	4	Cell differentiation and death - Molecular mechanism of cell differentiation, Stem cells. Apoptosis; Cancer- carcinogens, oncogenes, tumor suppressor genes.	
III		**Signaling pathways in plants**	**10**

	5	Plant hormones and signaling pathways, light signaling and photomorphogenesis, signaling in plant growth and development.	
	6	Signal perception and transduction in plant responses to environmental stimuli, crosstalk between signaling pathways in plants. Cell polarity (brief account only)	
IV	**Origin and Evolution of life**		**12**
	7	Introduction with the aspects of pre-biotic and molecular evolution; brief outlook on the classical theories of evolution, modern theory of synthesis.	
	8	Forces of evolution- Mutation, genetic drift, natural selection; speciation-allopatric, peripatric, parapatric and sympatric.	
	9	Evolution above species level: Brief account of molecular evolution citing the role of chromosome number, genome size and structure and organelle DNA; origin of new genes by gene duplication, chimeric genes and the role of viruses in directing evolution.	
V	**Cellular communication**		**15**
	10	Introduction to cell signalling, cell surface receptors and ligands, signal transduction pathways, secondary messengers, and regulation of signalling pathways.	
	11	Bacterial and two-component systems, bacterial chemotaxis and quorum sensing.	
	12	Regulation of hematopoiesis, general principles of cell communication, gap junctions, extracellular matrix, cell adhesion, and role of different adhesion molecules.	

Suggested Readings

1. De Robertis and De Robertis (2017) Cell and Molecular Biology. 8 Edn., B. I. Waverly Pvt Ltd. New Delhi.
2. J.D. Watson et. al., (2017) Molecular biology of the gene. 7th Edn. Cold Spring Harbor Laboratory, Tania, MIT
3. Janet Iwasa and Wallace Marshall (2020) KARP'S Cell And Molecular Biology 9th Edn., John Wiley & Sons, Inc.
4. Harvey Lodish et.al. (2016) Molecular Cell Biology 8th Edn. W. H. Freeman and Company
5. Strickberger MW (2013) Evolution, 5th Edn., Jones and Bartlett Publishers, New York.
6. Graur, D. & Li, W.-H. (2000). Fundamentals of molecular evolution., 2nd Edn., Oxford University Press. Sinauer.
7. Cooper G. M (2013) The Cell – A Molecular approach,. 6th Edn., Sinauer Associates Inc, Sunderland, USA.

References

1. Jocelyn E. Krebs, E. S. Goldstein & S. T. Kilpatrick (2017) Lewin's Genes XII, 12th Edn., Jones & Bartlett Learning, Burlington, USA
2. Bruce Alberts et.al., (2014) Molecular Biology of the Cell 6th Edn. Garland Science, Taylor & Francis Group, LLC

3. Sproule A (2022) Charles Darwin (Scientists who have changed the world.) Crabtree Publishing Co,USA.
4. Bergstrom CT & Dugatkin L.A (2023) Evolution, 3rd Edn., WW Norton & Co, New York.
5. James A. Shapiro (2011) Evolution A View from the 21st Century. Prentice Hall, New Jersey, USA

Web link

1. https://plato.stanford.edu/entries/cell-biology/
2. https://education.nationalgeographic.org/resource/resource-library-cell-biology
3. https://learn.genetics.utah.edu/content/basics/
4. https://evolution.berkeley.edu/evolution-101/an-introduction-to-evolution/
5. https://bio.libretexts.org/Bookshelves/Botany/Botany_(Ha_Morrow_and_Algiers)/
6. Unit_0%3 A_Introduction_to_Botany/01%3A_Introduction/1.03%3A_Intro_to_Evolution

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the ultrastructure of cells, and the function of different cell organelles and help to correlate their structure and function.	U, An	PSO-2
CO-2	Understanding the principles regulating cell multiplication and death; helps to recognise the reason for various diseases associated with the malfunctioning of the processes.	U, An	PSO-2
CO-3	Identify different stages of cell division.	Ap	PSO-2
CO-4	Understand basic principles of cellular and extracellular communication and help to realise how cells coordinate to function as an organism and how they interact with the environment.	U, An	PSO-2
CO-5	Understand the basic principles of evolution and apply them to analyze the adaptations developed in plants	U, An	PSO-2,4

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

Name of the Course: Cell biology and Evolutionary biology

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	U, An	F,C	L,T	

2	2	2	U, An	F,C	L,T	
3	3	2	Ap	F,C	L,T	P
4	4	2	U, An	F,C	L,T	P
5	5	2,4	U, An	F,C	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	**BOTANY**				
Course Code	**UK6DSCBOT301**				
Course Title	**PLANT PHYSIOLOGY**				
Type of Course	**DSC**				
Semester	**VI**				
Academic Level	**300 – 399**				
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
I		**Water absorption and mineral nutrition**	**07**
	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	
II		**Carbon Assimilation**	**07**
	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	**Transport and Break down of Molecules**		**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	**Physiological Response of Plants**		**08**
	7	Plant Growth: Definition, different phases of growth, Sigmoid curve, Measurement of growth; Growth regulators: Physiological effect and practical applications - Auxins, Gibberellins, Cytokinins, Abscisic 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	**Plant Physiology for Human Beings**		**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.	

Practicals		
	Study of the following experiments (1-7) and set up any of the experiments by students. 1. Demonstration of osmosis using Osmoscope. (Thistle funnel/papaya petiole experiment) 2. Incipient Plasmolysis using Rheo peel. 3. Determination of water absorption and transpiration ratio. 4. Calculation of the stomatal index and comparison of the stomatal frequency of any three mesophytes. 5. Observe and record deficiency symptoms of plants grown in nutrient-deficient solutions (N, P, Mg, K) over a period of time.	**30**

	6. Observe and record the effect of growth regulators (Auxin/Cytokinin/Gibberllin) 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_2 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.	

Suggested Readings

1. Devlin R M & Witham F H (1986). Plant Physiology4thEdition, 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 andEcology, Jaya Publishing House, N Delhi
4. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5thEdition.
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- NewDelhi.
4. Noggle G R & Fritz G J (1983) . Introductory Plant physiology 2nd Edition, Prentic 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	**BOTANY**				
Course Code	**UK6DSCBOT302**				
Course Title	**ENVIRONMENTAL SCIENCE AND CONSERVATION BIOLOGY**				
Type of Course	**DSC**				
Semester	**VI**				
Academic Level	**300 - 399**				
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	Fundamental concepts of ecosystems and ecosystem management are included in this course. Biodiversity management including threats, conservation strategies, legislations, and international conventions are analyzed in detail. The impact of society on the environment and the role of humans in mitigating environmental problems are also introduced..				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Ecosystems**	**15**
	1	Ecological Hierarchy: Individual & Species, Populations & Communities, Ecosystems, Biomes and Biosphere. (Brief account). Basic Components of ecosystems: Abiotic (Sunlight, temperature, soil, water and atmosphere) and Biotic components (Producers, consumers and decomposers).	
	2	Characteristics of a community: Species diversity- richness, evenness, stratification, dominance, ecological indicators. Ecotone and Edge effect, Concepts of Ecological Niche and Guild.	
	3	Concept of ecosystem: Productivity- Gross and Net, Primary productivity, Secondary Productivity. Energy efficiency. Food chain, Foodweb. Ecological pyramids- number, biomass, energy- Energy flow, (Lindeman's "Law of 10%".) Biogeochemical cycles: Gaseous and Sedimentary cycles, Carbon cycle, Nitrogen cycle. **(**Detailed study of anyone). Ecological succession: Primary, Secondary, Seasonal. (Detailed study of anyone). Ecosystem goods and services: Supporting services, Provisioning services, Regulating Services, Cultural Services. UN Millenium Ecosystem Assessment (MA)2000.	

		Ecosystem Types: Terrestrial: Forest, Grassland, Desert, Aquatic: Marine, Freshwater. Plant adaptations for survival: Morphological, anatomical & physiological adaptations - Hydrophytes, Xerophytes, Halophytes, Epiphytes, Parasites Biomes: Forest Biome, Grassland Biome, Desert Biome, Aquatic Biomes. ***Learning Activity:-*** 1. Comparison and recording ecological adaptations of different plants from different ecosystems. 2. Visit to ecologically significant locations (National parks/ mangroves/estuaries).	
II	**Natural Resources**		**08**
	4	Natural Resources: Land, Water, Energy, Forests, & Wildlife. Degradation of natural resources: Land and water resources, over-exploitation, deforestation, agriculture, mismanagement, desertification, overgrazing, soil erosion, mining, urbanization, and industrialization. Conservation of Natural resources and sustainable lifestyles-Afforestation, Regeneration of wasteland, Rainwater harvesting, Groundwater enrichment; Promoting the use of renewable resources: solar, tidal, and wind; biofuels. Reforestation, Community forestry programs.	
III	**Biodiversity**		**10**
	5	Biodiversity: Definition and Significance - Levels of biodiversity: Genetic, Species and Ecosystem; Biodiversity in India - Biogeographical regions(Brief account); India as a Mega Diversity Nation- Hotspots of Biodiversity- criteria, hotspot in India, Hopespots; Endangered and endemic plant species in India- Threats to Biodiversity- (loss of habitat, poaching, man-wildlife conflict, . Over exploitation). Endangered and endemic species of India-plants: - *Orchid sp., Nepenthes khasiana*. Keystone species, Umbrella species, and Flagship species.	
IV	**Conservation Biology**		**15**
	6	Conservation Strategies: in-situ and ex-situ conservation. In situ (on-site)- National Parks, Wildlife Sanctuaries, Biosphere reserves, World Heritage sites. RAMSAR Convention and RAMSAR sites in India. Ex-Situ Conservation: Seed gene bank, botanical gardens, and wildlife safari parks- CITES and 2020 Global Biodiversity Agenda. Global and National Conservation Initiatives: Stockholm Convention (2001), Aichi Biodiversity Targets(2020). NBAP 2008. Kerala State Biodiversity Board (KSBB), Peoples Biodiversity Register(PBR). ***Learning Activity:-*** 1. Preparation of biosphere reserve map of India. 2. Preparation of RAMSAR site map of India 3. Prepare a map of Kerala showing Protected Area Network (PAN) in it.	

		4. Familiarisation of Green Protocol and EIA process using any Environmental Consultancy Services / NGO.	
	7	Environmental Issues: Definition of Pollution, Types: Air, Water, Soil, Noise, Radiation, and Thermal, Hazardous waste; pollution control measures- Waste reduction at source, Solid waste management, 3R's in waste management- Bharat Stage emission standards (BS 2000), Case study: Namami Ganga Project. Climate change- Global warming and Sea level rise, Desertification, Acid rain, Ozone layer depletion, Nuclear accidents. International climate change agreements-Montreal protocol(1987), Basel convention(1989) ,UNFCCC(1992), UNCCD(2007).	
V	**India centric aspects of Biodiversity.**		**12**
	8	Major forest types of India - IUCN Red Data Book Categories, Blue Flag Beaches of India- Wetlands in India- NWCP Aim and Objectives. Mangrove forests - Mangrove distribution in Kerala, Common mangrove plants, Green Coast Project, Coral Reefs in India: types, Global threats to coral reefs. CRZ norms. Biodiversity act 2002, National Clean Air Programme (NCAP).	

Suggetsted Readings

1. Kumar, H. D. (2000). Modern Concepts of Ecology. Vikas Publishing House, New Delhi
2. Ahluwalia VK &Sunitha Malhotra (2009). Environmental science, Ane Books PvtLtd.
3. Krishnamoorthy K V (2012). An Advanced text book of Biodiversity Conservation.
4. Kumaresan B. (2009). Plant Ecology & Phytogeography– Rastrogi Publications.
5. Misra S P and Pandey S N. (2009). Essential Environmental studies, Ane Books Pvt.Ltd
6. Odum Eugene P (2018)– Fundamentals of Ecology, 5 thEdn. Philladephia&Saunders,
7. Principles and Practise, Oxford& IBH publishers Co Pvt. Ltd

References

1. Prithipal Singh, (2007). An Introduction to Biodiversity. Ane Books Pvt.Ltd
2. Sharma, P. D. (2004). Environmental Biology, Himalaya Publications.
3. Stiling, P. (2012). Ecology: Global Insights and Investigations, McGraw-Hill Companies, NewYork.
4. Chapman, J. and Reiss, M. (2000). Environmental Biology. Cambridge University Press
5. Aravind Kumar (2009). Pollution and Biodiversity, Biosocial aspects, , DayaPublishingHouse
6. Hardy, J.T. (2003). Climate Change: Causes, Effects and Solutions. John Wiley & Sons.

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	Recognize different types of pollution and their impacts on natural resources.	U,R	PSO-1
CO-2	Apply techniques for studying plant communities	U,Ap	PSO-2
CO-3	Compare biodiversity between different plant communities.	An	PSO-2
CO-4	Measure the impact of environmental stress conditions on plants.	An	PSO-5
CO-5	Comprehend the scope and enforcement of environmental legislation.	Ap	PSO-6,7

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

Name of the Course: Environmental Science and Conservation Biology

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	U,R	F, C	L, T	
2	2	2	U,Ap	F, C	L, T	
3	3	5	An	F, C	L, T	P
4	4	5	An	C.P	L, T	
5	5	6,7	Ap	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	**BOTANY**				
Course Code	**UK6DSCBOT303**				
Course Title	**BIOCHEMISTRY AND MOLECULAR BIOLOGY**				
Type of Course	**DSC**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	04 Hours	-	-	04 Hours
Pre-requisites	Basic knowledge of biology, including cell structure and function and Basic understanding of genetics				
Course Summary	The course is designed to provide a comprehensive understanding of the fundamental molecules that make up living organisms and the molecular mechanisms that govern cellular processes. The students will explore key concepts in molecular biology, such as DNA replication, transcription, translation, and gene regulation.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Biomolecules**	**15**
	1	Definition and classification of biomolecules – Micro and Macromolecules. Importance of biomolecules in plants	
	2	Carbohydrates : Structure and Function - Monosaccharides (Glucose, Fructose), disacharides (maltose and sucrose) and polysaccharides (Starch and cellulose).	
	3	Lipids- Fatty acids, triglycerides, classification- simple lipis(fat and oil), complex lipids (phospholipid and glycolipid), and derived lipids (cholesterol), Function	
	4	Proteins- Amino acids, peptide bonds, and protein structure levels (primary, secondary, tertiary, and quaternary)- Function.	
	5	Enzymes – Properties – classification - nomenclature - enzyme-substrate interaction – factors influencing enzyme action: temperature, pH, and substrate concentration.	
	6	Nucleic acids – Chemical Structure –Nucleotide composition of DNA and RNA, Watson and Crick model of DNA structure, Satellite and repetitive DNA; RNA structure-properties and functions of tRNA, mRNA, and rRNA.	

	7	***Learning Activity:-*** 1. Qualitative test of carbohydrate - Molisch's test, starch-iodine test reducing sugar - Benedict's test, 2. Qualitative test for proteins – Biuret test and Xanthoproteic test 3. Qualitative test for Lipids – Sudan test/ Translucent Oil drop test/ Solubility Test 4. Quantitative estimation of reducing sugar and protein in plant tissue	
II		**DNA Replication and Repair**	**15**
	8	DNA as genetic material- experimental evidence- Griffith's experiment on Bacterial transformation, Avery's experiment, Hershey-Chase Experiment.	
	9	Replication of DNA in prokaryotes- An overview, General principles and features, Semi conservative model- Meselson and Stahl experiment.	
	10	Leading strand and lagging strand synthesis, Okazaki fragments, replication fork and origin of replication; Unidirectional and Bidirectional replication; Replisome.	
	11	Enzymology of replication: topoisomerase, helicase, primase, polymerase, and ligase; Speed and accuracy of replication, Proof reading- Replication of DNA in eukaryotes (brief account only).	
	12	DNA repair –photoreactivation, Base excision repair, Nucleotide Excision Repair, Mismatch repair, Nonhomologous end joining, SOS repair system.	
	13	***Learning Activity:-*** 1. Study of semi-conservative replication of DNA through micrographs/ schematic representations 2. DNA extraction from plant tissue using CTAB method (demonstration)	
III		**Gene Expression – Transcription**	**08**
	14	Concept of gene-Units of a gene, cistron, recon, muton; Types of genes- Housekeeping genes (constitutive genes), Luxury genes (nonconstitutive genes), overlapping genes.	
	15	Transcription; Core Promoter and Regulatory Promoter, Transcription apparatus.	
	16	RNA Processing in eukaryotes- removal of introns by spliceosome; Capping and Tailing. Reverse transcription.	
IV		**Gene Expression – Translation**	**10**
	17	Translation – ultrastructure of ribosomes, genetic code. Amino acylation of tRNA- Initiation factors, Cap dependant and independent initiation in eukaryotes- Elongation – Verification of incoming tRNA by codon-anticodon interaction in the ribosome.	
	18	Transpeptidation mediated by ribozyme activity of 50S subunit. Translocation, Release factors, and Termination.	
	19	Post-translational modifications: glycosylation, ubiquitination, proteolytic cleavage	

V	**Regulation of gene expression**		**12**
	20	Regulation of gene expression in prokaryotes – DNA binding proteins with unique motifs.	
	21	Lac operon - negative and positive control	
	22	Transcriptional regulation in eukaryotes–Chromatin structure modification, DNA methylation, Histone acetylation, Enhancers and insulators, silencers, Activators, coactivators, repressors and silensors.	
	23	RNA interference; Epigenetic Regulation	

Suggested Readings

1. "Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox (2020, 8th Edition).
2. "Biochemistry" by Lubert Stryer (2019, 8th Edition)
3. "Harper's Illustrated Biochemistry" by Victor W. Rodwell, David Bender, et al. (2020, 31st Edition)
4. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman
5. Alexander McLennan, Andy Bates, Phil Turner, Michael White, BIOS Instant Notes in Molecular Biology 4th edition (2012).
6. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
7. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
8. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Web link

1. https://www.mcgill.ca/biochemistry/about-us/information/biochemistry
2. https://biochemistry.org/education/careers/becoming-a-bioscientist/what-is-biochemistry/
3. https://www.britannica.com/science/biochemistry
4. https://www.britannica.com/science/molecular-biology
5. https://study.com/academy/lesson/what-is-plant-physiology-definition experiments.html

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify important biomolecules and their applications in human welfare.	R,U	PSO-2
CO-2	Understand different processes of protein synthesis	R,U	PSO-2,4

CO-3	These studies will be helpful to students for a better understanding of the scientific principles and skillful implementation of the experiments.	An	PSO-6
CO-4	Able to understand the regulation of gene expression in prokaryotes.	U	PSO-2
CO-5	Apply practical techniques for the isolation, purification, and characterization of biomolecules.	Ap	PSO-4,6

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

Name of the Course: Biochemistry and Molecular Biology

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	2,4	R,U	F, C	L, T	
3	3	6	An	F, C	L, T	P
4	4	2	U	F, C	L, T	P
5	5	4,6	Ap	F, C	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		✓	✓	✓
CO 5		✓	✓	✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK7DSCBOT401**				
Course Title	**METHODOLOGY IN BIOLOGICAL RESEARCH**				
Type of Course	**DSC**				
Semester	**VII**				
Academic Level	**400 - 499**				
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 be proficient in basic mathematics for understanding statistical concepts. Students should possess basic skills in scientific writing for effectively communicating research findings.				
Course Summary	Methodology in Biological research is a comprehensive course designed to provide students with the necessary skills and knowledge to conduct scientific research in the fields of biology and related disciplines. The course covers essential topics in research design, data collection, statistical analysis, and interpretation of research findings. Emphasis is placed on understanding the principles of experimental design, data analysis techniques, and the application of biostatistics in biological research.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Biostatistics**	**04**
	1	Biostatistics - definition - statistical methods - basic principles. Variables -measurements, functions, limitations and uses of statistics.	
	2	Collection of data primary and secondary - types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data – sampling methods.	
	3	Measures of central tendency - mean, median, mode (grouped & ungrouped data).	
	4	Measures of dispersion - range, standard deviation, mean deviation, standard error, Co- efficiency of variations.	
	5	Testing of Hypothesis- Null and Alternative hypotheses; Concepts of statistical errors - Type I and Type II errors	
II		**Correlation patterns & statistical inference**	**06**

	6	Correlation - types and methods of correlation, regression, simple regression equation, similarities and dissimilarities of correlation and regression	
	7	Statistical inference - hypothesis - simple hypothesis - student's test - chi-square test, F-test, ANOVA, DMRT, TUKEY's Test,	
	8	Uses of advanced software - (MS Excel, SPSS, and R) in modern biostatistics.	
III	**Introduction to Research Methodology**		**08**
	9	Introduction - Objectives and motivations in research, Characteristics, and limitations of research – Components of research work - Criteria of good research.	
	10	Research process – Types of Research, Fundamental, Pure or Theoretical Research – Applied Research –Descriptive Research – Experimental Research – Qualitative and Quantitative Research.	
	11	Research Design – definition – concepts and features of a good research design - types of research design, Basic principles of experimental designs: concept of Independent & Dependent variables	
IV	**Research problem identification & Literature review**		**12**
	12	Defining a research problem: Selection and necessity of defining the problem– problem statement formulation – formulation of hypothesis- Qualities of a good Hypothesis- Null Hypothesis and Alternative Hypothesis; Hypothesis Testing: Logic and Importance.	
	13	Experimental design: methodology - Completely Randomised Design (CRD), Randomised Block Design (RBD), Latin Square Design (LSD).	
	14	Literature review: purpose, sources, and importance - review procedure- Formulation of the research objectives.	
V	**Essentials of Effective Scientific Writing**		**15**
	15	Report Writing – Different types – Format of Research report- Contents of the report –executive summary – chapterization – contents of a chapter – final proof -the title of the report	
	16	Research Paper: Research journal, Impact factor, indexing, Writing a research paper: using biological literature, deciding on a title, presenting the methodology, drafting and revising the content according to the journal requirements, citing sources in the text, and preparing the reference section.	
	17	Common tools for reference preparation: Reference Management Software like Zotero / Mendeley; Formats and Styles (APA, Chicago, MLA); Software for paper-formatting like LaTeX / MS Office, Software for detection of Plagiarism; Quoting, Paraphrasing, and Avoiding Plagiarism.	
	18	Ethical issues in research: Code of Ethics in Research – Importance of Ethics in Research. Ethical issues related to publishing- Plagiarism, and Self-Plagiarism.	

Practicals

	1. To collect data on different parameters (e.g. height/weight) of plant samples and test for significance, the difference between mean, mode, and median. 2. To compute the 'test of independence' and 'goodness of fit' with samples/data provided using the Chi-square test. 3. To compute the Coefficient of Variance from data collected and measure variability. 4. To perform test/ F test (ANOVA) for given samples/data provided. 5. To learn calculation and graphical representation of data using MS Excel/SPSS/R 6. Submission of Project report based on field studies (sample collection, data analysis, and interpretation using the above statistical tests)	**30**

Suggested Readings

1. Norman Bailey, T. J. (2012). Statistical methods in Biology, Cambridge University Press
2. Khan, I. A. and Khanum, A. (2008). Fundamentals of Biostatistics, 3rd edition
3. Richards, J. & Sunder Rao, P. S. S.(2006). An introduction to Biostatistics and research methods
4. Thomas, C. G. (2021). Research Methodology and Scientific Writing. Germany: Springer International Publishing.
5. Kumar, R. (2010). Research Methodology: A Step-by-Step Guide for Beginners. United Kingdom:SAGE Publications.

References

1. Veer Bala Rastogi, (2015). Biostatistics. 3rd edition. Medtech
2. Research Methodology: A Handbook for Beginners. (2017). (n.p.): Notion Press.
3. Research Methodology: A Practical and Scientific Approach. (2019). United States:CRC Press.
4. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. India: New Age
5. Dutta, N. (2002). Fundamentals of Biostatistics: Practical approach
6. Kothari, C. R. & Garg, G. (2018). Research Methodology. New Age International Publishers.
7. Gurumani, N.(2009). Research Methodology: for Biological Sciences. MJP Publishers, New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Develop the skills to collect and represent data in tabular and graphical forms.	U,An	PSO -1
CO-2	Analyze data and interpret experimental results using, spreadsheet software and online/offline software tools.	An	PSO -6

CO-3	Acquire basic skills to set up hypotheses and design research studies	U,E	PSO-7
CO-4	Enable students to differentiate among various experimental designs and apply appropriate statistical software tools.	E,Ap	PSO -7,9
CO-5	Basic understanding and skill to develop a research plan related to critical issues in plant science.	U,An	PSO- 6

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

Name of the Course: Methodology in Biological Research
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	U,An	P		P
2	2	4,6	An	P		P
3	3	7	U,E	F	L	
4	4	7,9	E,Ap	C	L	P
5	5	6	U,An	F	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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK7DSCBOT402**				
Course Title	**PLANT INTERACTION AND DEFENCE MECHANISM**				
Type of Course	**DSC**				
Semester	**VII**				
Academic Level	**400- 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	UK6DSCBOT301, UK6DSCBOT303				
` Course Summary	The course provides a understanding of different levels of plant interactions and defence mechanism seen in plants. Students will learn effectiveness of plant defense strategies and developing critical thinking skills to evaluate the significance of plant defense mechanism in agriculture, ecology etc				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Plant interaction and the factors triggering interaction**	**08**
	1	Plant interaction: Plant - Plant, allelopathy, competition & parasitism.	
	2	Factors influencing interactions – light & volatile organic compounds, root exudates, nutrient availability (Pi, NO_3-) - Effect of the interaction in the environment.	
	3	Role of protein -STOP 1, ALMT 1 or NRTs in triggering systemic movement.	
II		**Plant microbial interaction**	**08**
	4	Parasitic, endophytic, epiphytic, competition, commensalism, mutualism.	
	5	Symbiotic association with root nodule (NOD factor- lipochito oligosaccharide signalling).	
	6	Arbuscular mycorrhizal association - Role of Strigolactone in stimulating spore germination.	
	7	Rhizoplane, phyllosphere, spermosphere, plant growth promoting rhizobacteria (PGPR), root- root interaction.	
III		**Plant – pest interaction and resistance responses**	**08**
	8	Plant Defense against Pathogens and Herbivores, Principles, and concepts of host-parasite interaction.	
	9	Mediation of host-parasite specificity; Discriminatory events before and during penetration into plants.	

	10	Cytological changes in host and parasite after infection- Cross-protection and induced resistance.	
	11	Microbe associated molecular factors (MAMPs), Pathogen associated molecular factors (PAMPs), Plant Dynamin- Related Proteins (DRPs), Pathogenesis-related proteins (PRPs).	
IV	**Acquired and Induced systemic Resistance**		**06**
	12	Pre-existing and post-existing structural defense mechanisms in plants.	
	13	Systemic Acquired Resistance and Induced Systemic Resistance and Hypersensitive reaction	
	14	Major signaling pathways of plant defense mechanism- Jasmonic acid Pathway.	
	15	Role of phytoalexins and other phenolic compounds in defense mechanisms, their induced formation, and biosynthesis.	
V	**Defence Mechanism in Plants**		**15**
	16	Physical defense barriers- Structural defense – Epidermal structures - Cuticle, wax, Trichomes, Stinging cells, Thorns, spines.	
	17	Chemical defense- primary metabolites (Carbohydrate, Lipids, amino acids, proteins); Secondary metabolites- Terpenoids,Phenolics flavonoids, anthocyanins, tannin, lignin, furanocoumarins-Nitrogen compounds (alkaloids, cyanogenic glycosides).	

Practicals		
	1. Detection of ROS by NBT (nitrozolium blue tetrazolium) staining and submission of the result with photographs. 2. Ninhydrin staining of filter paper imprints to detect amino acids in root exudates and submission of the result with photographs.e 3. Cotton blue staining of root sections for detecting fungal endophytes and submission of the result with photographs. 4. Staining with phloroglucinol in monocot plants (Curcuma, Ginger, etc) after induction of defense by Salicylic acid (aspirin tablet) spray and submission of the result with photographs. 5. Germination of green gram in different leaf extracts to demonstrate allelopathic effect and submission of the result with photographs.	**30**

Suggetsted Readings

1. Barry Scott, (2022)Carl Mesarich. The Mycota. Plant Relationships : Fungal- Plant interactions. Third edition. Springer.
2. John .A. Bailey.(2022) Biology and Molecular Biology of Plant- Pathogen interactions. NATO ASI Series. Series H: Cell Biology. Vol.1
3. Gary Stacey, Noel. T. Keen.(1996) Plant- Microbe Interations. Volume. 1. Chapman and Hall.
4. Michel Nicole , Vivienne Gianinazzi- Pearson.(2022). Histology, Ultra structure and Molecular Cytology of Plant- Microorganism Interactions. Kluwer Academic Publishers.

5. Ajit Varma, Swati Tripaathi, Ram Prasad.(2019). Plant Biotic Interactions. State of the Art. Springer.
6. Khalid Rehman Hakeem and Mohd Sayeed Akhtar. (2016). Plant, Soil and Microbes. Mechanism and Molecular Interactions.Volume. 2. Springer.
7. Simardeep Kaur, Mahesh Kumar Samota, Manoj Choudhary, Mukesh Choudhary, Abhay K. Pandey, Anshu Sharma, and Julie Thakur .(2022). How do plants defend themselves against pathogens-Biochemical mechanisms and genetic interventions. Physiology and Molecular Biology of Plants. doi: 10.1007/s12298-022-01146-y

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To understand the significance of different interactions and defense mechanisms in plants.	U	PSO- 1
CO-2	To analyze the various defense mechanisms using laboratory techniques.	An	PSO- 2,3
CO-3	To evaluate the impact of various plant interactions	U,R	PSO -1,3,4
CO-4	To interpret the effect of plant interaction.	E	PSO- 4
CO-5	To acquire the skill of identifying different defense mechanisms in plants using laboratory techniques.	U,Ap	PSO- 2, 4

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

Name of the Course: Plant interaction and defense mechanism

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	U	F,C	L	-
2	2	2,3	An	F,C	L	-
3	3	1,3,4	U,R	F,C	L	P
4	4	4	E	F,C		P
5	5	2, 4	U,Ap	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	**BOTANY**				
Course Code	**UK7DSCBOT301**				
Course Title	**GENETIC ENGINEERING**				
Type of Course	**DSC (For Minors)**				
Semester	**VI1**				
Academic Level	**300 - 399**				
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 function and Basic understanding of genetics				
Course Summary	This course introduces students to foundational concepts in molecular genetics and genetic engineering. Students trace the historical journey of molecular biology and explore the structure and composition of DNA. They delve into gene structure, replication, and transcription mechanisms, advancing to gene regulation in prokaryotes and eukaryotes. The course delivers an understanding of biotechnological applications, ethical considerations, and entrepreneurship opportunities in the field.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Foundation of Molecular Genetics**	**06**
	1	"Tracing Molecular Biology's Journey: From DNA's Double Helix to Modern Breakthroughs"- Structure and composition of Double Helical Model of DNA, Compare B-DNA with A, Z, and cruciform types.	
	2	Basic structure and function of genes, units of a gene, types of gene, gene transfer within and between organisms	
	3	Overview of DNA replication, enzymes involved in DNA replication, errors in DNA replication and repair.	
II		**Recombinant DNA Technology**	**04**
	4	Processes of Recombinant DNA Technology: Isolation of DNA - Cutting of DNA at specific location - Amplification of gene of interest using PCR - Insertion of Recombinant DNA into Host- Obtaining the foreign gene product	
III		**Tools for Genetic Engineering**	**12**
	5	Important Tools for Genetic Engineering: Restriction enzymes- Discovery, types, and function- Ligation- mode of action of ligase- Vectors- Properties, and types. Cloning vectors- BR 322, pUC 19, Bacteriophage vector, Cosmids, YAC, and BAC- Suitable Host.	

	6	vectors for higher plants- Agrobacterium-mediated gene transfer mechanism.	
	7	Transformation in bacterial cells- Recombinant selection & Screening -use of chromogenic substrates, Insertional inactivation, Nucleic acid hybridization (Brief study only).	
	8	PCR amplification techniques- The key requirements for the PCR - DNA template- a pair of primers- DNA polymerase.RT-PCR, Nested PCR (Brief study only).	
IV	**Analysis of Cloned gene**		**08**
	10	Construction of cDNA library and Colony Hybridization, Nucleic acid probes (Radioactive and non-radioactive), Hybridization techniques: FISH, Northern, Southern, and Western blot techniques.	
	11	Applications–Pharmaceuticals: recombinant Insulin, Vaccine-Hepatitis-B)- Agriculture- Plants make their insecticide (Bt-brinjal), Herbicide-resistant crop (Roundup Ready) - Antiscence RNA technology(fruit ripening in Tomato)- Forensic science – DNA profiling **(**Crime suspects, Kinship study)- Gene editing- CRISPR-Cas9, TALENs, and zinc finger nucleases- Gene therapy. (Brief study only)	
V	**Controversies and Future Prospects of Genetic Engineering**		**15**
	12	Ethical issues-GM-Plants, gene therapy,Terminator technology, Legal, and Social Implications (ELSI) of genetic engineering, Regulatory Frameworks and Biosafety, Role of Artificial intelligence in genomic data analysis, Drug designing, and personalized medicine. Biotechnological entrepreneurship.	

Practicals		
	1. Isolate DNA from Plant tissue/ microbial culture 2. Find ORF and design PCR primer for a given DNA sequence using online softwares (BioEdit or EMBOSS or ORF finder- NCBI for ORF finding ,Primer-BLAST-NCBI or OligoAnalyzer-IDT or Oligo design tools- ThermoFisher for designing primers for PCR 3. Demonstration of PCR amplification of DNA 4. Perform an insilico restriction digestion experiment using online tools (NEBcutter or ApE plasmid editor or SMS sequence manipulation tool) 5. Demonstration of Restriction digestion of Genomic DNA/PCR product using Restriction Enzyme 6. Agarose Gel Electrophoresis of Genomic DNA/PCR product/digested DNA 7. Use NCBI tools to download nucleotide and protein sequences for genetic engineering- BLASTn, BLASTp 8. Visit a biotechnology research center or biotechnology startup facility.	**30**

Suggested Readings

1. Friefelder, D. 2005 Molecular biology. Second Edition.Narosa Publishing House.

2. Watson, J.D. et al., 2003 Molecular biology of the Gene. IV Edition. The Benjamin Cummings Pub.Co.
3. Gerald Karp 2002 Cell and Molecular Biology. John Wiley & Sons, NY.
4. Gupta, P.K. 2004 Cell and Molecular biology. III Edition, Rastogi Publications.
5. Friefelder,d. 2005. Molecular biology.Second edition.Narosa pub. House.
6. Lewin, b. 1994. Genes v. Oxford University Press.
7. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick (2014).Molecular Biology of the Gene

References

1. Sobtir. c. And gobe. 1991. Eukaryotic chromosomes. Narosa publishing house.
2. Smith-Keary, P. 1991. Molecular genetics.Macmillan pub. Co. Ltd. London.
3. Strickberger,M.W.1990. Genetics.Third edition. Macmillan Publishing Company.
4. Brown, T.A. (2015) Gene Cloning and DNA Analysis: An Introduction.
5. Bernard R. Glick and Jack J. Pasternak (2010)."Molecular Biotechnology:
6. Principles and Applications of Recombinant DNA

Weblink

1. https://www.thermofisher.com/blog/ask-a-scientist/what-is-molecular-biology/
2. https://www.britannica.com/science/molecular-biology
3. https://www.yourgenome.org/facts/what-is-genetic-engineering/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the Historical Development of Molecular Biology	U	PSO-2
CO-2	Comprehend the Structure and Composition of DNA	R, U	PSO-2
CO-3	Apply knowledge of gene expression regulation to interpret experiment data	Ap	PSO-6,7
CO-4	Compare expression levels of cloned genes in heterologous systems	An	PSO
CO-5	Design binary vectors using online tools for specific research goals	C	PSO

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

Name of the Course: Genetic Engineering

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

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK7DSCBOT302**				
Course Title	**PLANT METABOLIC PROCESSES**				
Type of Course	**DSC (For Minors)**				
Semester	**VI1**				
Academic Level	**300 - 399**				
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 cell biology and biochemistry				
Course Summary	Students should have a basic knowledge of the various physiological processes in plants, structure and function of various biomolecules in plants				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Concept of Metabolism**	**02**
	1	Introduction, anabolic and catabolic pathways, amphibolic pathways, and anapleurotic reactions.	
II		**Carbon assimilation**	**10**
	2	Concept of light-action and absorption spectra, photosynthetic pigments, the role of photosynthetic pigments (chlorophyll and accessory pigments (no structural details), antenna molecules, and reaction centers- Red drop and Emerson's enhancement effect.	
	3	Photochemical and chemical phases of photosynthesis- Two pigment systems - PSI, PSII- photophosphorylation-Q cycle, Z-scheme- CO_2 reduction.	
	4	C3cycle- C4 pathways, CAM (in brief, no pathway)- Photorespiration- factors affecting CO_2 reduction.	
III		**Carbon Oxidation**	**10**
	5	Aerobic respiration - glycolysis, Krebs‘s cycle- anaerobic respiration -fermentation- mitochondrial electron transport, oxidative phosphorylation, factors affecting respiration.	
	6	ATP Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation- The chemiosmotic mechanism, ATP synthase, the role of uncouplers, P/O ratio	
IV		**Nitrogen and Lipid Metabolism**	**08**
	7	Nitrate assimilation, biological nitrogen fixation, Physiology and biochemistry of nitrogen fixation.	
	8	Ammonia assimilation (GS-GOGAT),reductive amination and transamination.	

	9	Lipids: Synthesis and breakdown of triglycerides, beta-oxidation.	
	10	Glyoxylate cycle, gluconeogenesis, and its role in the mobilization of lipids during seed germination.	
V	**Sensory Photobiology**		**15**
	11	Sensory photobiology - Introduction- light receptors in plants- phytochrome, cryptochrome and phototropin- structure and function.	
	12	Mechanism: phytochromes - photomorphogenesis and flowering- Cryptochrome- hypocotyl elongation- phototropins- stomatal movement; chloroplast orientation -- photo movement (brief study).	

Practicals		
	1. Separation of chlorophyll pigments by chromatographic technique 2. Construct absorption spectrum of photosynthetic pigments. 3. Estimation of chlorophyll by colorimetric method 4. Hill activity by DCPIP/ ferricyanide reduction. 5. Physiological identification of CAM in plant species. Differentiation of CAM and non-CAM plants by titration. 6. Setting up of Plant Physiology experiments to measure Photosynthesis, and Respiration 7. To study the activity of amylases in germinating seeds.	**30**

Suggested Readings

1. DevlinR M & Witham F H (1986). Plant Physiology 4th Edition, C B Spublishers.
2. Lehninger (2012). Principles of Biochemistry 6th Edition,W H Freeman & Co.
3. Salisbury F. B. & Ross C.W. (2005) Plant physiology Wadsworth, publishing company.
4. Harborne, J. B. 1999. Plant Biochemistry. Chapman & Hall, New Delhi.
5. Jain, J. L. 2017. Fundamentals of Plant Physiology 19th Edition. S Chand Publishing
6. Taiz, L. & Zeiger, E. 2010. lant Physiology. 5th Edition. Sinauer Associates Inc., Publishers.
7. Hopkins W. G. & Hüner N. P. A. 2008. Introduction to Plant Physiology. 4thEdition John Wiley & Sons
8. Sinha S. K. 2013. Modern Plant Physiology 2nd Edition. Narosa Publishers.
9. Richard F Venn (2004). Principles and Practice of Bioanalysis, Taylor & Francis, Ane Books Pvt. Ltd.

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1. https://study.com/academy/lesson/what-is-plant-physiology-definition-experiments.html
2. https://www.vedantu.com/biology/plant-physiology
3. https://learn.careers360.com/biology/plant-physiology-chapter/
4. https://www.geeksforgeeks.org/most-important-questions-on-plant-physiology/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the regulation and integration of metabolic processes in plants with reference to crop productivity.	U	PSO -1
CO-2	Gain knowledge of physiological and biochemical processes in the plant system	U	PSO -1
CO-3	Analyze and interpret metabolic pathways in plants, including the identification of key intermediates, enzymes, and regulatory mechanisms involved in metabolic reactions	An	PSO-1,2
CO-4	Design and conduct experiments to investigate plant metabolic processes, including the selection of appropriate experimental techniques, data collection, analysis, and interpretation.	C	PSO -3
CO-5	Students will explore innovative approaches and technologies in plant metabolism research, including metabolic engineering, synthetic biology, and biotechnological applications.	C	PSO -4

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

Name of the Course: Plant metabolic processes

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	U	C	L	
2	2	1	U	F	L	
3	3	1	An	P	L	
4	4	2, 4,5	C	P		P
5	5	3,4	C	M		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	**BOTANY**				
Course Code	**UK7DSCBOT303**				
Course Title	**HEREDITARY SCIENCE**				
Type of Course	**DSC (For Minors)**				
Semester	**VI1**				
Academic Level	**300 - 399**				
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 cell biology and genetics				
Course Summary	Hereditary Science is a comprehensive study of the principles, mechanisms, and applications of genetics beyond the introductory level. The course delves into advanced topics in cytogenetics, population genetics, developmental genetics, biochemical & quantitative genetics and microbial genetics. Emphasis is placed on understanding the intricate mechanisms underlying genetic phenomena and exploring the practical applications of genetic knowledge in various fields.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Classical Genetics**	**06**
	1	Mendelian principles – Brief account and critical evaluation.	
	2	Linkage, recombination, and linkage maps – Bateson's concept of coupling and repulsion. Morgan's concept of linkage, linear arrangement of genes, linkage groups, complete and partial linkage, recombination linkage maps, three-point test crosses, interference, coefficient of coincidence, and negative interference	
	3	Sex determination and Dosage Compensation: Sex determination patterns in flowering plants-A detailed account of the following chromosomal mechanisms- XX-XY, XX-XO, ZZ-ZW. Lyon's hypothesis.	
II		**Cytogenetics**	**08**
	4	Chromosome morphology, Chromosome Variation – Structural and Numerical variations in chromosomes –Structural: Deletions, Duplications, Inversions and translocations. Meiotic behavior of structural variants. Numerical: Euploids and aneuploids. Meiotic behavior of numerical variants. chromosome banding.	
	5	Human genetics: Pedigree analysis, Abnormal karyotypes, genetic disorders.	
III		**Population &Evolutionary Genetics**	**10**

	6	Allele frequencies, genotype frequencies, Hardy- Weinberg law, the role of natural selection, mutation, genetic drift, genetic variation, and speciation(modes of speciation and genetics of speciation).	
	7	Genetic control of development in plants with stress to developmental genes in *Arabidopsis.* Role of cytoplasm in development.	
IV	**Biochemical & Quantitative Genetics**		**06**
	7	Inborn errors of metabolism- Major types of metabolic errors in man: Phenylketonuria, Alkaptonuria, Albinism, Tyrosinosis, and Goitrous cretinism.	
	8	Nature and inheritance of continuous traits, Quantitative Genetic Analysis, Heritability, Response to Selection, Genetic Correlations, Quantitative Trait Loci, QTL analysis.	
V	**Microbial Genetics**		**15**
	9	Genetic recombination in viruses – lysogenic and lytic cycles in bacteriophages. Retroviruses, reverse transcriptase, onco viruses, and oncogenes.	
	10	Bacterial recombination-transformation experiment of Griffith, Avery *et al.* Conjugation – F+, F-, and Hfr F- conjugations. Conjugation mapping – F– duction (sexduction)- Transduction-generalized and specialized. Recombination in fungi (tetrad analysis in *Neurospora*), Complementation tests.	

Practicals		
	1. Work out problems in linkage 2. Two-point and three-point test crosses. 3. Construction of chromosome map from a given progeny data by analyzing the linkage relationship and determining the correct gene orders, computing coefficient of coincidence, and interference 4. Work out problems in population genetics 5. Work out problems in microbial genetics	**30**

Suggested Readings

1. Krebs, J. E., Goldstein, E. S. &Kilpatrick, S. T. (2018). LEWIN'SGENESXII. Jones&BartlettLearning
2. 2.Snustad, P. D. &Simmons, M. J. 2012. Principles of Genetics 6th Edition.John Wiley&Sons, Inc
3. Strickberger, M. W. (2008). Genetics Edition. Pearson Education India
4. Benjamin A. Pierce. (2012). Genetics. A Conceptual Approach 4th Edition.W.H. Freeman and Company.
5. Klug, W. S., Cummings, M. R., Spencer, C. A. &Palladino. M. A. 2012. Concepts of genetics. Pearson Education, Inc.
6. Brown, T. A. (2006). Genomes. 3 Garland Science.
7. Tamarin, R. (2001). Principles of Genetics 7th Edition. McGraw HillEducation.
8. Goodenough, U. Genetics. 1984. Holt Saunders, NewYork.

9. Sinnot, E. W. Dunn, L. C. &Dobzhansky, T. (1958). PrinciplesofGenetics.McGraw Hill, NewDelhi.
10. Russell, P. J. (2010). Genetics: A molecular approach. 3rd Edition. Pearson Education, Inc.

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1. https://plato.stanford.edu/entries/cell-biology/
2. https://education.nationalgeographic.org/resource/resource-library-cell-biology
3. https://www.cdc.gov/genomics/about/basics.htm

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	demonstrate a thorough understanding of genetic linkage, and the relationship between linkage and physical distance along chromosomes	U	PSO -1,4
CO-2	Analyze pedigrees to infer patterns of inheritance and recognize the presence of genetic disorders within families.	An	PSO -1,4
CO-3	Analyze and interpret karyotypes to identify chromosomal abnormalities	An	PSO -1
CO-4	Analyze genetic data using population genetic tools	An	PSO -5,2
CO-5	Evaluate the impact of evolutionary forces on population dynamics, adaptation, speciation, and the formation of biodiversity.	E	2

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

Name of the Course: Hereditary science

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	An	P	L	
4	4	5,2	An	P		P

5	5	2	E	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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK7DSCBOT304**				
Course Title	**BIODIVERSITY AND CONSERVATION**				
Type of Course	**DSC (For Minors)**				
Semester	**VI1**				
Academic Level	**300 - 399**				
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, *Myristica* 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.	
IV	**Environmental awareness and the role of organizations**		**07**
	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).	
V	**Trends of conservation and biodiversity**		**15**
	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.	

Practicals		
	1. Field trip to ecologically significant sites (National parks/ Mangrove site/ ramsar site/ *Myristica* swamp) and submit a detailed report with geotagged photos for evaluation. 2. Plant and maintain at least three plants of IUCN category in the campus. 3. Participation in community awareness programmes in the conservation of biodiversity in the locality and create an audio-visual document of the same.	**30**

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.

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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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK8DSCBOT401**				
Course Title	**ADVANCES AND APPLIED ASPECTS OF THALLOPHYTES**				
Type of Course	**DSC**				
Semester	**VIII**				
Academic Level	**400 - 499**				
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 the classification and general characters of thallophytes.				
Course Summary	The course enables the students to understand the recent classification and phylogeny of thallophytes and thus interpret the significance of thallophytes in the evolution of higher plant groups. They will be able to evaluate the ecological role and economically important products obtained from thallophytes and their uses. Also, they can apply their views and conclusions on latest research in potential thallophytes.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Advances and applied aspects of Algae**	**08**
	1	Polyphyletic origin of algae and its evolution (with emphasis on endosymbiosis).	
	2	Gene sequencing in algal systematics (18SrRNA).	
	3	Molecular mechanism of nitrogen fixation by blue-green algae.	
	4	Molecular genetic techniques for algal bioengineering – *Chlorella*	
	5	Phylogenomics in algal research - Current trends, Allelopathy in algae.	
II		**Industrial and biotechnological applications of algae**	**07**
	6	Algal culture: Scope- isolation and culturing techniques- Isolation, purification and sterilization of algae; Freshwater and marine culture media (BG-11 and Provasoli ES medium).	
	7	Photobioreactors and large-scale production of microalgae-upstream and downstream processes.	
	8	Microalgae biotechnology, Seaweed farming, microalgae for aquaculture.	
	9	Bioluminescent forms; Algae in nanotechnology.	
III		**Advancing the frontiers in Mycology & Mycotechnology**	**08**
	10	Fungi as a model organism in genetic experiments (*Neurospora*).	

	11	Mycotechnology: Recent research trends in fungi – role in sustainable environments and in alleviating stress in plants, advances in fungal interactions research - PGP (plant growth promoting) endophytic fungi – Methods of identification- molecular phylogeny with emphasis on ITS, and BLAST.	
	12	Fungal elicitors in secondary metabolite production, biocontrol (Nematophagus only), and bioluminescence.	
IV	**Advances and applied aspects of Lichens**		
	13	Lichens– Ecological role, Nature of associations of algal and fungal partners, Identification- morphological and chemical methods.	
	14	Advancements in methods used for identification of lichens: Chemotyping, DNA Barcoding, PCR Genotyping. *In vitro* culture of lichen partners.	**07**
	15	Key mechanisms involved in desiccation tolerance in lichens - polyols, LEA proteins, HSPs, antioxidant system, thylakoidal oligogalactolipids (Brief account).	
	16	Impact of climate change on lichens and ecosystem services of lichen diversity.	
V	**Potential thallophytes and applied aspects**		
	17	Bioprospecting of Thallophytes (General account).	
	18	Detailed study of the structure and reproduction of the algal types - *Chlorella, Spirulina, Haematococcus and Dunaliella.* Fungi in Mycotechnology: Yeasts, Mucorales, *Aspergillus, Penicillium, Monascus.*	**15**
	19	Benefits for the environment and humans – Nutrient cycling- human health- environment protection -food industry- agriculture- fungal mycotoxins (Aflatoxins, Amatoxin, Ergot, Fusarin), Commercial production of Organic acids (Citric acid), Enzymes (Cellulase), Plant hormones, Mycoproteins, alcohol, Antibiotics, Volatile organic compounds, Pigments (*Monascus* pigments).	
	20	Synthesis of nanoparticles from thallophytes (Brief account).	

Practicals		
	1. Algal culture - *Chlorella* culture 2. Isolation of fungi from rotten vegetables and culturing the same on PDA 3. Fungal mycelium staining using lactophenol cotton blue. 4. Colour spot test to detect lichens (Demonstration) 5. Prepare a review article in any selected research area in thallophytes.	**30**

Suggested Reading

1. Lee RE. 2018. Phycology 5th Edition. Cambridge University Press, New Delhi.
2. Kashyap AK & Kumar HD. 1994. Recent advances in Phycology. Rastogi &Company. Sharma OP. 2011. Textbook of Algae. Tata McGraw Hill Publ. Comp. Ltd. New Delhi.
3. Sharma PD. 2004.The Fungi for University students. Rastogi Publications, Meerut.
4. Hale ME.1983. Biology of Lichens. Edward Arnold, London.
5. Gagulee HC & Kar AK. 1973. College Botany, Vol. I. New Central Book Agency.

References

1. Prescott GW. 1984. The Algae: A review. Lubrecht & Cramer Ltd.
2. Round FE. 1984. The Ecology of Algae. Cambridge University, Press, London.
3. Frtsch FE. 1935, 48. Structure and reproduction of algae. Cambridge University Press.
4. Dalip Kumar Upreti, Pradeep K. Divakar, Vertika Shukla, Rajesh Bajpai (2015). Recent Advances in Lichenology, Modern Methods and Approaches in Biomonitoring and Bioprospection, Volume 1, Springer.
5. Dube HC. 2013. An Introduction to Fungi. 4th Edition. Scientific Publishers, India.
6. Kirk P, Cannon PF, Minter DW & Stalpers JA. 2008. Ainsworth & Bisby's Dictionary of Fungi. 10th Edition. CAB International, Oxon UK.
7. Alexopoulose CJ, Mims CW & Blackwell M. 2007. Introductory Mycology.4thEdn. John Wiley & Sons, New York.
8. Sharma OP. 2007. Textbook of Fungi. Tata Mc Graw Hill, Publishing Co. Ltd. New Delhi.
9. Awasthi DD. 2000. Lichenology in Indian Subcontinent - A Supplement to 'A Handbook of Lichens' ISBN-10: 81-211-0187-5
10. Awasthi DD. 2007. A Compendium of the Macrolichens from India, Nepal, and Sri Lanka ISBN-13: 978-81-211-0600-9.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the recent classification and phylogeny of thallophytes.	U	1,2
CO-2	Evaluate the ecological role of thallophytes and economically important products obtained from thallophytes and their uses.	R, U	1, 4
CO-3	Interpret the significance of thallophytes in the evolution of higher plant groups.	An, Ap	6
CO-4	Apply the views and conclusions of the latest research in thallophytes.	Ap, C	2,6
CO-5	Acquire skills related to entrepreneurial ideas related to thallophytes	C	7,8

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

Name of the Course: Applied aspects of Thallophytes
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	L	
2	2	1, 4	R, U	C	L	
3	3	6	An, Ap	P	L	
4	4	2,6	Ap, C	P	L	
	5	7,8	C	M	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	**BOTANY**				
Course Code	**UK8DSCBOT402**				
Course Title	**ADVANCES AND APPLIED ASPECTS OF ARCHEGONIATES**				
Type of Course	**DSC**				
Semester	**VIII**				
Academic Level	**400- 499**				
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 the general characters about archegoniates				
` Course Summary	The course enables the students to understand the recent classification and phylogeny of archegoniates and interpret their significance of in the evolution of higher plant groups. They will be able to evaluate the ecological role and economically important products obtained and their uses. Also, they can apply their views and conclusions on a latest research in potential archegoniates.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Advances and applied aspects of Bryophytes**	**09**
	1	Origin and evolution of sporophyte and gametophyte in Bryophytes (General account).	
	2	Evolutionary insights and recent discoveries in Bryophytes - latest advances in the ecological, biological, physiological, metabolomic, and transcriptomic studies.	
	3	Exploration of bioactive molecules in Bryophytes.	
	4	Conservation of Bryophytes (conventional and *in vitro* methods). The ecological and economic significance of Bryophytes.	
II		**Advances and applied aspects of Pteridophytes**	**08**
	5	Trends and concepts in classification of Pteridophytes with emphasis on PPG- Evolutionary trends in Pteridophytes.	
	6	The ecological and economic significance of Pteridophytes - Ecological indicators - Role of pteridophytes in ecophysiological studies - Fungal associations in pteridophytes.	
	7	Bioprospecting using pteridophytes - Pteridophytes for treating human ailments.	
	8	Endemic pteridophytes- Conservation of pteridophytes- Contributions of Indian Pteridologists.	
	9	DNA barcoding in Pteridophytes (Brief account).	
III		**Advances and applied aspects of Gymnosperms**	**09**

	10	Classification by Christenhusz and Byng (2016)- Evolutionary significance of gymnosperms towards angiosperm evolution. Evolution of pollen and seed -the key reproductive evolutionary mechanisms for Life on Land.	
	11	Relationships among gymnosperms - molecular phylogeny - Gene families.	
	12	Phytochemicals from gymnosperms and their exploitation.	
	13	The ecological and economic significance of gymnosperms – Economically important products from gymnosperms (mentioning the taxa also)	
IV	**Fossil archegoniates**		**04**
	14	Applied aspects of fossil archegoniates – A multi-disciplinary approach.	
	15	Recent research on paleobotany of gymnosperms.	
V	**India centric aspects of Biodiversity.**		**15**
	16	Detailed study of the structure and reproduction of potential archegoniate members: *Marchantia, Sphagnum, Asplenium, Azolla, Araucaria, Cedrus*,	
	17	General account on the applied aspects of archegoniates - Economic utility and application in human welfare.	
	18	Bioactive phyto-constituents from archegoniates and their exploration.	
	19	Extant and extinct forms of gymnosperms- Threat status of gymnosperms- need and methods of conservation.	

Practicals		
	1. Techniques for the experimental culture of any bryophytes (Demonstration only) 2. Construction of a pilot-level plant for Azolla cultivation. 3. Ecophysiological behavior measurement of any Pteridophyte species by: steady-state porometry (stomatal conductance)/ thermocouple psychrometry (water potential)/ chlorophyll fluorescence. 4. Conduct a case study to summarize the reasons for the fast extinction of gymnosperms and submit a report based on your findings. 5. Preparation of a review article on- Any potential archegoniate group and their applied aspects/ Applied aspects of fossil archegoniate – A multi-disciplinary approach.	**30**

Suggetsted Readings

1. Botanical Survey of India. 2016. Liverworts and Hornworts of India – An annotated checklist.
2. Vanderpoorten A & Goffinet B. 2009. Introduction to Bryophytes. Cambridge Publishers.
3. Shaw J & Goffinet B. 2000. Bryophyte Biology, Cambridge University Press.
4. Chopra RN. 1998. Topics in Bryology. Allied Printers, New Delhi.
5. Sharma OP. 2017. Textbook of Pteridophyta. McGraw Hill Education.

6. Sporne KR. 1986. Morphology of Pteridophytes. Hutchinson University Library, London.
7. Chamberlain CJ. 2000. Gymnosperms. CBS Publishers, New Delhi.
8. 8.Sundara Rajan S. 1999. Introduction to Pteridophyta. New Age Publications, New Delhi.
9. Sporne KR. 1986. Morphology of Gymnosperms, Hutchinson University Library, London.
10. Ramanujan CGK. 1976. Indian Gymnosperms in time and space. Today and
11. Tomorrow's printers and publishers, New Delhi.

Reference

1. Chopra RN & Kumara PK. 1988. Biology of Bryophytes. Wiley East, New Delhi.
2. Smith GM. 1976. Cryptogamic Botany Vol. II. Tata McGraw Hill. PublishingCo. Ltd. New Delhi.
3. Stewart WN. 1983. Paleobotany and Evolution of Plants. Cambridge University Press, London.
4. Parihar NS. 1980. An Introduction to Embryophyta Vol. II. Pteridophyta. CentralBook Depot, Allahabad.
5. Scott DH.1962. Studies in Fossil Botany. Hafner Publishing Co. NewYork.
6. Vashishta PC. 1999. Gymnosperms, S Chand & Company, New Delhi.
7. Sharma OP. 1997. Gymnosperms, Pragati Prakasan, Meerut.

Web links

1. https://courses.lumenlearning.com/bio2labs/chapter/fungi-lab/
2. https://www.worldatlas.com/articles/what-is-the-economic-importance-of-algae.html
3. https://www.thoughtco.com/what-are-gymnosperms-4164250
4. https://www.embibe.com/exams/gymnosperms/
5. https://palaeobotany.org

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the recent classification and phylogeny of different groups of archegoniates.	R,U	PSO-1,2
CO-2	Interpret the significance of archegoniates in the evolution of higher plant groups.	R,U	PSO-1,2
CO-3	Apply the views and conclusions of the latest research in archegoniates.	Ap	PSO-1,6
CO-4	Acquire an entrepreneurial idea related to	C	PSO-1,3

	archegoniates.		
CO-5	Analyze the ecological role and economically important products obtained from archegoniates and their uses.	An	PSO-1,2

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

Name of the Course: Applied aspects of Archegoniates

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,R	F, C	L,T	
2	2	1,2	U,R	F, C	L,T	
3	3	1,6	Ap	F, C	L,T	
4	4	1,3	C	F, C		P
5	5	1,2	An	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	**BOTANY**				
Course Code	**UK8DSCBOT403**				
Course Title	**BIOINFORMATICS**				
Type of Course	**DSC**				
Semester	**VIII**				
Academic Level	**400- 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	Understanding fundamental biological concepts in genetics, molecular biology, biochemistry, and cell biology. Basics of computers and internet				
` Course Summary	Basics of Bioinformatics provides students with a solid foundation in bioinformatics principles and techniques, preparing them for further studies or careers in fields such as computational biology, biotechnology, and biomedical research. Through a combination of theoretical learning and hands-on practice, students develop the skills necessary to tackle complex biological problems using computational approaches.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Bioinformatics**	05
	1	Definition, scope, aims, and history of Bioinformatics- Branches of Bioinformatics.	
	2	Basics of Internet- Web lab, wet lab	
	3	Computational Biology and Systems Biology (Brief account).	
	4	Research areas in Bioinformatics.	
II		**Biological databases**	10
	5	Biological databases: Types of data and databases- Primary, secondary, and composite – Biomolecular - Model organism and Biodiversity databases.	
	6	Nucleotide sequence databases- (EMBL, GENBANK, DDBJ)	
	7	Protein sequence databases (PIR, SWISS - PROT, TrEMBEL) - Secondary Databases (PROSITE, PRINTS, BLOCKS) - Protein Structure Database (PDB).	
	8	Information retrieval from databases – Search concepts- tools for searching, homology searching.	
III		**Structural Bioinformatics**	07
	9	Structural Bioinformatics –Molecular visualisation. Molecular Structure viewing tool – Rasmol.	

	10	Protein Structure Prediction – Secondary and Tertiary structure- Comparative modelling, Abinitio prediction, Homology modelling.	
	11	Bioinformatics tools for Protein Structure Prediction -GOLD, AlphaFold (brief account only)	
IV	**Sequence Analysis and Molecular Phylogeny**		**08**
	12	Sequence alignment-Global and Local Alignment, pairwise & Multiple sequence alignment	
	13	Scoring Matrices, Analysis tools- BLAST, Clustal X, Clustal W.	
	14	Molecular Phylogeny – Gene and Species tree- Molecular evolution	
	15	Phylogenetic Trees, Terminology in Phylogenetic tree. Cladogram and Phylogram.	
	16	Significance of Molecular Phylogeny. Software used in Phylogeny- MEGA X, PHYLIP	
V	**Genomics, proteomics, Metabolomics, and Applications of Bioinformatics**		**15**
	17	Basics of Genomics - Types (Structural and Functional), Comparative genomics - Proteomics, Metabolomics. (Brief account only)	
	18	Applications of Bioinformatics – (Detailed account)- Transcriptomics, Metabolomics, Pharmacogenomics (Brief Accounts). Structural bioinformatics in Drug discovery.	

Practicals		
	1. Retrieve information from different biological databases. 2. Molecular visualisation using RasMol 3. Blast search with Protein Sequence. 4. Blast search with Nucleic Acid Sequence. 5. Phylogenetic tree creation with CLUSTAL X/W 6. Molecular docking (using either Free or commercial Software) (Demonstration only) 7. Visit to a Bioinformatics laboratory .	**30**

Suggetsted Readings

1. Ghosh, Z., Mallick, B. (2008). Bioinformatics – Principles and Applications, 1st edition.
2. New Delhi, Delhi: Oxford University Press.
3. Baxevanis, A.D., Ouellette, B.F., John (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
4. Roy, D. (2009). Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House.
5. Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). Bioinformatics: A practical guide to the analysis of genes and proteins, New Jersey, U.S.: John Wiley and Sons.
6. Khan, I.A., Khanum, A. (2004). Fundamentals of Biostatistics, 5th edition. Hyderabad: Ukaaz publications.
7. Campbell, R.C. (1998). Statistics for Biologists. Cambridge, U.S.A.: Cambridge University Press

Reference

1. 1.Pevsner, J. (2009). Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
2. Xiong, J. (2006). Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press.
3. Mount, D.W. (2004). Bioinformatics: Sequence and Genome analysis 2nd edition, Cold Spring Harbor Laboratory Press, USA.
4. Zar, J.H. (2012). Biostatistical Analysis, 4th edition. London, London: Pearson Publication.
6. Pandey, M. (2015). Biostatistics Basic and Advanced. New Delhi, Delhi: M V Learning

Web links

1. http://www.jaist.ac.jp/~bao/talks/IntroBioinformaticsE.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	**Understand the principles of bioinformatics**: Students will demonstrate knowledge of the fundamental principles and concepts underlying bioinformatics, including sequence analysis, structural biology, and systems biology.	U	PSO-1,2
CO-2	Proficiency in bioinformatics tools and software: Students will be able to use a variety of bioinformatics tools and software packages for tasks such as sequence alignment, homology modeling, and phylogenetic analysis.	U, Ap	PSO-2,3,4
CO-3	Sequence analysis: Students will understand the algorithms and methods used for sequence analysis, including sequence alignment, motif discovery, and gene prediction.	U, An	PSO-3, 5
CO-4	Structural biology: Students will be able to analyze and interpret protein structures using bioinformatics techniques, including protein structure prediction, modeling, and docking.	An, C	PSO-7,9

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

Name of the Course: Bioinformatics

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

CO No.	CO	PO/PSO	Cognitive	Knowledge	Lecture	Practical

			Level	Category	(L)/Tutorial (T)	(P)
1	1	1.2	U	F,C	L,T	
2	2	2.3.4	U, Ap	F,C	L,T	
3	3	3,5	U, An	F, P		P
4	4	7,9	An, C	F, 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	✓	✓		✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK8DSCBOT404**				
Course Title	**DEVELOPMENTAL BOTANY**				
Type of Course	**DSC**				
Semester	**VIII**				
Academic Level	**400- 499**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	Fundamental knowledge about cell, tissues and basic anatomy and knowledge about reproductive parts of flower, and their structure and function.				
` Course Summary	This course provides a detailed account of growth and development, morphogenesis and differentiation, factors influencing growth and development and reproductive biology. A brief account of tumerogenesis in plant was also included				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Embryonic and post-embryonic development**	**05**
	1	Embryonic and post-embryonic development: Structure and development of the zygote, embryo development-Dicot embryo (*Capsella bursa-pastoris*) and Monocot embryo (Najas).	
	2	Endosperm – Development of Free nuclear endosperm (*Cocos nucifera*) - cellular endosperm (*Cucumis*) - helobial endosperm- Ruminate endosperm	
II		**Morphogenesis and Differentiation**	**09**
	3	Cell differentiation growth and development: Basic concepts of development (potency, commitment, specification, determination- molecular basis of determination and cytoplasmic determinants, and differentiation- brief account); Cell polarity- Origin, structure, and function of shoot apical meristem (SAM) - Ultrastructure and cytohistological zonation of the meristem.	
	4	Root differentiation and vascular development: -Organization and maintenance of root apical meristem, radial patterning during vascular development, Root branching; lateral root development, genetic control of pattern formation	
III		**Growth and Development**	**09**
	5	Seed development and organogenesis - A general account of seed germination and development- hormonal regulation of germination,	

		Gene expression regulating meristem function; Organogenesis- Differentiation of root, stem, leaf, and axillary buds.	
	6	Mechanism of Leaf primordium initiation- development and Phyllotaxis (Diversity in size and shape of leaves) - regulation of stomatal patterning in plants - plastochrone index - transition from vegetative apex into the reproductive apex.	
	7	Evolution of developmental complexity from algae to angiosperm (mention chloroplast evolution).	
IV	**Factors Controlling Growth and Sex determination in plants**		**07**
	8	Hormonal control of growth**:** mode of action of auxin, gibberellin, cytokinin & ethylene, abscisic acid, bassinosteroids, salicylic acid and jasmonic acid-Photomorphogeneis.	
	9	Developmental patterns at flowering apex: ABC model specification of floral organs. Molecular regulation of flowering in Arabidopsis.	
	10	Sex differentiation in plants- factors influencing sex differentiation in monoecious and dioecious plants - environmental, hormonal, and ploidy- Micro RNAs in growth and development.	
	11	Senescence- cellular and molecular changes during senescence, Programmed cell death.	
V	**Factors influencing development and tumorogenesis in plants**		**15**
	12	Factors influencing development- Effects of nuclear and cytoplasmic factors in development-environmental effects, maternal effects. Nuclear cytoplasmic interactions with particular reference to Acetabularia.- Patterns of growth and differentiation in plants, Gene expression, and mutations regulating meristem function, embryogenesis, seedling, root, leaf, and flower development.	
	13	Tumorigenesis in plants- Crown Gall -Tumour (CGT) cells - crown gall and plant transformation - Interaction between wound cell and bacteria - Leaf gall- morpho-histological changes in galled leaf.	

Practicals		
	1. Familiarising types of meristem and their organization by observing permanent slides 2. Seed viability test- tetrazolium test 3. Seed germination study and role of exogenous hormone in germination 4. Study of stages of embryo development (Pea, Tridax) 5. Histochemical localization of proteins and carbohydrates during seed germination 6. Micropreparation of galled leaves –(Hydnocarpus/Mangifera/Alstonia leaf)	**30**

Suggetsted Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA
2. Esau, K. 1990. Plant Anatomy, Wiley Eastern Pvt Ltd New Delhi
3. Evert, R.F. (2006) Esau's Plant Anatomy: Meristem, Cells, and Tissues of the Plant
4. Karp G., 1985. Cell Biology; Mc.Graw Hill Company
5. Raghavan, V., 2000. Developmental Biology of Flowering plants, Springer, Netherlands.

6. Jose Luis Riechman, Frank Wellmer, 2014, Edn, Methods in Molecular Biology series- Flower development- methods and protocols, Springer Protocols, Humana press
7. Twyman RM (2010) Instant Notes- Developmental Biology, BIOS Scientific Publishers UK
8. Wolpert, L. (2002). Principles of Development, Oxford University Press, Oxford.

Web links

1. http://evolution.berkeley.edu
2. www.benbest.com
3. http://labs.biology.ucsd.edu
4. www.mdpi.com
5. http://advances.sciencemag.org
6. http://mcb.asm.org
7. www.dnalc.org
8. https://swayam.gov.in
9. https://epgp.inflibnet.ac.in/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understanding various levels of organization in a plant body with an outlook in the correlation between the structure and function	U	PSO-1
CO-2	Analyze different angiosperm embryos and the stages of embryological development.	U,An	PSO-2
CO-3	Understanding various levels of organization in a plant body with an outlook in the relationship between the structure and function through comparative studies	U,An	PSO-2,4
CO-4	Analyze and Apply the knowledge of hormonal influence in plant propagation and growth.	An, Ap	PSO-1,4

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

Name of the Course: Developmental 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	

2	2	2	An	C,P	L	P
3	3	2,4	S	P	L	P
4	4	1,4	Ap An	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		✓	✓	✓

Discipline Specific Elective Courses

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK3DSEBOT201**				
Course Title	**ETHNOBOTANY AND IPR**				
Type of Course	**DSE**				
Semester	**III**				
Academic Level	**200 - 299**				
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
I		**Ethnobotany**	**10**
	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.	
II		**Methods and Techniques used in Ethnobotany**	**10**
	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.	
III	**Introduction to Intellectual Property Rights**		**10**
	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.	
IV	**Procedures of Patenting**		**15**
	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	
V	**International Agreements and Treaties Related to IPR**		**15**
	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. 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 J2013. Law of Intellectual Property (2nd Edition) Thomason Reuters,
3. Irini A. Stamatoudi & Paul L.C.. Torremans.2000. Copyright in the New Digital

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
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:)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK3DSEBOT202**				
Course Title	**FORESTRY**				
Type of Course	**DSE**				
Semester	**III**				
Academic Level	**200-299**				
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	The course provides an overview of forestry, such as forest ecology, management practices, conservation, sustainable development and agroforestry. The students will gain an understanding of the principles and practices of forestry and their role in environmental conservation and resource management				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction**	**15**
	1	General introduction, definition and scope of forestry	
	2	Types of Forest- Natural and Manmade	
	3	Classification of forest- Tropical, temperate, evergreen semi-evergreen, deciduous. ***Learning Activity:-*** 1. Field trips should be organized to different forest types 2. Hands-on training on navigation and map reading 3. Identification of forest Trees by Seeds / Bark (10 trees) 4. Examination of Microscopic Features of Wood 5. Analysis of Forest Vegetation- Density, Frequency and Abundance 6. Preparation of seedlings of forest tree species and planting.	
	4	Deforestation, reforestation and Afforestation	
II		**Forest Management**	**12**
	5	Silviculture- concept and scope of study - natural and artificial regeneration of forests- Monoculture, multipurpose.	
	6	Clear felling, uniform shelter, wood selection, coppice and conservation systems.	
	7	Silviculture practices (Brief outline only) of some of the economically important species in India such as, *Tectona grandis*, *Eucalyptus indica*, *Swietenia mahagoni*, *Dalbergia sisso*, *Santalum album.*	

III	**Forestry practices**		**08**
	8	Social and agroforestry. Selection of species and role of multipurpose trees. Food, fodder and energy.	
	9	Farm forestry, urban forestry, joint forest management - concepts, objectives and programmes, Avenue plantation.	
	10	Sacred groves- conservation and importance	
IV	**Forest Economics and Valuation**		**10**
	11	Forest resources and utilization. Forest products- timber, pulp wood, secondary timbers. Non timber forest products (NTFPs)-Gums, resins, fibers, oil seeds, nuts, rubber, canes and bamboos, medicinal plants, charcoal. Lac collection and marketing	
	12	Ecosystem services provided by forests	
V	**Forest Policy and Governance**		**15**
	13	Forest laws- necessity, General principles, Indian forest act	
	14	Community-based forestry and participatory approaches	
	15	Forest governance: stakeholders, institutions, and decision-making processes	

Suggested Reading

1. A Hand book of Kerala Timbers- KFRI, Trichur.
2. B.S. Chundawat and S.K.Gautham. (1996). Text book of Agroforestry. Oxford and IBH Publishing House , NewDelhi
3. Parthiban K T (2016) Forestry, Competition Tutor publishers
4. Praveen Dhar T .(2018). Introduction to Forestry Narendra Publishing House, New Delhi
5. Sagreiya, K.P. (1994). Forests and Forestry (Revised by S.S. Negi). National book trust. NewDelhi.

References

1. Singh M.P. and Vinita Vishwakarma.(1997) .Forest environment and Biodiversity. Daya publishing house, NewDelhi.
2. Tiwari K.M. (1983). Social forestry in India.
3. Tribhawan Mehta, (1981). A handbook of forest utilization. Periodical Expert Book Agency, NewDelhi

Weblink

1. https://www.esa.org/seeds/toolkits/forests/introduction-to-forestry/
2. https://www.britannica.com/science/forestry
3. https://agri-bsc.kkwagh.edu.in/uploads/department_course/FRST-121_Forerstry_notes.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the structure, composition, and function of forest ecosystems, including the interactions between biotic and abiotic components.	R, U	PSO-1,2
CO-2	Explain the principles and practices of forest management, including silviculture, timber harvesting, and forest regeneration.	An, U	PSO-1,2
CO-3	Develop skills in conducting forest inventories and assessing forest resources.	Ap, C	PSO-1,2
CO-4	Gain an understanding of forest economics, including the economic value of forests, sustainable forest management practices, and the role of forests in supporting local economies and livelihoods	E, C	PSO-1,2
CO-5	Students understand the various Forest Policy and Governance	U,R	PSO-1,2

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

Name of the Course: Forestry

Credits: 4:0:0 (Lecture:TutorialPractical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	1,2	R, U	F, C	L, T	
2	2	1,2	An, U	P	L, T	
3	3	1,2	Ap, C	E, C	L, T	P
4	4	1,2	E, C	F, C	L, T	P
5	5	1,2	U,R	F	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	**BOTANY**				
Course Code	**UK4DSEBOT201**				
Course Title	**HERBAL TECHNOLOGY**				
Type of Course	**DSE**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05Hours
Pre-requisites	No Pre-requisites				
Course Summary	This course gives the student the knowledge of basic understanding of herbal drug industry, the quality of raw material, guidelines for quality of herbal drugs, herbal cosmetics, natural sweeteners, nutraceutical etc. The subject also emphasizes on Good Manufacturing Practices (GMP).				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Herbs & Industrial Application**	**08**
	1	Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation, Selection, identification and authentication of herbal materials, Processing of herbal raw material.	
	2	Indian Systems of Medicines- Ayurveda, Siddha, Unani and Homeopathy (Basic principles), Ayurvedic formulations viz Aristas and Asawas, Ghutika, Churna, Lehya and Bhasma.	
	3	General Introduction - Herbal Industry- Herbal drugs industry: Present scope and prospects.	
	4	A brief account of plant-based industries and institutions involved in work on medicinal and aromatic plants in India	
II		**Cultivation of Medicinal plants**	**07**
	5	Agricultural practices for the cultivation of medicinal plants- *Aloe vera, Centella asiatica, Curcuma longa.*	
	6	Pest and Pest management in medicinal plants: Biopesticides/Bioinsecticides	
III		**Herbal Nutraceuticals & Cosmetics**	**08**
	7	General aspects, Market, growth, scope, and types of products available in the market.	
	8	Health benefits and role of herbal nutraceuticals in ailments like Diabetes, Cardiovascular diseases, Cancer, Gastrointestinal diseases.	
	9	Study of herbs as health food: Ginger, Fenugreek, Garlic, Amla, Ashwagandha, Turmeric, Pepper.	

	10	Sources and description of raw materials of herbal origin used via, fixed oils, waxes, gums, colors, perfumes, protective agents, bleaching agents, and antioxidants in products such as skin care, hair care, and oral hygiene products	
IV	**Herbal excipients & formulations**		**07**
	11	Herbal Excipients – Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavours & perfumes.	
	12	Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosomes	
V	**Evaluation of Drugs**		**15**
	13	WHO & ICH guidelines for the assessment of herbal drugs. Stability testing of herbal drugs.	
	14	Components of Good Manufacturing Practices (Schedule – T) and its objectives.	
	15	Infrastructural requirements, working space, storage area, machinery and equipment, standard operating procedures, health and hygiene, documentation and records	

Practicals		
	1. Identify herbal drug sources based on morphological characters. 2. Perform preliminary phytochemical screening (Qualitative) of crude drug formulations (Aristas, Asawas, Ghutika, Churna, Lehya and Bhasma)- Saponins, flavonoids, alkaloids, phenols, steroids, terpenoids, glycosides. 3. Preparation of herbal cosmetics- Aloe vera gel, face cream, face pack, herbal shampoo & hair oil 4. Quantification of flavonoids, Phenol and total alkaloid content in herbal samples (Demonstration only) 5. Monograph analysis and documentation of herbal drugs from recent Pharmacopoeias	**30**

Suggested Reading

1. Trease & Evans. Textbook of Pharmacognosy
2. Tyler, Brady & Robber. Textbook of Pharmacognosy
3. Purohit and Gokhale. Pharmacognosy by Kokate.
4. Dr.S.H.Ansari Essential of Pharmacognosy
5. V.D.Rangari. Pharmacognosy & Phytochemistry
6. Pharmacopoeal standards for Ayurvedic Formulation (Council of Research in
7. Indian Medicine & Homeopathy)
8. Mukherjee, P.W. Quality Control of Herbal Drugs: An Approach to Evaluation of
9. Botanicals. Business Horizons Publishers, New Delhi, India, 2002.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will be able to understand the herbal raw material as a source of herbal drugs	U	PSO-3
CO-2	Students will practice the cultivation of herbs and the development of drug products.	U, Ap	PSO-3
CO3-	The student will analyze herbal cosmetics, natural sweeteners, nutraceuticals, and other aspects related to herbal technology	An	PSO-4, 6
CO-4	Students will be able to perform preliminary phytochemical screening of crude drugs	An, Ap, E	PSO-7
CO-5	Student will understand the WHO and ICH guidelines for evaluation of herbal drugs.	R,U	PSO-8

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

Name of the Course: Herbal Technology

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	1	3	U	F, C	L	
CO-2	2	3	U, Ap	P	L	P
CO3-	3	4,6	An	M	L	P
CO-4	4	7	An, Ap, E	P	L	P
CO-5	5	8	R, U	F	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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK4DSEBOT202**				
Course Title	**FOOD SCIENCE AND QUALITY CONTROL**				
Type of Course	**DSE**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	03 Hours	-	02 Hours	05 Hours
Pre-requisites	No Pre-requisites				
Course Summary	This course is designed to provide a comprehensive understanding of the principles and practices involved, and maintaining quality control standards in food production. The course covers topics ranging from sources of nutrients in nature to food safety regulations and quality assurance techniques. Students will gain practical skills through laboratory sessions and case studies, preparing them for roles in food production, quality control, and regulatory compliance.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**The food – Composition and constituents**	**06**
	1	Introduction and scope of Food Science	
	2	Composition of food: Carbohydrates- Major sources and functions. Proteins-Major sources and functions. Lipids-Saturated and unsaturated fatty acids- Dietary functions of fats.	
	3	Minerals- Calcium, Phosphorus, Magnesium, Sodium, Potassium, Zinc Vitamins- fat soluble and water soluble- Enzymes- Amylase, Protease, Lipoxygenase, Pectic enzymes, Lipase - Pigments- Chlorophylls, Carotenoids, Anthocyanin.	
II		**Classification of foods, food additives and food-borne health complications**	**07**
	4	Types of food- Nutraceuticals, Probiotics, Prebiotics, GM food, Organic food, Traditional foods, Fermented foods	
	5	Food additives: Food colours, Sweeteners, Gelling agents, Flavour enhancers, Surface acting agents, Bleaching agents, Stabilizers, and thickeners	
	6	Foodborne illness and diseases: Food poisoning, Botulism, Ergotism, Staphylococcal intoxication, Mycotoxicosis	
		Food adulteration	**06**

III	7	Food adulteration: Definition, Common adulterations in food, Reasons for adulteration.	
	8	Testing adulteration: in milk, ghee, tea, coffee, chilly powder, turmeric powder, Honey-Harmful effects of food adulteration.	
IV	**Food preservation techniques**		**11**
	9	Food spoilage: reasons for food spoilage, Physical and Chemical changes in food that affect texture, flavour, odour, stability and nutritive value during processing and storage.	
	10	Food preservation methods: Asepsis, Removal of microorganisms, Drying, Smoking, Low temperature, High temperature, Canning, Vacuum filling, UV radiation, Lyophilization, Nitrogen packaging.	
	11	Food Preservatives: Salt, Vinegar, Sugar, Benzoates, Sorbates, Nitrates, Propionates, Antioxidants, Antibiotics, Antifungal preservatives	
V	**Quality control in mechanisms in Food industries**		**15**
	12	Quality control (QC) in the food industry, major concepts of QC, Significance	
	13	Food safety Standards and Regulations-ISO 22000, HACCP, FSSAI, GMP, AGMARK	
	14	Quality control activities and Inspection, Certification, and Testing laboratories	

Practicals		
	1. Activity: Carry out a market survey of additives used in different types of foods, classify them based on their role, and present your findings as ppt (p) 2. Hands-on training on Adulteration testing of milk, chilly powder, and tea: Brands available in the market. Prepare a report (p) 3. Activity: Familiarize with different preservation methods employed for the preservation of vegetables, fruits, cereals, and pulses-Submission of the report (p) 4. Visit any Food industry/Food processing unit that follows food safety standards and regulations and submit a report (p)	**30**

Suggested Reading

1. Adams, M.R.& Mass, M.D. 2008. Food Microbiology, New Age International Pvt Ltd.
2. Banwart, G.T.2017. Basic Food Microbiology, 2nd edition, CBS Publications, New Delhi ISBN-13 978-8123906461.
3. Black, J.G.1999. Microbiology Principles and Exploration, 4th Edition. John Wiley and Sons Inc. ISBN-13 978-0471377320
4. Frazier, W.C. (1989). Food Microbiology. 4th Edition, McGraw Hill Education. ISBN- 13 978-0071004367
5. Grumezescu, A. M., & Holban, A. M. (2017). Microbial Contamination and Food Degradation. Academic Press.

Reference

1. Lara, W.2019. Food Science and Quality Control ED Tech press, ISBN-978-1-83947-260 Liu, D.2018.Handbook of Foodborne diseases. CRC Press
2. Longree.1972. Quantity Food Sanitation. John Wiley & Sons, ISBN-13 978- 0471544463

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify the food components and issues relevant to food processing and food quality management systems.	U	PSO-1,2
CO-2	Discuss the spoilage and deterioration mechanisms in foods and methods to control spoilage.	R, U	
CO3	Classify the food preservatives based on risk and benefit basis	An	
CO4	Employ the principles of food science in practical, real-world situations and Predict the consequences of excess use of additives.	E	
CO5	Budget the cost of implementing food safety standards and regulations for a small-scale unit.	C	PSO-6,8

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

Name of the Course: Food Science and Quality control

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		R, U	P	L, T	P
3	3		An	F, C	L, T	p
4	4		E	P	L, T	
5	5	6,8	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	**BOTANY**				
Course Code	**UK5DSEBOT301**				
Course Title	**ANALYTICAL TECHNIQUES IN PLANT SCIENCE**				
Type of Course	**DSE**				
Semester	**V**				
Academic Level	**300 - 399**				
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
I		**Imaging and related techniques**	**05**
	1	Principles of microscopy- Light microscopy- Fluorescence microscopy; Confocal microscopy- SEM and TEM -Transmission and Scanning electron microscopy – sample preparation for electron microscopy.	
II		**Cell Fractionation and Chromatography**	**09**
	2	Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient 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.	
III		**Spectrometry**	**10**
	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.	
IV		**Electrophoresis**	**06**
	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.	**15**

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

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	Knowledg 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	**BOTANY**				
Course Code	**UK5DSEBOT302**				
Course Title	**HORTICULTURE AND NURSERY MANAGEMENT**				
Type of Course	**DSE**				
Semester	**V**				
Academic Level	**300 - 399**				
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 in botany and Basic principles of horticulture or gardening				
Course Summary	The course "Fundamentals of Horticulture and Propagation Techniques" provides students with a comprehensive understanding of essential horticultural principles, including soil management, irrigation techniques, and plant propagation methods such as cutting, layering, budding, and grafting. Through practical exercises and theoretical knowledge, students learn to apply these fundamentals in garden design, nursery management, and sustainable horticulture practices, preparing them for careers in the diverse field of horticulture and agriculture.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of Horticulture and Propagation Techniques**	**05**
	1	Fundamentals of Horticulture: Definition and scope- importance of horticulture in modern society- divisions of horticulture.	
	2	Soil, Fertility, and Irrigation Management: Understanding soil composition and soil types; Preparation of potting mixtures; Irrigation methods: surface sprinkler, and drip systems.	
	3	Vegetative Propagation Methods: Cutting; Layering- Air layering, Ground layering (Tip, Trench and Compound); Budding- T-budding; Grafting: Approach grafting, Bridge grafting, whip and tongue grafting.	
II		**Nutrient Management and Garden Design**	**09**
	4	Manures, Fertilizers: Types- Application methods, Timing and frequency of application, Soil amendments and pH management, Integrated nutrient management.	
	5	Components of Garden: Design ,Principles, Plant Selection, Site, Planting Techniques, Maintenance Practices, Hard Landscaping Elements, Soft Landscaping Elements, Specialty Gardens.	
II		**Nursery Management**	**10**
	6	Introduction to Nursery Management: Definition and Significance, Role of Nurseries in Horticultural Production; Types of Nursery enterprises	

	7	Infrastructure and Facilities: Essential Infrastructure for Nursery Operations: Greenhouses, Shade Structures, Propagation Areas; Equipment and Tools for Nursery Management.	
	8	Nursery Stock Selection and Management: Selection Criteria -Ornamentals, Fruit Trees, Shrubs; Procurement and Maintenance of Mother Plants; Inventory Management Techniques for Nursery Stock. Biopesticides, Pest and disease management.	
IV	**Entrepreneurship in Nursery Management**		**06**
	9	Business planning and development: Budgeting, Financial Management and Record-keeping, Regulatory requirements and Permits: Legal and Regulatory Requirements for Nursery Operations	
	10	Marketing and Sales Strategies: Market analysis and identification of target customers, Branding, packaging, and product presentation; Effective Marketing Techniques: Advertising, Promotion, and Social Media	
V	**Advanced Horticulture Practices and Sustainable Management**		**15**
	11	Advances in Horticulture and Nursery Management: Precision Nursery Management-Remote Sensing, Sensor Networks, Drones; Controlled Environment Agriculture (CEA)- Aquaponics, Hydroponics. Vertical Nursery Production: Vertical Growing Systems, Multi-level Shelving, Stacked Container Systems.,	
	12	Sustainable Horticulture Practices- Organic Farming, Crop Rotation, Sequential Cropping, Polyculture, Agroforestry, Soilless cultivation,	

Practicals		
	1. Study the vegetative propagation techniques described in the syllabus. 2. Visit a Horticultural Nursery to understand its operational procedures, enlist the various components of capital investment and submit a report. 3. Visit a farm practicing sustainable horticulture techniques like organic farming/agroforestry/ hydroponics	**30**

Suggested Readings

1. Arteca, Richard N. (2018). Introduction to Horticulture. Pearson.
2. Chand, Sultan Singh, and Malik, Amanullah (2017). Nursery Management. New India Publishing Agency.
3. George, P. V. and Rajagopal, V (2018). Horticulture: Principles and Practices . New India Publishing Agency
4. Govindaraj, G. and Murugesan, R. (2014). Nursery Management Practices of Horticultural Crops. Agrobios (India).

References

1. Gupta S N (2010) Instant Horticulture, Jain Brothers publishing
2. Hundal S. S and Nanda (2017). Textbook of Horticulture Kalyani Publishers
3. Mishra, R. K. (2018). Handbook of Nursery Management. New India Publishing.
4. Rattanpal H. S, Raj Kumar and Walia S.S (2017). Handbook of Horticulture. Kalyani Publishers
5. Sharma, S.K. (2016). Commercial Horticulture. Rastogi Publications.
6. Singh, A.K. (2017). Nursery Technology. Daya Publishing House.
7. 7.Venkatesha, H. and Natarajan, K.(2015).Handbook of Horticulture. New India Publishing Agency

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyze the fundamental principles of garden design to enable students to create aesthetically pleasing and functional outdoor spaces.	U, An	PSO-1
CO2	Understand soil composition, potting mix preparation, and irrigation methods to enhance theoretical understanding of plant growth in horticulture	U	PSO-3
CO-3	Understand various fertilizers and their Role in Crop Production, Develop skills in vegetative propagation methods	U, Ap	PSO-3
CO-4	Master flower arrangement techniques	U, Ap	PSO-3,6
CO-5	Demonstrate understanding of nursery operational procedures and capital investment components, showcasing proficiency in nursery management principles and financial considerations in horticultural enterprises.	An, Ap	PSO-3,8

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

Name of the Course: Horticulture and Nursery management

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	U, AN	C	L	
2	2	3	U	C	L	
3	3	3	U, AP	P		P
4	4	3,6	U	C	L	
5	5	3,8	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	**BOTANY**				
Course Code	**UK5DSEBOT303**				
Course Title	**GREEN TECHNOLOGY AND SUSTAINABLE DEVELOPMENT**				
Type of Course	**DSE**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	04 Hours	-	-	04 Hours
Pre-requisites	Basic understanding in environmental botany and ecological issues.				
Course Summary	The course on Green Technology and Sustainable Development aims to provide students with a comprehensive understanding of sustainable development principles, environmental challenges, and the role of technology in promoting environmental conservation and sustainable practices. Through lectures, case studies, discussions, students will explore various green technologies, renewable energy sources, sustainable design principles, and strategies for mitigating environmental impact				

Detailed Syllabus

Module	Unit	Content	Hrs
I		**Introduction to green technology**	**10**
	1	Scope And Significance of Green Technology- Past and Present Perspective.	
	2	Green Energy, Green Infrastructure, Green Economy and Green Chemistry and principles	
	3	Green Planning- Concept of green cities.	
	4	Key Components of Green Technology-Introduction to renewable energy technologies. Solar energy-Photovoltaic, Wind energy- Wind turbines and wind farms. Hydroelectric power, biomass, geothermal, and tidal energy	
II		**Green techniques**	**10**
	5	Successful Green Technologies- blending of fossil fuels with bioethanol, LED, green refrigerant, biodegradable plastic. Life Cycle Assessment (LCA) (brief account only).	
	6	Technologies to reduce Greenhouse emissions. Carbon Capture and storage.	
	7	5 R's of green technology: Recycle, Reuse, Reduce, Recover, Refuse.	
III		**Implementation of Green Technology**	**08**
	8	Role of government and institutions in implementing green technology.	

	9	Green policy and protocol, Leadership in Energy and Environmental Design (LEED). Green Rating for Integrated Habitat Assessment (GRIHA)	
	10	Green initiatives in Industrial Policy, Funding, Subsidies and tax rebates, Energy saving initiative	
IV	**Successful Green Initiatives**		**20**
	11	Solar panels, Rainwater harvesting, Biogas plant, Vermicomposting, Well recharging, Solid waste management, Electric vehicles	
	12	Employee Green training, Plant-based packaging, vertical gardens.	
	13	Case Study on Haritha Karma sena. A case study on green initiatives in Kumarakomon Rural Sustainable development for tourism	
	14	***Learning Activity:-*** 1. Waste and energy audit of an institution/organisation 2. Life cycle assessment of a product 3. Determination of ecological footprint of individuals 4. Vermicomposting and its utilization 5. Hydroponics in buildings (Demonstration) 6. Extraction of bio-oil - chemical and physical methods and its characterization 7. Anaerobic digestion of biomass for biogas production	
V	**Sustainability, Auditing, and Entrepreneurship for Greener Tomorrow**		**12**
	15	Waste auditing of the institution, Energy auditing, estimation of the ecological footprint of an individual, steps to do green audit on campus- Land Use System - Biodiversity Status-Climatic Conditions- Air Quality- Noise Pollution- Water Resources and Management- Waste disposal and management- Environmental Awareness-Mitigation and Management practices.	
	16	Case studies and entrepreneurship of successful Green Startups. Case study- Agritech – Startup - CropIn, Ninjacart.	

Suggested Readings

1. Jairam Ramesh Green Signals: Ecology, Growth, and Democracy in India"
2. Sivasankar. B "Green Chemistry: Environmentally Benign Approaches" b
3. Rajeev. B. R. Green Cities of India: Pioneering Approaches to Urban Sustainability"
4. "Renewable Energy Sources and Emerging Technologies: Solar Energy, Wind Energy, Biomass, and Geothermal Energy" by H. P. Garg and J. Prakash "Green Chemistry and Engineering: A Practical Design Approach" by S. S. Bhagat
5. "Carbon Capture and Storage Technologies: Advances in CO2 Capture, Sequestration, and Conversion" by Rajesh Kumar

References

1. "Waste Management: Principles and Practices" by A. K. Bhatia - "Sustainable Development in India: Strategies, Initiatives, and Challenges" edited by A. K. Mukherjee and R. S. Kumar
2. "Green Rating for Integrated Habitat Assessment (GRIHA): An Introduction" by Sanjay Seth
3. "Industrial Policies and Practices for Sustainable Development in India" edited by P. S. Sundararajan and A. K. Dhingra

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Summarize the objectives of green planning and its implications for urban development.	R	PSO-3
CO-2	Recognize successful green technologies and their applications in reducing environmental impact	U	PSO-3
CO-3	Knowledge of green techniques to identify opportunities for their implementation.	AP	PSO-2,3
CO-4	Analyze the effectiveness of government and institutional efforts in promoting green technology adoption.	AN	PSO-5,7
CO-5	Evaluate the strengths and weaknesses of policies and protocols in achieving sustainability goals. Develop strategies for implementing techniques to reduce greenhouse emissions in different sectors	E	PSO-6,8

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

Name of the Course: Green technology for Sustainable Development.

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

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

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

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1		3									
CO 2	1		3									
CO 3			3									
CO 4			3			6			3		5	6
CO 5			3						3			

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

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

Mapping of COs to Assessment Rubrics :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK5DSEBOT304**				
Course Title	**PLANT BIOTECHNOLOGY**				
Type of Course	**DSE**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	04 Hours	-	-	04 Hours
Pre-requisites	Basic knowledge about the various aspects of plants, concept of totipotency, genetic material				
Course Summary	This course provides a detailed account of the requirements of a tissue culture lab and covers the major procedures and events in plant tissue culture and recombinant DNA technology with speial ention its scope and application. An outlook on functional genomics and conservation biotechnology was also incorporated.				

Detailed Syllabus

Module	Unit	Content	Hrs
I		**Introduction and Techniques in tissue culture**	15
	1	Introduction to plant Biotechnology- Tissue culture- Basic principles, Totipotency of cells, differentiation and dedifferentiation. (brief account)	
	2	Requirements of tissue culture laboratory: culture vessels, instruments (pH meter, autoclave, weighing balance, refrigerator, distillation unit, microscope, Laminar air flow hood) (general account).	
	3	Medium composition and preparation: MS media- brief mentioning of different types of media- plant growth regulators; Procedures in tissue cultures- sterilization (dry, wet), aseptic techniques- explants in tissue culture.	
	4	Types of culture- Tissue and cell culture- callus culture- Cytodifferentiation, organogenesis- direct and indirect- *In vitro* techniques of micropropagation- axillary bud proliferation- meristem and shoot tip culture- production of virus-free plants and its applications; Somatic embryogenesis: Principle and concept- factors affecting embryo formation.	
	5	Cell Suspension Culture: Types- batch culture- continuous culture-open continuous-closed continuous, semi-continuous; Growth patterns in cell suspension culture- growth measurements- techniques for single cell culture. Root and hairy root culture. ***Learning Activity:-*** 1. Preparation of stock solution of MS media 2. Sterilization of tissue culture utensils 3. Preparation and sterilization of culture media	

		4. Techniques of culture- inoculation, sub culture etc.	
II	**Protoplast culture & Somatic hybridization**		**5**
	6	Protoplast culture and somatic hybridization- Significance, Problems and limitations; Protoplast isolation: methods- mechanical and enzymatic - production of protoplasts, osmoticum- protoplast viability and density- protoplast purification. Culture of Protoplast: Culture techniques- culture medium and environmental factors- cell wall formation, growth, division, and regeneration of plants.	
	7	Protoplast fusion and somatic hybridization- types- spontaneous fusion, induced fusion- types of fusogen- identification, and selection of hybrid cells-verification and characterization of somatic hybrids,-Cybrids.	
III	**Applications of Plant Tissue Culture**		**13**
	8	Clonal propagation, production of genetically variable plants. Crop improvement through tissue culture, scope, and application of tissue culture in forestry.	
	9	Production of secondary metabolites- method of production – factors affecting yield. Immobilized cell systems, bioreactors.	
	10	Application of somatic embryogenesis- Production of synthetic seed- encapsulation- Embryo rescue recovery of interspecific hybrids.	
	11	In vitro production of Haploids: Androgenic haploids and cyanogenic haploids- endosperm and embryo culture- Significance of haploids.	
	12	Application of plant biotechnology in agriculture horticulture and forestry: Improvement of cereals, vegetable crops, oil-yielding plants, ornamentals and forest trees. ***Learning Activity:-*** 1. Direct and indirect organogenesis 2. Preparation of artificial seeds	
IV	**Somaclones and Transgenics**		**15**
	13	Somaclonal variation- Origin and causes of somaclonal variants- applications, achievements, and limitations.	
	14	Recombinant DNA techniques- vectors, enzymes, PCR, Gene transfer mechanisms- Vector-mediated and vectorless gene transfer, Ti plasmid-mediated DNA delivery methods- Direct genetic transformation of DNA, particle bombardment, transformation of protoplast by electroporation, microinjection. ***Learning Activity:-*** 1. Isolation of DNA 2. Plasmid isolation 3. PCR amplification (demonstration only) 4. Agarose gel electrophoresis	
	15	Transgenic plants- GM crops-BT crops, Golden rice, Flavr -saver Tomato Current status and prospects of GM crops in India-New products - pharmaceuticals, bioremediation, edible vaccines, antiviral proteins.	
V	**Conservation Biotechnology & Functional Genomics**		**12**

	16	Germplasm Storage and Cryopreservation - Conservation Biotechnology –techniques of cryopreservation, choice of material, pre-culture, cryoprotection, freezing, thawing, reculture, vitrification, encapsulation applications of cryopreservation.	
	17	Analytical tools in Biotechnology: Molecular markers- RFLP, RAPD, microsatellites, NGS, Blotting techniques.	
	18	Innovations in plant biotechnology- Gene silencing, Antisense technology, Molecular pharming, Genome editing tools- CRISPR-Cas 9- Biosafety and bioethics in plant biotechnology.	

Suggested Readings

1. Brown, C.W., I. Campbell and F.G. Priest. 1987. Introduction to biotechnology Blackwell
2. scientific publications. Oxford.
3. Buchanan B.B, Gruissem W. and Jones R.L 2000. Biochemistry and Molecular Biology of
4. Plants. American Society of Plant Physiologistsm Maryland, USA.
5. Chawala, H. S. 2002. Introduction to Plant Biotechnology. Oxford & IBH Pubilishing Co.
6. Pvt.Ptd. New Delhi.
7. Dubey, R.C.1993. A Text book of Bio-Technology. S.Chand& Co. Ltd. New Delhi.

References

1. Turner, P.C. A.G. MC Lennan. A.D. Bates And M.R.H. White. 1998. Instant Notes in
2. Molecular. Biology. Viva Books Pvt. Ltd. Chennai.
3. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co, Clifornia.
4. De Robertis, E.D.P & De Robertis, E.M.F (1980) Cell and molecular biology, Holt Saunders
5. International Editions, Philadelphia, Tokyo.
6. Ignacimuthu, S.J. 2012 Biotechnology –An introduction. Narosa Publishing House, New Delhi.

Web Link

1. https://www.intechopen.com/chapters/40180
2. https://www.apsnet.org/edcenter/disimpactmngmnt/labexercises/PlantBiotechnology/Documents/PlantTissueCulture.pdf
3. https://www.intechopen.com/chapters/63134
4. https://www.microscopemaster.com/transgenic-plants.htm

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the core concepts and fundamentals of plant biotechnology	U	PSO-2
CO-2	students will be able to the function of cells in molecular – cellular totipotency	Ap	PSO-2

CO-3	Equip the students to carry out plant tissue culture. Analyse and evaluate secondary metabolite production from cultures	An, E	PSO-4
CO-4	The students will be able to understand the knowledge of the production of biologically important secondary metabolites through tissue culture.	AP	PSO-6,8
CO-5	Understand the current developments in the field of Biotechnology-strategy of conservation, artificial seeds, somaclonal variation	Ap	PSO-8

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

Name of the Course: Plant Biotechnology
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	U	F, C	L	P
2	2	2	Ap	P	L	P
3	3	4	An, E	P	L	P
4	4	6,8	Ap	P	L	P
5	5	8	Ap	F, C,P	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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK6DSEBOT301**				
Course Title	**PLANT PROPAGATION AND CROP IMPROVEMENT**				
Type of Course	**DSE**				
Semester	**VI**				
Academic Level	**300 - 399**				
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 and Genetics and gardening				
Course Summary	This course offers a comprehensive exploration of plant propagation methods, including seed and vegetative propagation, along with advanced techniques such as tissue culture. Additionally, it delves into crop improvement strategies encompassing traditional breeding methods, biotechnological approaches, and sustainable agricultural practices, providing students with a holistic understanding of enhancing crop productivity and agricultural sustainability.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Plant Propagation**	**08**
	1	Introduction to plant propagation: Importance and objectives- Asexual and Sexual methods of propagation.	
	2	Seed Propagation: Methods of Seed Propagation- Direct Seeding, Nursery Bed- Broad Casting-Dibbing- Drilling.	
	3	Vegetative Propagation - cutting, layering (Air layering) ground layering (Tip, Trench, and Compound), Budding (T- budding) Grafting (approach grafting, Bridge grafting, whip, and tongue grafting).	
	4	Environmental factors influencing propagation success: Light, temperature, humidity, and substrate; Hormonal regulation in plant propagation: Role of auxins, cytokinins, and other growth regulators.	
	5	Propagation Facilities: Mist Chamber-humidifiers, Green houses, Glass houses, Cold Frames,-Hotbeds, Poly-houses, Phytotrons.	
II		**Micropropagation**	**07**
	6	Introduction to tissue culture- Totipotency- definition and importance, dedifferentiation, redifferentiation, and Cytodifferentiation. Plant tissue culture techniques: sterilization, medium preparation (MS medium), and culture initiation, Equipment, and other requirements in tissue culture laboratory. Procedure for Tissue Culture - Selection of Explants, Sterilization,	

		Inoculation, Subculture, Organogenesis, hardening, and establishment (Restrict to meristem culture).	
III	**Crop Improvement**		**06**
	7	Introduction; Goals, significance and objectives- Plant Genetic Resources, their conservation and utilization in Crop Improvement, Importance of crop improvement in food security and agricultural sustainability.	
	8	Case Studies in Crop Enhancement and Sustainability: Impact and significance - Green Revolution - Golden Rice: Alleviating Vitamin A deficiency, Kalyan Sona: A Milestone in Wheat Cultivation and the Green Revolution in India.	
IV	**Methods of Crop Improvement**		**09**
	9	Traditional Breeding Methods: Plant Introduction: Definition, types, and procedure; Selection: mass selection, pure line selection, clonal selection; Hybridization: objectives, procedure, major achievements, Types of Hybridization: interspecific and intergeneric; Mutation and polyploidy breeding.	
	10	Biotechnological approaches for Crop Improvement: Genetic Engineering (Transgenic crops and Genome Editing), Marker-Assisted Selection (MAS).	
V	**Sustainable Crop Improvement Strategies**		**15**
	11	Agroecology and Agroforestry- Conservation Agriculture-Precision Agriculture-Climate-Resilient Crop Varieties, Biofortification: Organic Farming and Sustainable Intensification; Water-Efficient Irrigation Systems; Biopesticides, Biofertilizers and Biological Control; Integrated pest management (IPM).	
	12	Agriculture in India: Challenges and Innovations, Breeding techniques and achievements with reference to the following crops in India: (a) Rice (b) Wheat (c) Potato (d) Coconut.	
	13	Centres of crop breeding: International and National (with special reference to Kerala)	
	14	E-resources for Farmers: Digital Tools for Crop Management-Mobile Applications, Online Portals and Websites, Market Information Systems, Online Training and Extension Services; Community Forums and Discussion Platforms; E-Marketplaces and Agri-Tech Platforms.	

Practicals		
	1. Learn Vegetative Propagation techniques - Layering (Air Layering) Grafting (Whip and Tongue), Budding (T Budding) 2. Study the techniques of Emasculation and Hybridization of any bisexual flower 3. Study the impact of any chemical mutagens in onion root tip 4. Document the diversity and significance of any one crop variety cultivated in your area 5. Conduct a survey to study the importance of improved crop varieties over traditional varieties 6. Outline the cultivation practices associated with a specific crop variety 7. Visit to an ICAR institution/ organization.	**30**

Suggested Readings

1. Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA
2. Dash, S., & Pradhan, S. K. (2017). Principles and Practices of Plant Breeding. Satish Serial Publishing House.
3. Gayathri M C (2015), Plant Tissue Culture: Protocols in Plant Biotechnology, Narosa Publishers Pvt Ltd.
4. Hartmann, H. T., Kester, D. E., Davies Jr, F. T., & Geneve, R. L. (2011). Hartmann & Kester's Plant Propagation: Principles and Practices. Pearson Education.
5. Pandey, A. K., & Singh, M. (2000). Principles of Plant Breeding. Kalyani Publishers.
6. Randhawa G.S. and Sodhi A.S. (1988) Plant Propagation: Principles and Practices, New Age International Publishers.
7. Razdan M. K. (2016) An introduction to Plant Tissue Culture, Oxford and I B Publishers
8. Reddy, M. P., & Murthy, K. N. (2003). Plant Breeding Principles and Methods. Science Publishers.
9. Singh B.B (2004) Principles of Plant Propagation and Nursery Management, Kalyani Publishers.
10. Singh, B. D. (2004). Plant Breeding: Principles and Methods. Kalyani Publishers.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the concept of plant propagation and its significance in horticulture and agriculture	U	PSO-2
CO-2	Develop skills in different propagation methods	U, Ap	PSO-7
CO-3	Understand different plant breeding procedures	U	
CO-4	Develop skills in emasculation and hybridization techniques	U, Ap	
CO-5	Demonstrate and analyse chromosomal aberrations in onion root tips using chemical mutagens	U, Ap, An	

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

Name of the Course: Plant Propagation and Crop improvement
Credits: 3:0:1 (Lecture:Tutorial:Practical)

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

3.	3.		U	C	L	
4.	4.		U	C	L	
5.	5.		U, Ap	C, 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	**BOTANY**				
Course Code	**UK6DSEBOT302**				
Course Title	**PHYTOCHEMISTRY AND DRUG DEVELOPMENT**				
Type of Course	**DSE**				
Semester	**VI**				
Academic Level	**300 - 399**				
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
I		**Phytochemistry**	**10**
	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,	
II		**Extraction, Separation, and Structural Analysis of Phytochemicals**	**09**
	6	Extraction: Solvent extraction- Polar and non-polar solvents-Cold extraction- Hot extraction (Soxhlet & Clevenger).	
	7	Separation: Chromatography-Paper Chromatography- Thin Layer Chromatography-Column Chromatography- High-Performance	

		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	**Drug Development**		**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	**Standardization of Phytoformulations**		**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	**Sustainable Phytochemical Innovation: Case Studies and Practical Applications**		**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.	

Practicals		
	1. Qualitative test for reducing sugar : Benedict‘s test. Molisch‘s test, Lugol’s Iodine test. 2. Test for proteins : Biuret test. Xanthoprotein test, Translucent Oil drop test, Solubility Test. 3. Preparation of buffers. Phosphate, carbonate, Tris HCl. 4. Estimation of reducing sugars. 5. Extraction and estimation of soluble proteins by Lowry’s/ Bradford method. 6. Subject any one of the given plant to Soxhlet extraction/ hydrodistillation/Cold extraction -*Curcuma longa* rhizome powder,	**30**

	Piper nigrum fruits powder, *Syzygium aromaticum* , *Cinnamomum malabatram (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.	

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 (2016Textbook 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	**BOTANY**				
Course Code	**UK6DSEBOT303**				
Course Title	**MODERN TRENDS IN PLANT SYSTEMATICS**				
Type of Course	**DSE**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	04 Hours	-	-	04 Hours
Pre-requisites	UK3DSCBOT202/UK5DSCBOT301				
Course Summary	The course provides a clear out look to students regarding the new approaches in taxonomy and its applications.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Taxonomy and systematics**	**09**
	1	Introduction to classical and modern approaches in classification	
	2	Micro taxonomy and macro taxonomy; Stages of taxonomy - Alpha, beta and gamma taxonomy.	
	3	Taxonomic hierarchy- infra specific and supra specific categories- Hierarchy of categories and higher taxa.	
	4	Concept of Species- Biological species, Recognition species, Evolutionary species, Cohesion species, taxonomic or morphological species, Phylogenetic species, Genealogical species, Cryptic species.	
II		**Taxonomy, types and concepts**	**16**
	5	Phylogenetic systematics-Cladistics – Introduction, principles and features Apomorphy, plesiomorphy, symplesiomorphy and synapomorphy.	
	6	Methodology and applications of Phylogenetic systematics Phylogenetic trees: Cladogram, phenogram, phylogram, dendrogram. Rooted vs unrooted. consensus	
	7	Cladogram construction-Parsimony, Maximum likelihood and Bayesian analysis (Brief account only). Tools for cladistic analysis - MEGA X	
	8	APG IV classification	
III		**Trends in taxonomy**	**8**
	9	Chemotaxonomy, Cytotaxonomy, Numerical taxonomy.	
	12	Molecular taxonomy. Sources of molecular data-mitochondrial, nuclear, chloroplast loci. Molecular markers - RAPD, AFLP, RFLP, SSRs, SNPs (very brief overview) Usefulness of Internal Transcribed Spacer (ITS 1 & ITS 2), rbcL, matK-Application of DNA barcoding in species identification, The Barcode of Life Data system (BOLD).	

IV	23	***Learning Activity:-*** 1. Download the nucleotide sequence of five species from a genus and construct a phylogenetic tree. 2. Identify plants on the campus using online tools mentioned in the syllabus and compare them with authentic information 3. Debate on the user-friendliness of online systematic tools for plant identification and comparison. 4. Survey the plant diversity in the campus/locality and create a database.	**15**
V	**Automated taxon identification**		**12**
	24	Tools for Web-based techniques in plant taxonomy- Online plant identification tools - PlantNet, Plant.id, Google lens, Naturalist Picturethis.	
	25	Geographic Information System (GIS) -Application of GIS in plant taxonomy.	
	26	Online resources in taxonomy. Virtual e herbarium, Virtual Gardens, Index Herbariorum. Global Taxonomy Initiative (GTI). Taxonomy tools and resources recommended by convention on biological diversity Taxonomic Tools (cbd.int).	
	27	Application of Artificial Intelligence in Taxonomy.	

Suggested Readings

1. Davis, P. H. and V. H. Heywood. (1963). Principles of Angiosperm Taxonomy.
2. Oliver and Boyd, London. Heywood, V. H. (1965) . Plant Taxonomy. ELBS , London.
3. Heywood, V. H. and D. M. Moore (Eds). (1984). Current Concepts in Plant Taxonomy. Academic Press, London.
4. Hills, D.M. et al. (1996). Molecular Systematics (Ed. 2). Sinauer Associates, USA.

References

1. Hutchinson, J. (1959). The Families of Flowering plants. Oxford.
2. Judith, E.W.(2002). Describing Plant Species.
3. Kitching, I.J. et al. (1998). Cladistics – the theory and practice of Parsimony Analysis. Oxford University Press.
4. Michael G. Simpson.(2019) Plant systematics

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/

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Know the concept of classification and different systems of classification	U	PSO-3

CO-2	Understand the taxonomic hierarchy	R, U	PSO-3
CO-3	Understand the various new branches of taxonomy	U	PSO-3
CO-4	Experience the application of information technology in taxonomy problem-solving	A	PSO-10
CO-5	Experiment with the use of phylogeny analysis tools	E	PSO-10

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

Name of the Course: Modern trends in Plant Systematics
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	1	3	U	F, C	L	
CO-2	2	3	R, U	F, C	L	
CO-3	3	3	U	F, C	L	
CO-4	4	10	A	P	L	P
CO-5	5	PSO-10	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		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK6DSEBOT304**				
Course Title	**CLIMATIC CHANGE AND DISASTER MANAGEMENT**				
Type of Course	**DSE**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	04	04 Hours	-	-	04 Hours
Pre-requisites	Basic understanding in environmental botany and ecological issues.				
Course Summary	Understanding of the Earth's climate system, including the natural greenhouse effect and dark heating. Students learn about international organizations and agreements addressing climate change. The concepts of hazards, vulnerability, and disasters, along with risk evaluation and climate change risks outlined in IPCC reports. Classification of disasters and management strategies and measures				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Climate change**	12
	1	Climate system- The Earth's natural greenhouse Effect and Dark Heating, radiation balance, Climates of the past. Natural versus anthropogenic causes of climate change, enhanced greenhouse effect, climate forcing, climate forcing agents- greenhouse gases, aerosols, clouds, land use etc; global warming: role of CO2, CH4, water vapor etc., importance of monsoons, El-Nino	
II		**International response to climate change**	12
	2	IPCC -UNEP, WMO, Structure, IPCC bureau, Task Groups, Principles and procedures, UNFCC-The convention, Sites and Platforms, Montreal protocol, Kyoto Protocol, Paris agreement, 2020 ambition, Talanoa, Documents and decisions, National and local government responses: NAPCC, Glasgow Climate Agreement 2021	
III		**Introduction to Disasters**	12
	3	Understanding of Hazard, Vulnerability & Disasters. Concept of Risks, Evaluation of Risks. Climate change Risk (IPCC Report): Natural & man-made factors. Driving forces of Vulnerability of cities. Landforms Developing forces- Exogenic and endogenic . Concept of on-site Disasters. Disaster Mitigation – Emerging Trends in Disaster Management - UN Draft.	
IV		**Types of Disasters**	12

	4	Classification of Disasters: (Natural & man-made)- Natural Disasters: climatic disasters (wind & water related)-tropical cyclone-floods &drought; Earth related Disasters (Geological Disaster): earthquake, tsunami, landslides & volcano eruption- Man-made Disasters: industrial (on-site) Disasters: toxic gas leak, exploision, nuclear- Chemical and Technological Disasters (BLEVE-boiling liquid expanding vapor explosion); Accidental Disasters: rail, road, air and sea. Ecological Disasters: pollution, soil degradation, loss of biodiversity & Global warming. Epidemics: cholera, typhoid; Biological Disasters: COVID-19 global environmental problems- ozone depletion, greenhouse effect, global warming, acid rain, nuclear hazards – Climate change, Eutrophication.	
V	**Disaster Management**		**12**
	5	Disaster management- Basic measures for Disaster management**: p**reventive measures**, p**reparedness measures (Disaster mapping profile),redictability, forecasting & warning- Response and Relief measures. - recovery& rehabilitation measures. Disaster Management Bill, 2005- Institutional Framework for Disaster Management- Role of Media in Disaster Management.Basic Safety Measures (Pre and During): Earthquake & Floods. Case studies - Different disaster management in different counties with different disaster situation.	

Suggested Readings

1. IPCC, 2001: Impacts Adaptation and Vulnerability, GRID, Aewndal.
2. Natural Hazards, Bryant Edwards (2005), Cambridge University Press, U.K.
3. Space Technology for Disaster management: A Remote Sensing & GIS Perspective, Roy, P.S. (2000), Indian Institute of Remote Sensing (NRSA), Dehradun.
4. Natural Disaster, Sharma, R.K. & Sharma, G. (2005), (ed) APH Publishing Corporation, New Delhi.
5. Disaster Management : A disaster Manager's Handbook, Carter, N W. (1992), Asian Development Bank, Manila.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Summarize the differences between natural and anthropogenic causes of climate change.	U	PSO-5
CO-2	Analyze the effectiveness of international climate agreements in addressing climate change.	An	PSO-5
CO-3	Apply knowledge of disaster mitigation strategies to evaluate emerging trends in disaster management.	Ap	PSO-5,4

CO-4	Apply knowledge of disaster management frameworks to analyze case studies of disaster situations in different countries.	AP	PSO-8
CO-5	Interpret the role of greenhouse gases in the enhanced greenhouse effect.	U	PSO-5

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

Name of the Course: Climate Change and Disaster Management

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

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK7DSEBOT401**				
Course Title	**PLANT METABOLISM**				
Type of Course	**DSE**				
Semester	**VII**				
Academic Level	**400 - 499**				
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 a basic knowledge of the various physiological processes in plants, structure and function of various biomolecules in plants				
Course Summary	The course provides a understanding of different biochemical pathways and regulatory mechanisms involved in plant metabolism. Students will learn biochemical and hormonal regulation of seed germination, floral organ development, and fruit ripening processes, as well as their significance in plant growth, development, and agricultural practices.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Metabolic process**	**02**
	1	Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation, and Isozymes).	
II		**Carbon assimilation**	**10**
	2	Organization of photosynthetic apparatus -PSI and PSII, photosynthetic mechanism- C4 and Crassulacean acid metabolism-photorespiration-factors affecting CO_2 reduction.	
III		**Carbon oxidation**	**08**
	3	Metabolic regulation of glycolysis, acetyl CoA synthesis- and citric acid cycle- Mitochondrial electron-transport complexes–-ATP synthesis- chemiosmotic mechanism.	
IV		**Nitrogen and Lipid metabolism**	**10**
	4	Biological nitrogen fixation- physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination, and transamination.	
	5	Synthesis and breakdown of triglycerides- beta-oxidation, glyoxylate cycle-gluconeogenesis, and its role in the mobilization of lipids during seed germination.	
V		**Metabolic processes in seed germination, flowering, and fruit ripening**	**15**
	5	Metabolic processes during seed germination- the role of hydrolytic enzymes- phytohormones (abscisic acid, salicylic acid,	

		jasmonates, ethylene- respiratory reactivation, glyoxylate cycle in oil seed germination.	
	6	Floral organ development in flower induction - primary metabolites (carbohydrates, lipids, and proteins) - Secondary metabolites (polyamines, phenols), Stress-induced flowering pathway.	
	7	Fruit ripening - factors affecting fruit ripening (internal & external)- Changes associated with ripening (rate of respiration, hormonal changes (ethylene), chlorophyll loss, carotenoid accumulation, enzyme activity, synthesis of volatile compounds, synthesis of simple sugar.	

Practicals		
	1. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature, and senescence) by Arnon method. 2. Hill activity by DCPIP/ ferricyanide reduction. 3. Physiological identification of CAM in plant species. Differentiation of CAM and non-CAM plants by titration. 4. To study the activity of amylase in germinating seeds 5. Estimation of Anthocyanin pigment from floweres. 6. Estimation of Protein from fruit by Lowry's method	**30**

Suggested Readings

1. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA.
2. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
3. Maria Duca (2015). Plant Physiology, Springer International Publishing, Switzerland.
4. Kochhar, S. L.& Sukhbir Kaur Gujral (2020). Cambridge, University Press
5. Lehninger (2012). Principles of Biochemistry 6 thEdition,W H Freeman & Co.
6. Noggle G R & Fritz G J (1983) . Introductory Plant physiology 2 nd Edition, Prentice , Hall of India.
7. Pandey S.N. & Sinha B. K. (1996) Plant physiology 3rd Edition, Vikas publishing House- New Delhi.
8. Salisbury F. B. & Ross C. W.4th Edition (2005) Plant physiology, Wadsworth publishing company
9. Noggle G R & Fritz G J (1983). Introductory Plant Physiology 2 nd Edition, Prentice Hall of India
10. JainJ L, Sanjay Jain and Nitin Jain (2016). Fundamentals of Biochemistry. S Chand and Co.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the process and regulation of metabolic processes	U	2

CO-2	Gain knowledge of physiological and biochemical processes in the plant system and compare it with other type of systems	U	1,4
CO-3	Understand the molecular mechanisms underlying ATP synthesis and cellular energy metabolism and analyze complex biological systems at the molecular level.	U, An	1,4
CO-4	understand the physiological, biochemical, and molecular mechanisms underlying nitrogen and lipid metabolism, offering insights into fundamental biological processes and their applications in agriculture, biotechnology, and medicine.	Ap	2,4
CO-5	Understand the intricate metabolic processes governing seed germination, floral organ development, and fruit ripening in plants, and also gain insights into the regulatory mechanisms and environmental factors influencing these developmental stages, providing a foundation for further research and applications in agriculture, horticulture, and plant biotechnology.	Ap	1,5

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

Name of the Course: Plant metabolism
Credits: 3:0:1 (Lecture:Tutorial:Practical)

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

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- 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	**BOTANY**				
Course Code	**UK7DSEBOT402**				
Course Title	**INDUSTRIAL TISSUE CULTURE**				
Type of Course	**DSE**				
Semester	**VII**				
Academic Level	**400 – 499**				
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
I		**Introduction to plant Tissue culture**	**06**
	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	
II		**Laboratory organization and Instrumentation**	**06**
	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.	
III		**Tissue culture media**	**06**

	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, Phytagel, 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	**Micropropagation**		**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	**Commercial Operations**		**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.	

Practicals		
	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	

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 entreprenuer	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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK7DSEBOT403**				
Course Title	**AQUATIC BOTANY**				
Type of Course	**DSE**				
Semester	**VII**				
Academic Level	**400 -499**				
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 in aquatic environment and ecosystems				
Course Summary	The course provides a understanding various aspects of aquatic life. Through this course, students able to learn different types of aquatic ecosystems and the physiological adaptations of aquatic plants to their environment, as well as their ecological roles in aquatic ecosystems, including nutrient cycling, habitat provision, and interactions with other organisms.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Aquatic ecosystems**	**08**
	1	Aquatic ecosystems: Definition, features, types, and functions of aquatic ecosystems- marine ecosystems (ocean, coastal) and freshwater ecosystems (lotic, lentic, and wetlands).	
	2	Freshwater/Inland ecosystems: Origin, classification, and distribution of rivers, lakes, and ponds, major river systems of India. Riparian flora.	
II		**Marine ecosystem**	**05**
	3	Marine ecosystem**:** Origin of the ocean floor, classification of marine ecosystem.	
	4	Seas bottom topography: Abyssal, canyons, trenches. main physical (density, viscosity, surface tension, temperature) and chemical (major and minor constituents) properties of seawater,	
	5	Tides, currents, and waves, and their effects in estuaries and coastal area.	
III		**Aquatic plant resources: Lower plants**	**10**
	6	Aquatic plant resources: marine plant groups- Introduction and classification- brief idea of Plankton, Nekton, Benthos.	
	7	Marine Phytoplankton- Dinoflagellates, nano-plankton, ultra-plankton, coccoliths. marine Fungi, Actinomycetes, Lichens and Bacteria in brief.	

	8	Algae in Aquatic Environments: Microalgae and macroalgae, fresh water and marine algae- Uses of *Spirulina, Chlorella, Dunaliella* and *Haematococus.* Use of microalgae as food, food supplements, Biofuel, and bioremediation.	
	9	Seaweeds and seagrasses: Structure and types of Seaweeds - Indian Seaweed resources- Seagrasses: diversity, distribution, and importance - Economic importance of seaweeds.	
	10	Physical factors affecting growth: light, temperature, space, etc- Chemical factors affecting growth: nutrients, salinity- Biological factors affecting growth: perennation, herbivory, allelopathy.	
IV	**Aquatic plant resources - Higher plants**		**07**
	11	Plant adaptations to the aquatic environment.	
	12	Plant decomposition and the role of aquatic fungi. trophic interactions between algae, macrophytes, and fauna in aquatic environments.	
	13	Mangroves- definition, distribution-adaptation, biogeography of Indian Mangroves- need for the conservation of Mangroves- role of institutions and NGOs in India- Mangroves of Kerala.	
	14	Salt marshes, sea grasses, and sand dune vegetation.	
V	**Major Threats to Freshwater ecosystems**		**15**
	15	Major threats to freshwater systems and aquatic plants: pollution and sand mining- climate change implications on freshwater systems. Biomonitoring- future of freshwater ecosystems.	
	16	Invasive plant species and their effect on aquatic ecosystem, aquatic invasive species management.	
	17	Impact of large dams and fragmentation on river ecology and fishery. River continuum concept- Environmental flow -Pollution and eutrophication.	
	18	Climate change implications on freshwater systems. Biomonitoring. Future of freshwater ecosystems. Aquarium plants- Java Moss, (*Taxiphyllum barberi, Anubias sp., Vallisneria, Lemna minor, Rotala, Echinodorus*.)	
	19	Conservation of freshwater ecosystems. Restoration of freshwater wetlands. Ramsar Convention, Ramsar sites, Role of Pollution Control Board (PCB)	

Practicals		
	1. Water quality analysis - Estimation of pH, dissolved oxygen, alkalinity, hardness, carbon dioxide, and nutrients. 2. Study of ecological characteristics of a stream/ pond/ lake/reservoir/marsh. 3. Collect common aquatic plants and set up a natural aquarium. 4. Mapping of a wetland/stream using GIS 5. Conduct a water quality analysis between two aquatic ecosystems using the Titrimetric method. (a. Dissolved oxygen, b) Alkalinity, c) Chloride of water) 6. Visit any one of the Ramsar wetland sites in Kerala and prepare a field report	**30**

Suggested Readings

1. Bames R.S.K. (1999) Introduction to Marine Ecology, Blackwell Science.
2. Edmondson, W.T. (1976). Freshwater Biology 2nd Ed. John Wiley (Ed) and Sons Inc.
3. Golterman, H.L., Clyno, R.S. and Ohnstad, MAM. (1978). Methods for physical and
4. chemical analysis of freshwater. 2nd Ed. IBP Handbook no. 8 Blackwell scientificpublication.
5. Grasshoff, K. Enrhardt, M. and Kreenling, K. (1983). Methods of seawater
6. analysisi 2nd Ed Verlag Chemical
7. Hutchinson, G.E. (1976). A Treatise on limnology. Vol I & II John Wiley & sons
8. Jeffery S. Levinton (2000). Marine Ecology, Biodiversity and Function. Oxford

References

1. Jhingaran, V.G. (1985). Fish and Fisheries of India. Hindustan publication Corp. New Delhi
2. Nair, B. N. and Thampy D.M (1980). A text Book of Marine Ecology
3. Nybakaken, J.W. (2001), Marine Biology an Ecological Approach 4th edition.
4. 4..Perkins, E.J. (1980). The Biology of Estuaries and coastal water. Academic Press, London

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	The students are able to define, identify features, list types, and recognize functions of aquatic ecosystems	R, U	PSO-1,2
CO-2	The students can elaborate on the idea of aquatic plant resources	R, U	PSO 1,2
CO- 3	The students can investigate the major threats to freshwater systems and aquatic plants, including pollution, sand mining, and climate change	Ap	
CO-4	The student is able to create a natural aquarium and develop a sense of conserving freshwater ecosystems	C	

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

Name of the Course: Aquatic 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	R, U	F, C		
2	2		R, U	P		
3	3		Ap			
4	4		C			

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		✓		✓

Multidisciplinary Courses

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK1MDCBOT101**				
Course Title	**LANDSCAPING AND GARDENING**				
Type of Course	**MDC**				
Semester	**I**				
Academic Level	**100 - 199**				
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	Through this course, students will acquire knowledge about gardening and landscaping as a growing business venture. They will understand the growing demand in the present day. The course may motivate the students to get into gardening and landscaping startups.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Landscaping and Gardening**	08
	1	Importance, Scope, and prospects of landscaping and gardening.	
	2	Designing and Preparation of Landscapes and Gardens. Outdoor and Indoor concept – Functional uses of plants for different purposes.	
	3	Landscape- Principles, Elements, Designs; Types of Landscape– Landscaping Highways, City Parks and Home. (brief study only)	
11		**Lawns - preparation and maintenance**	08
	4	Lawn – Types of lawn grasses, methods of establishing lawn – Land preparation, planting, mowing, rolling,	
	5	Application of manures and fertilizers, irrigation, weed control, plant protection, and rejuvenation of lawns.	
III		**History of gardening trends**	08
	6	Types of gardens – Styles in gardening- Characteristics and components of English gardens, Mughal gardens, Japanese gardens, Persian, French and Italian gardens- Popular gardens in India.	
	7	Garden Components – Living components – Non-living components – Enrichment items- Description and uses. Garden enclosures, surfacing materials, roads, and paths, advantages and disadvantages- examples	
		Selection of plants for gardens	12

IV	8	Annuals and herbaceous perennials — Types ,colour schemes, planting designs – Season and methods of planting – Cultural practices.	
	9	Shrubs and Trees – Types, planting, pruning, maintenance, rejuvenation – Trees for landscapes, avenue planting.	
	10	Climber and Creepers – Cacti, succulents – Ferns and palms – planting, care, and management. ***Learning Activity:*** *1. Field visit to a well-established nursery to study the techniques of gardening.* 2. *Virtual visits to two important gardens in the world and submit a report, highlighting its Significance*	
V	**Specialized Gardens**		**09**
	11	Specialized gardening techniques – Roof Garden, sunken garden, water garden, rock garden. Special requirements, establishment, and maintenance	
	12	Indoor gardening of plants – Function, selection, designs, types of indoor plants- Bonsai (brief account) environmental requirements – Containers and media, method of growing, special care for indoor plants, vertical garden, tray garden, terrarium, etc.	

Suggested Readings

1. Arora, J.S. 1998. Introductory ornamental Horticulture
2. Naik HB, Chandrasekhar SY and Jawaharlal M. Principles of Landscape Gardening. E-book Agrimoon .com
3. Bhattacharjee, S.K. 2004. Landscape Gardening and Design with plants.
4. Bhattacharjee, S..K 2006. Vistas in Floriculture. Pointer publishers
5. Singh,A.K. 2020. Textbook of Floriculture and Landscaping. New India Publishing Agency
6. Bhattacharjee,S.K.(ed). 2006. Advances in Ornamental Horticulture Vol. I to VI. Pointer Publishers, Jaipur.
7. Chadha, K.L. and Choudhury, B. 1992. Ornamental Horticulture in India., ICAR, New Delhi
8. Jindal, S.L. 1987. Flowering shrubs in India. Publications Division, Govt. of India, New Delhi.
9. Swarup.V. 1993. Indoor Gardening, ICAR, New Delhi
10. Kumar, N., 2017, Introduction to Horticulture, Med tech publishers India

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will understand the different components of a Garden and the requirement of landscaping.	U	PSO-4

CO-2	Students will familiarise with the important various styles types of Gardens in India and abroad	R, U	PSO-4
CO-3	Students will understand the preparation of Lawn and its maintenance and can apply in home garden	U, Ap	PSO-4
CO-4	Students will be understand the aesthetic significance of various types of plants in landscapes and gardens	U, An	PSO-4
CO-5	Students will be able to understand the aesthetic significance of various special types of gardens and the procedures involved in designing them and based on these information he/she will be able to create new garden designs.	U, Ap, C	PSO-8
CO-6	The course may generate interest in the students to become entrepreneurs in the business of landscaping and gardening	Ap,	PSO-4

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

Name of the Course: Landscaping and Gardening

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

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

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK1MDCBOT102**				
Course Title	**FLORICULTURE**				
Type of Course	**MDC**				
Semester	**I**				
Academic Level	**100 – 199**				
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	Through this MDC, students will acquire knowledge about floriculture as it is a growing business venture. The course may motivate the students to get into gardening and landscaping startups.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Floriculture**	06
	1	Present status of the cut flower industry in India and abroad	
	2	Constraints and prospects of commercial floriculture in India with special reference to Kerala. Greenhouse and shade house for cultivation of floricultural crops.	
	3	Flower Business– Grower, Wholesale, Retail, and specialty shops, Studio operations. Careers in the floriculture business as - shop owners, designers, Service personnel, packaging, and logistic personnel.	
II		**Major Floricultural crops**	10
	4	Marketing of loose flowers, cut flowers, and perfumery roses, protected cultivation for export.	
	5	Importance, uses distribution, classification, varieties, soil and climate, propagation, planting; special cultural techniques – nutrition, plant protection, harvesting, and marketing with special reference to Chrysanthemum, Rose, Orchids, and Anthurium.	
III		**Minor Floricultural crops**	10
	6	Bulbous plants – classification, uses, commercial value, propagation, soil, and climate – planting – Care and management – harvesting, storage of planting materials - Gladiolus, Tuberose, Alpinia, Heliconia, Dahlia, Amaryllis.	
	7	Minor commercial flowers – Marigold, Crossandra, Gomphrena, Aster, Celosia. – Uses, classification, propagation, soil and climate, planting, care and management, harvesting, marketing.	
IV		**Basics of Flower Arrangement**	10

	8	Principles – Balance, Focal Point, Rhythm, Harmony. Design elements – Line, Form, texture, color.	
	9	Selection of cut flowers and greens – Line flowers, Mass flowers, filler flowers, form flowers. Conditioning and storing of flowers and greens – reasons for deterioration, use of antitranspirants.	
	10	Mechanics and supplies in floral design – containers, floral foam, adhesive materials, cutting tools, picks, wires and wiring, floral taping, ribbons and bows.	
V	**Specialty Flower Arrangements**		**09**
	11	Flower Arrangement- Western and Eastern	
	12	Basic arrangements - Bud vases – flowers, foliages, and accessories for bud vases, Design of bud vases. Circular arrangements, Triangular arrangements, Line arrangements	
	13	Constructing Wreaths, Holiday arrangements, Wedding flowers – Corsages. Ceremonial decorations, Dry flower preparation Arranging permanent flowers – Silk flowers, paper flowers, Dried and preserved flowers.	

Suggested Readings

1. Griner C .2011. Floriculture – Designing and Merchandizing. Cengage, Australia.
2. Arora, J.S. 1998. Introductory ornamental Horticulture.
3. Swami GSK and Auxcilia J. Fundamentals of Horticulture. E-book. Agrimoon.com.
4. Singh AK .2020. Textbook of Floriculture and Landscaping. New India Publishing Agency.
5. Bhattacharjee,S.K.(ed). 2006. Advances in Ornamental Horticulture Vol. I to VI. Pointer Publishers, Jaipur.
6. Sidhu, S.S. 2016.Ornamental Horticulture. New India Publishing Agency,New Delhi.

References

1. Chadha, K.L. and Choudhury, B. 1992. Ornamental Horticulture in India., ICAR, New Delhi.
2. Jindal, S.L. 1987. Flowering shrubs in India. Publications Division, Govt. of India, New Delhi.
3. Pal, B.P. 1972. The rose in India. Indian Council of Agricultural Research, New Delhi.
4. Randhawa, M.S. 1983. Flowering Trees. National Book Trust, India, New Delhi.
5. Randhawa.G.S. and Mukhopadhyay. A. 1986. Floriculture in India. Allied Publishers, New Delhi.
6. Sabina, G.T. 2009. Ornamental plants. New India Publishing Agency.
7. Sheela, V.L. 2008. Flowers for trade. New India Publishing Agency, New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will get an overview of the scenario of the	U	4

	floriculture industry – its scope and limitations		
4CO-2	Awareness of various floriculture crops in India, their cultivation practices, and marketing	U	4
CO-3	Students will understand the basics of flower arrangements and the opportunities in the area of flower arrangements in large functions like weddings.	U	8
CO-4	The course may generate interest in the students to become entrepreneurs in the business of floriculture	Ap	4, 12

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

Name of the Course: Floriculture
Credits: 3:0:0 (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	U	F,C	L,T	
3	3	8	U	F,C	L,T	
4	4	4, 12	Ap	F,C		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	**BOTANY**				
Course Code	**UK1MDCBOT103**				
Course Title	**BOTANY IN FORENSIC SCIENCE**				
Type of Course	**MDC**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	03	02 Hours	-	02 Hours	04 Hours
Pre-requisites	No Pre-requisites				
Course Summary	Forensic botany is an integration of botany and forensics. The botanical aspect is primarily associated with the anatomy and taxonomy that helps to identify particular plant species. The forensic aspect deals with recognizing plant-based evidence at the crime scene, its collection, and proper processing to be admissible in a court of law.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction**	**01**
	1	Forensic botany- Introduction and its importance	
II		**Branches of Botany in Forensic Study**	**02**
	2	Branches of Botany in Forensic Study: morphology, anatomy, palynology, dendrochronology, algology, limnology, mycology, plant systematics, Plant Molecular Biology and ecology, and applications. The Lindbergh Case.	
II		**Botanical evidences**	**05**
	3	Plant evidence collection, analysis, and documentation - Types of plants (General plant classification schemes) Algae, Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms. Non-plant groups - Fungi and lichens.	
	4	Basic plant characteristics for the forensic investigator. Plant architecture- roots, stems, leaves, flowers, and fruits. Plant dispersal. Practical plant classification schemes: - vegetables and herbs, fruits bearing trees, landscaping plants: trees, shrubs and vines, grasses.	
III		**Analyses of Samples**	**06**
	5	Plant anatomy- cell structure and functions. Basic plant tissues (a very brief overview only).	
	6	Microscopy in Forensic botany: uses and applications - hand lens, compound microscope, stereo microscope, scanning electron microscope. (Working, principles are not required).	
	7	Various types of woods and timbers (a brief overview). Identification of wood-physical properties: color, fluorescence, hardness, weight, odour, lustre, texture, anatomical features, pore/vessel distribution,	

		size and arrangement, pore numbers, pore arrangements, inclusions, coloured deposits.	
	8	Types of fibers- man-made and natural fibers. Forensic aspects of fiber examination- fluorescent, optical properties, refractive index, birefringence, dye analysis.	
	9	Identification of starch grains, powder, and stains of spices.	
	10	Paper and Paper Pulp identification, Microscopic and biochemical examination of pulp material.	
	11	Forensic palynology: Study and identification of pollen grains. Case study: War crimes investigations by International Criminal Tribune for the former Yugoslavia.	
VI	**Algae in forensic science**		**04**
	12	Algal diversity (brief outline). Forensic Limnology: Methods of identification and comparison of various types of Planktons and diatoms and their forensic importance. Diatoms types and morphology. Extraction methods. Diatom testing. Case study: State of Connecticut (USA) vs. John C. Hoeplinger	
	13	Forensic mycology- a general account. Fungi as agents of poisoning and hallucinations	
V	**Poisonous plants and their toxins**		**12**
	14	Study of Various types of poisonous plants-*Abrus precatorius, Anacardium occidentale, Argemone mexicana, Calotropis, Cannabis sativa, Cinchona, Croton tiglium, Atropa belladonna, Gloriosa superba, Jatropha curcas, Lathyrus sativus, Manihot utilissima, Nerium indicum, Nicotiana tabacum, Plumbago, Ricinus communis, Semicarpus anacardium, Strychnos nux-vomica, Thevetia nerifolia, Cerbera odollum.*	
	15	Types of plants yielding drugs of abuse – Opium, *Cannabis*, Coco, Tobacco, *Datura*	
	16	How to become a forensic botanist?	

Practicals		
	1. Conduct a visit to a natural place and identify plant and non-plant groups mentioned in the syllabus. 2. Documentation of forensic evidence through photographs and charts. 3. Light microscopic examination of different paper samples. 4. Examine the physical properties and anatomical differences of common wood types in Kerala (any three). 5. Microscopic examination of natural and manmade fibers. 6. Study of poisonous plants mentioned in the syllabus. 7. Visit an aquatic ecosystem and identify diatoms by microscopic examination. 8. Microscopic examination of pollen grains and spores 9. Identify appropriate case studies using botanical evidence from literature (other than mentioned in the syllabus) and document (at least five cases)	**30**

Suggested Readings

1. Gibson, David J. 2022. Planting Clues: How plants solve crimes. Oxford University Press,
2. Bock, Jane H., and David O. Norris. 2015. Forensic plant science. Academic Press,
3. Hall, David W., and Jason Byrd. 2012.Forensic botany: a practical guide. John Wiley & Sons,
4. Coyle, Heather Miller. 2004. Forensic botany: principles and applications to criminal casework. CRC press,
5. Hesse, Halbritter, Heidemarie. 2009. Illustrated pollen terminology. Springer.

References

1. Breeze, 2005. "Microbial forensics." Microbial forensics. Academic Press.
2. Caccianiga, Marco, et al. 2021"Common and much less common scenarios in which botany is crucial for forensic pathologists and anthropologists: a series of eight case studies." International Journal of Legal Medicine 135:1067-1077.
3.Tranchida et al., 2020. The use of fungi in forensic science, a brief overview. Canadian society of forensic science journal, 54(2):1-14
4. Bateman, Nick, and others (eds). 2014. *Oxford Desk Reference: Toxicology*, Oxford Desk Reference Series (Oxford; online edn.)

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Evaluate the nature of plant-based evidence	R, U	PSO-1,2
CO-2	Observe how plant-based evidence has been used in forensic investigations.	R, U	PSO-4
CO-3	Apply logical analysis of plant-based evidence to crime solving	Ap	PSO-4
CO-4	Describe the techniques used to identify and evaluate plant-based evidence including microscopy	R, U	PSO-6
CO-5	Identify and able to name sources for poisonous plants and fungi	R	PSO-1
CO-6	Master an appropriate range of knowledge on plant structure including morphology, wood anatomy, palynology	R, U, Ap	PSO-2

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

Name of the Course: Botany in Forensic Science
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		R, U	F	L, T	
CO-2	2		R, U	F	L	
CO-3	3		Ap	C	L	P
CO-4	4		R, U	F, C		P
CO-5	5		R	C	L	P
CO-6	6		R, U, 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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK2MDCBOT101**				
Course Title	**PLANTS AND HUMAN WELFARE**				
Type of Course	**MDC**				
Semester	**II**				
Academic Level	**100 - 199**				
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
I		**Plant relation to humans**	**02**
	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).	
II		**Food crops**	**08**
	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	**Cash crops -** Beverages- Tea (Morphology uses and processing). Natural Rubber - (Morphology, Tapping and processing)	

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

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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK2MDCBOT102**				
Course Title	**ECOTOURISM**				
Type of Course	**MDC**				
Semester	**II**				
Academic Level	**100 - 199**				
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 students will understand the basic concepts of ecological balance of life and non-living environment on earth and factors that deteriorate this balance and the requirement of sustainable activities in every sphere of life. Students will appreciate the importance of ecotourism as the potential area for making awareness among the masses which indirectly helps in conserving nature.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of Ecology**	**09**
	1	Fundamentals of Ecology- Basic Concepts in Ecology	
	2	Biodiversity and its Conservation - Management of Ecosystem	
	3	Pollution-Ecological Foot Prints	
	4	Relationship between Tourism and Ecology.	
II		**Principles of Ecotourism**	**10**
	5	Evolution of ecotourism, Principles, Trends and Functions of Ecotourism	
	6	Mass Tourism Vs Ecotourism -Typology of Eco-tourists	
	7	Sustainable Ecotourism - Resource Management, Socio-economic Development	
	8	Ecotourism Activities and Impacts -Western Views of Ecotourism - Quebec Declaration 2002 - Kyoto Protocol 1997 - Oslo Declaration 2007	
III		**Ecotourism Policies**	**08**
	9	Ecotourism Policies, Planning and Implementation	
	10	Eco-friendly Facilities and Amenities - Carrying Capacity	
	11	Alternative Tourism -Responsible ecotourism- Ecotourism Programming	
IV		**Conservation through Ecotourism**	**09**
	12	Protected Area Management through Ecotourism - Stakeholder Engagement - Community Participation Types of Participation, Issues and Challenges	

	13	Ecotourism Projects Case Studies on Periyar National Park, Thenmala Eco-Project, Similipal. Ecotourism Project, Sunderban Ecotourism Project, Kaziranga National Park, Run of Kutch, Nandadevi Biosphere Reserve	
V	**Agencies Concerned with Ecotourism promotion**		**09**
	14	Role of agencies concerned with Ecotourism - International Ecotourism Society, UNWTO, UNDP, WWF - Department of Forest and Environment - Government of India, ATREE, EQUATIONS. ***Learning Activity*** 1. Nature walks /Hikes: Guided tours through natural habitats, focusing on flora, fauna, and ecological balances and disturbances and submit reports. / Bird watching: Learning about the local bird species, their habitats and conservation. / Wildlife Safari and Responsible wildlife viewing to observe animals in their natural habitats while minimizing disturbances. 2. Nature Photography: Exploring photography techniques while capturing the beauty of nature, promoting appreciation and conservation. / Nature camps: 1-2 days camps to understand the nature with a focus on minimal environmental impact and appreciation of natural beauty 3. Tree planting: Participating in reforestation projects to understand the importance of trees in the ecosystem./ Planting of endangered tree species in the campus. / Beach cleanup: Contributing to coastal conservation by removing litter and learning about marine ecosystems 4. Local community engagement: Visit a tribal settlement and interact with indigenous or local communities to understand their relationship with nature and conservation efforts. 5. Group discussions: on issues like conservation, man-wildlife conflict, eco-friendly practices and responsible tourism issues etc. / Debates: Debates on conventional practices /sustainable practices, renewable energy/nonrenewable energy, conventional tourism/ecotourism, Tourism a Boon/Curse to biodiversity, etc.	

Suggested Reading

1. Bhatt S, Liyakhat S (2008) Ecotourism Development in India Communities, Capital, and Conservation. Cambridge University Press.
2. Blumstein DT., Geffroy B, Samia DSM (2017) Ecotourism's Promise and Peril: A Biological Evaluation. Springer International Publishing
3. Fennel, D. A. (2002), Ecotourism Policy and Planning, CABI Publishing, USA
4. Ralf Buckley (2004), Environment Impacts of Ecotourism, CABI, London
5. Singh J (2010) Ecotourism. I.K. International Publishing House Pvt. Limited.

6. Sukanta K Chaudhury, Cultural, Ecology and Sustainable Development, Mittal, Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the significance of ecotourism	U	PSO-3
CO-2	Comprehend the theories and practices of ecotourism through group discussions/debates	U, An	PSO-3
CO-3	Become aware of the ecotourism projects in Kerala and India	U	PSO-3,6
CO-4	Apply the theoretical knowledge to manage ecotourism ventures.	Ap	PSO-8
CO-5	Create awareness among local communities on ecological balances and sustainable living	An, Ap	PSO-5

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

Name of the Course: Ecotourism

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	1	3	R, U	F,C	L,T	
2	2	3	U, An	F, C	L,T	
3	3	3,6	U	F, C	L,T	
4	4	8	Ap	P		P
5	5	5	An, 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	**BOTANY**				
Course Code	**UK2MDCBOT103**				
Course Title	**ORGANIC FARMING**				
Type of Course	**MDC**				
Semester	**II**				
Academic Level	**100 – 199**				
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	Students will understand and analyse the ill effects of conventional agricultural practices and appreciate the benefits of organic agriculture. They will apply the knowledge of methodology of organic farming in their home gardens. They will understand the global demand and premium price organic products fetch in the market. The course may motivate the students to get into Organic Farming and Marketing business ventures.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Agriculture**	**03**
	1	Introduction to Agriculture: Domestication of plants – early agricultural practices– intercropping and crop rotation, Green Revolution	
	2	Major cultivated crops and vegetables in India (Brief description about Rice, wheat, Maize, Brinjal, Ladies finger, Vigna, and Tomato).	
II		**Organic farming**	**06**
	3	Organic farming- definition, Principles and practices of organic farming. Need for organic farming.	
	4	Types - Integrated organic farming, Pure organic farming. Zero Budget Natural Farming (ZBNF), Advantages and disadvantages of organic farming ***Learning Activity:*** *Student may grow any short-duration vegetable by organic farming in their home and submit a report with geotagged photographs*	
III		**Importance of Soil in Agriculture**	**12**
	5	Definition; Soil formation; Composition and characteristics; Types of soil according to composition; Acidic, Alkaline and Saline soils; Effect of soil types on Agriculture; Method of reclamation.	
	6	Soil productivity: Meaning and Concept. Difference between Soil Fertility and Productivity; Method of Increasing productivity and fertility, importance of microbes in the enrichment of soil fertility.	

		Role of VAM as growth regulator. Drip irrigation. Relationship between soil fertility and soil pH.	
	7	Organic matter management in agricultural fields , Organic manures (cow dung, cow urine , leaves, coir pith, bone dust , etc), – plant health – sustainable agriculture– supplementation of NPK as bioresource – vermicomposting –mulching, green manure	
	8	Biogas slurry- Organic content. Status of Biogas Usage, benefits, and significance. Pipe compost- installation and benefits	
IV	**Biofertilizers and Biopesticides**		**12**
	9	Scope, application, types – mass cultivation of biological nitrogen fixers – Blue-green algae, Rhizobium, Azolla – Phosphate solubilizing bacteria – Mycorrhiza – cost-benefit analysis and Protection Measures: Integrated pest and disease management.	
	10	Organic pesticides, bio-pesticides- Types and benefits. Microbial biopesticides, and its advantages (*Trichoderma, Pseudomonas fluorescence*, *Bacillus thuringiensis*) Inorganic pesticides, disadvantages of their use. Seed, seedling, and soil Treatment measures. ***Learning Activity:*** *Preparation of tobacco decoction* (a plant-based pesticide)	
V	**Feasibility and Economics of Organic Farming**		**12**
	11	Feasibility of complete dependence on organic sources. Organic Agri-Horticulture in Urban and rural areas, terrace and kitchen garden. Value addition in organic products – government policies	
	12	Economics of organic products- cost of production and financial benefits to cultivator. Good Harvesting Practices; Storage; Transportation; Supply Chain. Need of certification and quality assessment of organic produce. Agencies involved in Organic certification in India.	
	13	National Programme for Organic Production. Organic Farming Mission of Kerala.	

Suggested Reading

1. Dubey, R.C., 2014. A textbook of biotechnology. S. Chand and co private limited, New Delhi.
2. Lakshmana, H.C. and Channabasava, A., 2014. Biofertilizers and biopesticides. Pointer publishers, Jaipur.
3. Himadri, P. and Dharamvir, H., 2007. Biofertilizers and organic farming. Gene–tech books, New Delhi.
4. Hegazi, N. I., Fayez, M. and Hamza, M., 2013. Biofertilizers for organic farming. Academic publishing, Egypt.
5. Dilip, N., 2016. Organic farming for sustainable agriculture.Springer publishing, New Delhi.

References

1. Goswami KP, 1989, Appropriate Technology for Rural India to produce biogas from vegetable waste.
2. Managing Manure, 2015 Mark Kopecky, Storey Publishing .

3. Rodale book of composting, 1992 , Grace Gershuny, Rodale press, Pennsylvania
4. Organic fertilizers 2019, Sonia Soloneski, Intech open.
5. Biogas fundamentals 2018, MeisamTabatabei, Springer.
6. Agriculture Research Data Book 2019, ICAR—Indian Agriculture. Statistics Research

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will understand the conventional agricultural practices that damage the health of people as well as the environment from the avaricious anthropogenic onslaughts due to the indiscriminate use of chemical fertilizers and pesticides.	U, Ap	PSO-3,4
CO-2	Students can assess the advantages of organic farming means and practices as an alternative to conventional agriculture.	U, An	PSO-3,4
CO-3	Students can analyze the various forms of microbes as suppliers of organic nutrients, including nitrates, and phosphates enriching the soil that would eventually have a bearing on the methods of cultivation with enhanced nitrogen supply.	An	PSO-3
CO-4	Students apply the knowledge of using biopesticides without harming the co- living microbiota and life forms in the ecosystem and understand that the use of crop protection chemicals can be avoided to safeguard environment.	Ap, An	PSO-5
CO-5	Students will use the acquired knowledge needed to prepare eco-friendly commercial formulations meeting national and international standards and regulations and float newer entrepreneurial ventures	U, C	PSO-3,8

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

Name of the Course: Organic Farming

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

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

2	2	3,4	An	F,C	L,T	
3	3	3	Ap, An	C,P	L,T	
4	4	5	U, C	C,P		P
5	5	3,8	U, An	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		✓	✓	✓

Value Addition Courses

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK3VACBOT201**				
Course Title	**GREEN INITIATIVES FOR SUSTAINABILITY**				
Type of Course	**VAC**				
Semester	**III**				
Academic Level	**200 - 299**				
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	Students will able to learn about green initiatives, water and waste management & air pollution. Students will learn about energy management, Afforestation, and mangrove conservation. Students know about biodiversity documentation and green audits.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Green Initiatives -Introduction**	**09**
	1	Green initiatives - Scope and importance for sustainability, Green initiative strategies for schools and higher education institutes, UN Sustainable Development Goals- 2030	
	2	Gardens and Conservatories: Botanic gardens, Zoological gardens, Ponds, Aquariums, Field gene banks, Butterfly parks, orchards.	
	3	Sustainable Agriculture: Definition, Principles and practices, Biological control, Biofertilizers and Biopesticides, Composting, Vermiculture, Farm tourism.	
II		**Water, Waste Management & Air Pollution**	**09**
	4	Irrigation and Water Management: Natural sources of water, Hydrological cycle, Irrigation methods- drip irrigation, Sprinkler method, Water conservation water harvesting.	
	5	Waste Management: Sources of waste, Types-Biodegradable, non-biodegradable, waste minimization, Solid waste management - Collection, Storage, Transport and Disposal of Wastes. Waste management methods- Recycling, incineration, landfill, Importance of 3Rs in waste management.	
	6	Air Pollution Reduction: Sources of air pollution, Air pollutants, Greenhouse gases, greenhouse effect and global warming, carbon footprint, Carbon sequestration - Biological, Air pollution - Control measures	
	7	Swachh Bharath Abhiyan: Gandhian philosophy of Cleanliness, Hygiene & Sanitation, Different phases of the SBA and its evaluation, Citizens' Responsibilities, Role of Swacchagrahi.	

III	**Energy Management**:		**09**
	8	Energy resources - Renewable and Non-renewable, Conventional - Thermal, Hydro, Nuclear fission, Non-conventional – Solar, Wind, Biomass, Energy from waste, Energy plantation.	
	9	Energy Audit – Types and Procedure, Energy Conservation Measures – Optimum performance of existing facilities, Energy Conservation opportunities in residential and commercial buildings-	
IV	**Afforestation & Mangrove Conservation**		**09**
	10	Afforestation: Techniques and practices, strategies- species selection, density and arrangement, Common plants for afforestation in Kerala, Agroforestry, Social forestry, Miyawaki forest.	
	11	Mangrove ecosystem – structure and function, floral and faunal diversity, mangroves and climate change, coastal defense, mangrove restoration, economic importance of mangroves.	
V	**Biodiversity documentation & Green audit**		**09**
	12	Biodiversity documentation**:** Assessment and monitoring of biodiversity, Methodology of assessment and analysis of different species groups, plant communities- Survey method, field study. Conservation strategies – In situ and Ex situ conservation, Peoples Biodiversity Register	
	13	Green Audit: Green Audit: Definition; Objectives; Scope, Coverage. GOI notification on Environmental Audit - Benefits to Industry. Reporting Environmental Audit Findings -Importance of Environmental Audit Reports to industry, the public, and the governments.	

Suggested Reading

1. Singh, M. P., Singh, J. K., & Mohanka, R. (2007). *Forest environment and biodiversity*. Daya Books.
2. Balooni, K., & Singh, K. (1994). *Role of NABARD in financing social forestry programmes including afforestation of wastelands in India*. Anand, India: Institute of Rural Management.
3. Mason, J. (2003). *Sustainable agriculture*. Landlinks Press.
4. Majumdar, D. K. (2001). *Irrigation water management: principles and practice*. PHI Learning Pvt. Ltd.
5. K R Gupta Environmental Legislation in India Atlantic Publishers & Dist, 2006 Atlantic Publishers & Dist, 2006
6. Afforestation M P Singh, B C Oraon, Narendra Prasad. APH Pub. Corp. 2011

Weblink

1. https://www.britannica.com/science/ecology
2. https://plato.stanford.edu/entries/ecology
3. https://www.cpcb.nic.in/https://www.free-ebooks.net/envirorumental-studies-academic
4. https://swachhbharatm ission.gov. in/SBMCMS/a bout-us.Htm

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will be able to understand the various aspect on afforestation, conservation and importance of trees for sustainable lifestyle.	U, R	PSO-5
CO-2	Students will be able detect the polluted sites, its major pollutants and recognize the need to mitigate pollution.	An, E	PSO-6
CO-3	Students will Identify and apply the basics of waste management towards sustainable development.	R, Ap	PSO-6
CO-4	The students will gain an understanding of the impact of energy on society, the need for sustainable energy various techniques of energy management and conservation and gained the basic ideas of conducting an energy audit.	U, An, Ap	PSO-5,9
CO-5	Students will be able to plan and execute species documentation field study and will be able to assist in the preparation of PBR and campus flora	Ap, E, C	PSO-6,7
CO-6	Students can develop attitudes toward research and undertake actions to execute green initiatives.	Ap, C	PSO-7,
CO-7	Students will be able to understand the significance of the Swachh Bharat Abhiyan, will gain the ability to analyze and predict the sanitation challenges of India, determine the link between sanitation and development, and contribute to the Swachh Bharat Abhiyan through real-time projects/fieldwork.	U, Ap, E	PSO-6

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

Name of the Course: Green initiatives for Sustainability

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

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

CO-4	4	6,7	U, An, Ap	F, C	L	
CO-5	5	7	Ap, E, C	P	L	
CO-6	6	6	Ap, C	M	L	
CO-7	7	6	U, Ap, E	F, C, 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 :

	Internal Exam	**Assignment**	**Project Evaluation**	**End Semester Examinations**
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓			✓
CO 5	✓	✓	✓	✓
CO 6	✓			
CO 7	✓			

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK3VACBOT202**				
Course Title	**BIOETHICS AND IPR**				
Type of Course	**VAC**				
Semester	**III**				
Academic Level	**200 - 299**				
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	Students will be able to understand the concepts related to bioethics, biopiracy and IPR and analyse the current norms relating to bioethics in the context of patenting				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Bioethics & Biopiracy**	**09**
	1	Nature, Concept and Relevance of Bioethics, Basic Principles of Bioethics; Necessity of Bioethics, Legal, Bioethics in Plants, Animals and Microbial Genetic Engineering, Ethical issues in Healthcare.	
	2	Biopiracy, Access to Biological Resources, Benefit Sharing and Informed Consent, Different paradigms of Bioethics – National & International. Social and ethical implications of biological weapons.	
II		**Intellectual Property Right**	**09**
	3	Introduction to Intellectual Property-Origin Development and Objectives and its different forms. Farmer's Rights, Animal and Plant breeders' rights.	
	4	Classification of Intellectual Property - Patents, Copyright, Trademark, Industrial Design, Geographical Indications, Sui generis rights, Protection of Plant Varieties and Traditional Knowledge, Development of patent system in India.	
III		**International agreements and Treaties relating to Intellectual Property**	**09**
	5	International agreements and Treaties relating to Intellectual Property: General Agreement on Trade and Tariff (GATT),	
	6	Trade Related Aspects of Intellectual Property Rights (TRIPS)	
	7	WTO agreement- Indian Position on WTO Regime; Establishment of WIPO – Mission and Activities- Budapest treaty	
IV		**Essentials of Patents**	**09**
	8	Basic requirements of patentability, Discovery and Invention	

	9	Patentable subject matters, novelty, utility and the Public Domain;	
	10	Product and process. Patent Laws in Indian Perspective.	
	11	Indian Patent Act 1970 (Patent Amendment Acts-1999, 2002 and 2005)	
V	**Patent filing procedures**		**09**
	12	Patent infringement- meaning, scope, litigation; 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.	
	14	Patent Case study: Basmati Case, Neem Controversy, Turmeric Case	

Suggested Reading

1. Kankanala C. 2007. Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd.,
2. Ahuja, V.K., Law Relating to Intellectual Property Rights, 3 rd Ed. Lexis Nexis
3. Cornish, W. R., Intellectual Property (Latest Edition)
4. Intellectual Property Rights by K. R. G. Nair, Ashok Kumar, K. R. G. Nair
5. Kilner, John, et.al, eds., Cutting-Edge Bioethics. Eerdmans.
6. Wadera, B.L. 2002.Patents, Trademarks, Copyright, Designs and Geographical Indications
7. 7.Ignacimuthu, S.2009.Bioethics, Alpha Science International, Limited
8. Matthew Rimmer.2008. Intellectual Property and Biotechnology: Biological Inventions

References

1. Arthur L. Caplan, Robert Arp, Contemporary Issues in Bioethics (2014)
2. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications Springer (India) (2014) (in press)
3. Nuffield Council on Bioethics (2002), The Ethics of Patenting DNA, A Discussion Paper, London: Nuffield Council on Bioethics

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will be able to understand the concepts related to bioethics, biopiracy, IPR and different subject matter of IPR like trademark, copyright, trade secret, Patent and geographical indication.	R, U	PSO-4
CO-2	Students will develop and apply a personal understanding of patent and bioethics, and their impact on day to day life.	An, Ap	PSO-4, 6

CO-3	Student will analyze the current norms relating to bioethics in the context of patenting	An	PSO-5
CO-4	Students will compare and contrast between intellectual property and bioethics	U	PSO-5

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

Name of the Course: Bioethics and IPR

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

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

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK4VACBOT201**				
Course Title	**ENTREPRENEURSHIP IN PLANT SCIENCE**				
Type of Course	**VAC**				
Semester	**IV**				
Academic Level	**200 - 299**				
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	This course aims to provide students with a comprehensive understanding of plant biology alongside the development of entrepreneurial skills necessary for creating, managing, and sustaining ventures in the botanical industry. Students will be equipped to identify opportunities, innovate, and establish successful businesses in various sectors related to plants, agriculture, and environmental conservation.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Entrepreneurship**	**09**
	1	Types and Characterization of Botanical Entrepreneurship- agribusiness, bio ventures, and aesthetics - characterizing ventures based on botanical products.	
	2	Need, Entrepreneurial Values, Motivation, and Barriers- Analyzing the socio-economic factors driving entrepreneurial endeavours in Botany- Identifying values- motivation factors- and overcoming barriers	
	3	Entrepreneurship as Innovation, Risk Assessment, and Solutions - Examining the role of innovation in botanical entrepreneurship. Assessing risks specific to botanical ventures and proposing strategic solutions.	
II		**Bio ventures in the context of Kerala**	**09**
	4	Overview of Key Botanical Industries in Kerala- Commercial uses of *Spirulina*, *Pleurotus sajor- caju*, *Ganoderma*, *Lentinus edodes*, *Moringa oliefera*, and Coconut industries within the Kerala context.	
	5	Case studies on successful ventures like Jackfruit 365 and Vegrow. Biotech startups and support mechanisms Zaara Biotech, KDISC, Bio 360 Life Sciences Park, BioNest.	
	6	Aesthetics in Kerala Botanical Entrepreneurship- Exploring the market for ornamental plants and flowers in Kerala. Opportunities and challenges specific to the aesthetics industry in the state.	
III		**Business planning and case studies**	**09**

	7	Preservation and processing- Canning and Processing of Fruits in Kerala -Overview of fruit canning processes and equipment, with a focus on Kerala's fruit varieties - Jack fruit, Pineapple, and Mango- Adapting processes to meet the unique demands of the Kerala fruit market.	
	8	Fruit and vegetable-based products- production of juices, squashes, and other fruit-based products considering Kerala's agricultural landscape.	
	9	Bamboo and cane-based products, Nutraceuticals, and oils- Herbal medicines and cosmetics.	
	10	Educational Business ventures- risks and possibilities - Udemy, Business Based learning.	
	11	MUDRA Yojana - Overview, its role in funding micro-enterprises. Practical insights into the application process and eligibility criteria.	
	12	Stand Up India- Exploring the Stand Up India scheme and its focus on promoting entrepreneurship among women and SC/ST communities.	
	13	SC/ST Hub: Understanding the SC/ST Hub initiative and its role in supporting entrepreneurs from marginalized communities. Examining how the SC/ST Hub facilitates access to finance, markets, and capacity building.	
	14	Schemes for women entrepreneurs -Mahila Samriddhi Yojana, Women Entrepreneurship Platform (WEP), Trade Related Entrepreneurship Assistance and Development (TREAD) Kudumba Shree/ Mahila Udhyami Yojana-Nai Roshni- Scheme for Leadership Development of Minority Women-Mahila Shakti Kendra	
IV	**Government initiatives and support scheme for Entrepreneurial Ventures**		**09**
	15	Navigating Government Support- Practical guidance on how entrepreneurs can navigate and access the above-mentioned government schemes	
	16	Analyzing real world success stories of entrepreneurs who have benefited from the mentioned government initiatives: BIRAC schemes, YIP, Atal innovation missions- Extracting key lessons and best practices.	
	17	Entrepreneurial Impact Assessment: Evaluating the impact of government schemes on entrepreneurial ventures. Discussing challenges faced and proposing solutions for improvement.	
V	**Success Stories**		**09**
	18	Develop a comprehensive business plan integrating one or more government schemes and do presentations.	
	19	Each student presents an analysis of a chosen success story related to government support schemes- Propose an entrepreneurial idea based on plant and plant products.	
	20	Make an audio-visual document of an interview with an entrepreneur.	

Suggested Reading

1. Yashpal Singh 2020: Botany for BSc Students Semester II: Entrepreneurship in Botan
2. Bonney, R., Cooper, C.B., Dickinson, J., & Steve, K., (2009). Citizen science: a developing tool for expanding science knowledge and scientific literacy. Bioscience, (NEP 2020- Jammu) S Chand Publishing.
3. Edmond, J. B., Musser, A. M., & Andrews, F. S., (1957). Fundamentals of Horticulture. McGraw Hill Book Co., New Delhi.

References

1. Arya, H., & Bhatt, T. K., (2021). Introduction of intellectual property rights. In The Design & Development of Novel Drugs and Vaccines. Academic Press.
2. Aydara, E. F., Sena, T., & Beraat, O., (2020). Plant-based milk substitutes: Bioactive compounds, conventional and novel processes, bioavailability studies, and health effects. Journal of Functional Foods. 103975. 1-15.
3. Beasley, K., Lee-Hammond, L., & Hesterman, S., (2021). “A Framework for Supporting the Development of Botanical Literacies in Early Childhood Education”. International Journal of Early Childhood 53 (2): 119–137.
4. Borlaug, N., (1970). "The Green Revolution, Peace, and Humanity”. Nobel Lecture. Available at http://www. nobel.se.
5. Chen, X., Lu, X., Shu, N., Wang, S., Wang, J., Wang, D., Guo, L., & Ye, W., (2017). Targeted mutagenesis in cotton (Gossypium hirsutum L.) using the CRISPR/Cas9 system. Scientific Reports. 7, 44304
6. Chrispeels, M. J., & Sadava, D. E., (1994). Plants, Genes and Agriculture. Jones & Bartlett Publishers
7. Cruses, W.V., & Fellows, P. J., (2000). Commercial fruits and vegetable processing. CRC press, United

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Demonstrate knowledge of diverse botanical entrepreneurship	R, U	
CO-2	Develop comprehensive business acumen for botanical ventures incorporating innovation, risk assessment, and strategic solutions	R, U	PSO-4,6
CO-3	Navigate and integrate government initiatives and support schemes in entrepreneurial endeavors in botanical sector.	U, AP,	
CO-4	Analyze and evaluate real-world success stories of entrepreneurs from government initiatives	Ap, An, E	PSO-7,8

CO-5	Propose entrepreneurial ideas based on plant and plant-based products conducting preliminary research	Ap, An, C	PSO-6,8

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

Name of the Course: Entrepreneurship in Plant Science

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	4,6	R, U	P	L, T	
3	3		U, AP,	F, C, P	L, T	P
4	4	7,8	Ap, An, E	F, C	L, T	
5	5	6,8	Ap, An, C	F, 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			✓	✓
CO 5		✓		✓

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK4VACBOT202**				
Course Title	**BIODEGRADABLE WASTE MANAGEMENT**				
Type of Course	**VAC**				
Semester	**IV**				
Academic Level	**200-299**				
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	To provide fundamental knowledge about biodegradable waste and their management**,** analysis of problems associated with wastes and finding out solutions and to Educate people about environmental sustainability for a better future.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Understanding Biodegradable Wastes**	**06**
	1	Introduction to biodegradable wastes- Definition and Significance	
	2	Source – kitchen, green, Leaf litter, food, wood, textile, biodegradable plastics.	
	3	Importance of Managing Biodegradable Wastes.	
II		**Challenges of Biodegradable Wastes Management**	**10**
	4	Inefficient waste disposal practices, Costly transportation to landfill sites, Underutilized bio-methanation potential- Pathogen detection and odour, production in composting, balancing Biodegradable Plastics and Recycling, Circular Economy Challenges, Education and Awareness, Inconsistent Regulations and Policies	
III		**Strategies, Solutions, and Importance**	**10**
	5	Composting - simple and vermicomposting, Anaerobic digestion, Landfill management, Waste-to-Energy Conversion	
	6	Segregation of waste at the source, community-based composting Promoting bio-methanation**,** Investing in eco-friendly waste processing technologies**,** Environmental sustainability, and reduction of ecological footprint	
	7	Environmental preservation, Soil enrichment, Reduced landfill burden. Energy generation: Circular economy, Health and Aesthetics:	
IV		**Technological Innovations & Future of Biodegradable Waste Management**	**10**

	8	Smart waste bins, Waste level sensors, Biogas production, Bioplastics and Biodegradable Products, Circular Economy Innovations, Edible food containers, fungi-based packaging materials, Novel Bioremediation Methods in Waste Management, bioenergy Recovery.	
	9	Biodegradable plastics and Materials- Advancements in Biodegradation Strategies, Circular Bio-economy**,** Interdisciplinary Approaches**,** Create a green, low-carbon economy**,** Organic waste valorization, Optimize resource use, Reduce reliance on non-renewable materials (such as petroleum and minerals)- Facilitate energy-efficient conversion.	
V	**Rules & Global Initiatives**		**09**
	10	The Solid Waste Management Rules 2016	
	11	Learning from Biodegradable Waste Management Practices National and Worldwide- The Netherlands: Organic Waste Conversion, South Korea: Mandatory Food Waste Recycling	
	12	UNEP Global waste management - Bio-economy	

Suggested Reading

1. Joseph,B. 2005. Environmental studies. Tata McGraw Hill Co.Ltd.
2. Debra,R.Reinhart, Timothy G. Townsend. Landfill Bioreactor Design and Operation. Lewis Publishers,Boca Raton, NewYork
3. Glynn Henry and Gary W.Henke.2004. Environmental Science and Engineering. Prentice Hall of India Pvt Ltd.
4. Purohit,S.S. Q.J.Shammi and A.K.Agarwal. 2004.A text book of Environmental Sciences. Saraswathi Purohit for Student Edition, Jodhpur.
5. Nath,K.J. 1984. Metropolitan solid waste management in India. In: Holmes JR, editor, Managing solid waste in developing countries. NewYork. John Willey and Sons.pp304
6. Ramachandra,T.V. 2006. Management of Municipal solid waste. Capital Publishing Company.

Web link

1. https://swachcoop.com/pdf/CAG%20Audit.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students gain knowledge about the concept of bio-degradability and the types of waste that fall under this category.	R, U	
CO-2	Students are able to Identify the challenges in biodegradable waste disposal and analyze different methods to overcome it.	U,An,	PSO-4,5

CO-3	Students explore the latest advancements in innovative technologies and apply them in the future	U,Ap,E	PSO-7,8
CO-4	Distinguish the role of various national and internal acts and laws applicable to biodegradable waste management and handling.	R,U,	

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

Name of the Course: Biodegradable waste management

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

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK4VACBOT203**				
Course Title	**PHYTONUTRACEUTICALS**				
Type of Course	**VAC**				
Semester	**IV**				
Academic Level	**200-299**				
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
I		**Introduction**	**09**
	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 (*Aloe vera*, *Hemidesmus indicus, Moringa oleifera, - Piper, Zingiber, Allium*)	
II		**Role of Nutraceuticals**	**09**
	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.	
III		**Manufacturing of Nutraceuticals**	**09**

	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.	
IV	**Clinical testing of Nutraceuticals**		**09**
	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.	
V	**Functional ingredients of Nutraceuticals**		**09**
	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 Parmacology. Humana Press.
3. Losso JN. 2007. Angi-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
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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	**BOTANY**				
Course Code	**UK4VACBOT204**				
Course Title	**DISASTER MANAGEMENT**				
Type of Course	**VAC**				
Semester	**IV**				
Academic Level	**300 - 399**				
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	Understanding of the Earth's climate system, including the natural greenhouse effect and dark heating. Students learn about international organizations and agreements addressing climate change. The concepts of hazards, vulnerability, and disasters, along with risk evaluation and climate change risks outlined in IPCC reports. Classification of disasters and management strategies and measures				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Climate change**	**07**
	1	Climate system- The Earth's natural greenhouse Effect and Dark Heating, radiation balance, Climates of the past. Natural versus anthropogenic causes of climate change, enhanced greenhouse effect, climate forcing, climate forcing agents- greenhouse gases, aerosols, clouds, land use, etc; global warming: role of CO2, CH4, water vapor etc., importance of monsoons, El-Nino	
II		**International response to climate change**	**07**
	2	IPCC - UNEP,WMO, Structure, IPCC bureau, Task Groups, Principles and procedures, UNFCC-The convention, Sites and Platforms, Montreal protocol,Kyoto Protocol, Paris agreement, 2020ambition, Talanoa, Documents and decisions, National and local government responses: NAPCC, Glasgow Climate Agreement 2021	
III		**Introduction to Disasters**	**07**
	3	Understanding of Hazard, Vulnerability & Disasters. Concept of Risks, Evaluation of Risks. Climate change Risk (IPCC Report): Natural & man-made factors. Driving forces of Vulnerability of cities. Landforms Developing forces- Exogenic and endogenic. Concept of on-site Disasters. Disaster Mitigation – Emerging Trends in Disaster Management - UN Draft	
		Types of Disasters	**15**

IV	4	Classification of Disasters. (Natural & man-made) Natural Disasters: Climatic Disasters (wind & water related): Tropical Cyclone, Floods & Drought. Earth related Disasters (Geological Disaster): Earthquake, Tsunami, Landslides& Volcano Eruption. Man-made Disasters: Industrial (on-site) Disasters: Toxic Gas leak, Exploision, Nuclear, chemical and Technological Disasters (BLEVE-boiling liquid expanding vapor explosion). Accidental Disasters: Rail, Road, Air &Sea. Ecological Disasters: Pollution, Soil Degradation, Loss of Biodiversity & Global warming. Epidemics: Cholera, Typhoid. Biological Disasters: COVID-19	
	5	Global environmental problems- ozone depletion, greenhouse effect, global warming, acid rain, nuclear hazards – Climate change, Eutrophication.	
V	**Disaster Management**		**09**
	6	Disaster management Basic measures for Disaster management**:** Preventive Measures**,** Preparedness Measures (Disaster mapping profile), Predictability, Forecasting &Warning. Response and Relief measures. Recovery& Rehabilitation measures. Disaster Management Bill, 2005.Institutional Framework for Disaster Management. Role of Media in Disaster Management. Basic Safety Measures (Pre and During): Earthquake & Floods. Case studies - Different disaster management in different counties with different disaster situations.	

Suggested Reading

1. IPCC (2001): Impacts Adaptation and Vulnerability, GRID, Aewndal.
2. Natural Hazards, Bryant Edwards (2005), Cambridge University Press, U.K.
3. Space Technology for Disaster management: A Remote Sensing & GIS Perspective, Roy, P.S. (2000), Indian Institute of Remote Sensing (NRSA), Dehradun.
4. Disaster Management : A disaster Manager's Handbook, Carter, N W. (1992), Asian Development Bank, Manila.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Summarize the differences between natural and anthropogenic causes of climate change.	U	
CO-2	Analyze the effectiveness of international climate agreements in addressing climate change	An	PSO-5
CO-3	Apply knowledge of disaster mitigation strategies to evaluate emerging trends in disaster management.	Ap	PSO-5
CO-4	Apply knowledge of disaster management frameworks to analyze case studies of disaster situations in different countries.	AP	PSO-5

CO-5	Apply knowledge of climate forcing agents to analyze the factors contributing to climate change.	AP	PSO-6
CO-7	Develop disaster management plans for specific disaster scenarios.	C	PSO-7

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

Name of the Course: Disaster Management

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	5	R, U	F, C	L,T	
3	3	5	Ap	F, C	L, T	P
4	4	5	Ap	p	L, T	P
5	5	6	C	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		✓		✓

Skill Enhancement Courses

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK4SECBOT201**				
Course Title	**MUSHROOM CULTIVATION**				
Type of Course	**SEC**				
Semester	**IV**				
Academic Level	**200 - 299**				
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
I		**Introduction to Mushrooms**	03
	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.	
II		**Nutritional Value of Mushrooms**	04
	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.	
III		**Cultivation Methods of Mushrooms**	07
	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 (*Pleurotus sps*.) Specify	
	11	Cultivation of Milky Mushroom (*Calocybe indica*)	
IV		**Pest and disease Management in Mushroom Culture**	04
	12	Common pests and pest management in	
	13	Commonly identified Diseases and its management	
	14	Disease prevention and control measures	
V		**Value Addition in Mushroom Culturing**	12

	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 2. Hands on training on Bedding and Bagging 3. Training in Oyster mushroom cultivation 4. Visit to a mushroom cultivation unit/house	**30**

Suggested Reedings:

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
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

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
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)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK4SECBOT202**				
Course Title	**ORGANIC AGRICULTURE PRACTICES**				
Type of Course	**SEC**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	03	02 Hours	-	02 Hours	04 Hours
Pre-requisites	No Pre requisites				
Course Summary	Students will understand and analyse the benefits of organic agriculture. They will apply the knowledge of methodology of organic farming in their home gardens. They will understand the global demand and premium price organic products fetch in the market. The course may motivate the students to get into Organic Farming and Marketing business ventures.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Need and Scope of Organic Farming**	04
	1	Principles and practices of organic farming	
	2	Need of Organic farming in present context and future prospects	
	3	Zero Budget Natural Farming (ZBNF)	
	4	Types. (Integrated organic farming, Pure organic farming,)	
II		**Agricultural practices in Organic Farming**	04
	5	Selection of plants	
	6	Early agricultural practices– inter cropping and crop rotation	
	7	Major cultivated crops and vegetables in India	
III		**Organic matter management in agricultural fields**	04
	8	Plant health and sustainable agriculture	
	9	Vermicomposting, mulching and green manure	
	10	Importance of microbes in the enrichment of soil fertility	
	11	Role of VAM as growth regulator	
IV		**Organic Farm Management**	06
	12	Land preparation - Tools and Technique	
	13	Preparation of seed bed, manuring, sowing, watering and raising of seedling	
	14	Pest control: Cultural, Biological and Mechanical method	
	15	Integrated Pest Management (IPM)	
V		**Value Addition in Organic Farming**	12
	15	Harvesting and Post Harvesting Management	
	16	Inspection, Certification, Labelling procedure, Marketing & Export	
	17	Quality Control and certification procedures of Organic products	

	18	Terrace and kitchen garden	
	19	Value addition in organic products - General Account only	

Practicals		
	1. Visit to Organic farm to study the various components, identification and utilization of Organic products. 2. Preparation of Organic Compost-Over ground compost, Pit compost, Liquid compost, Vermi compost. 3. Method of application of different types of fertilizer and Green manure.	**30**

Suggested Readings:

1. Alvares, C. (1996). The Organic Farming Source Book. The Other India Press, Mapusa, Goa.
2. Anonymous. (2001). Report of Task Force on Organic Farming, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, 2001, p. 76.
3. Dongarjal R. P. and Zade S.B. (2019). Insect Ecology and Integrated Pest Management, Akinik Publications, New Delhi.
4. Dushyent Gehlot. (2005). Organic Farming- standards, accreditation, certification and inspection. Agribios, India.
5. Guideline of National Project on Organic Farming, Department of Agriculture and Cooperation, INM Division, Ministry of Agriculture, Govt. of India

References

1. Gupta, M. (2004). Organic Agriculture Development in India. ABD publishers, Jaipur, India.
2. Kumaraswamy K. (2002). Organic farming relevance and prospects. Indian Soc. Soil Sci. Newsletter, No. 12, p 1.
3. Organic Farming: The Ecological System- Agronomy Monograph 54, ASA, USA.
4. Robin Mittenthal. (2007). From the ground - a guide to basic organic vegetable, flower, and herb gardening for new gardeners. 1-108
5. S K Singh, R B Yadav, Jagadish Singh and Bijendra Singh. (2017). Organic Farming in Vegetables, IIVR, Government of India, Technical Bulletin 77, p. 1-42.
6. Sathe, T.V. (2004) Vermiculture and Organic Farming. Daya Publishers.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Basics principles and methods of vegetable farming	U	PSO-1

CO-2	Evaluate and analyse different steps and agricultural practices adopted in organic farming	An	PSO-1
CO-3	Examine various pest and disease management techniques	Ap	PSO-11
CO-4	Learn about different procedures in Organic farming related to post harvesting techniques and quality control in Organic farming.	U	PSO-4

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

Name of the Course: Organic Agriculture Practices

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	PSO-1		F, C		
CO-2	2	PSO-1		P		
CO-3	3	PSO-12		F		
CO-4	4	PSO-4		M		

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	**BOTANY**				
Course Code	**UK4SECBOT203**				
Course Title	**BASICS OF PLANT TISSUE CULTURE**				
Type of Course	**SEC**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	03	02 Hours	-	02 Hours	04 Hours
Pre-requisites	No Pre requisites				
Course Summary	The SEC will make the student capable to become an entrepreneur. It deals with basic aspects and opportunities of plant tissue culture.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Plant Tissue Culture**	04
	1	History and Basic concept of Plant Tissue Culture	
	2	Laboratory requirements, Tools and techniques	
	3	Laboratory contaminants- it's control and measures.	
II		**Media and Culture Preparation**	04
	4	Media preparation- pH, Temperature and Solidifying agents	
	6	Role of Micro and macro nutrients, Growth regulators, Vitamins and carbon source in tissue culture	
	5	Composition of commonly used culture media - MS Media	
III		**Prerequisites for Plant Tissue Culture**	05
	8	Explants selection, sterilization and inoculation	
	9	Micropropagation through various explants (Leaf and Node)	
	10	Culture media-MS Medium, composition and preparation	
IV		**Culture techniques**	05
	11	Micropropagation – steps -Innoculation – Subculture, Callus and suspension culture, meristem culture	
	12	Somaclonal variation- Somatic embryogenesis and organogenesis.	
	13	Production of haploids – pollen culture, anther culture – protoplast culture – somatic hybrids – cybrids - Synthetic seeds	
V		**Future Prospects of Plant Tissue Culture**	12
	14	Somatic embryogenesis and production of synthetic seeds	
	15	Application of tissue culture in forestry and agriculture	
	16	Tissue and cell culture technology in India, and its prospects	
	17	Biosafety and ethical issues	

Practicals		
	1. Preparation of culture media and sterilization 2. Inoculation of explants and micropropagation 3. Visit to a well-equipped tissue culture laboratory to familiar with the use of equipments and glasswares. 4. Encapsulation of seeds	**30**

Suggested Readings:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. VikasPublicationHouse Pvt. Ltd., New Delhi. 5th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications ofrecombinant DNA. ASM Press, Washington.

References

1. Pullaiah. T. and M.V.Subba Rao. (2009). Plant Tissue culture. Scientific Publishers, New Delhi.
2. Razdan M. K. (2016) An introduction to Plant Tissue Culture ,Oxford and I B Hpublishers
3. Reinert J. and Bajaj Y. P. S (1982). Plant cell, Tissue and Organ Culture, WC Brown publishers.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand basics of plant tissue culture techniques	R	PSO-1
CO-2	Familiarize about the components and preparation of culture media	U	PSO-1, 6
CO-3	Know the sterilization techniques, inoculation of explants, induction of callus and morphogenesis	Ap	PSO-1, 6
CO-4	Analyse applications of tissue culture in different fields	An	PSO-1, 11

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

Name of the Course: Basics of Plant Tissue culture
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		R	F	T	
CO-2	2		U	C	T	
CO-3	3		Ap	P		P
CO-4	4		An	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 :

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK5SECBOT301**				
Course Title	**VEGETABLE GARDENING**				
Type of Course	**SEC**				
Semester	**V**				
Academic Level	**300 - 399**				
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	Through this SEC, students will acquire knowledge about gardening and different vegetables that can be cultivated through gardening. They will understand the global demand and premium price organic products fetch in the market. The course may motivate the students to get into vegetable gardening and its Marketing.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Vegetable Gardening**	04
	1	History and scope of Vegetable gardening	
	2	Need for healthy lifestyle through Vegetable gardening	
	3	Qualities of a good garden	
II		**Garden and Garden Planning**	10
	4	Soil preparation and Potting mixture	
	5	Different types and importance of containers in gardening	
	6	Garden Planning and designing	
	7	Different types of vegetables for gardening	
III		**Gardening techniques**	14
	8	Different types of propagules for garden	
	9	Preparation of nursery beds for raising vegetable seedlings	
	10	Sowing/Planting Methods	
	11	Watering and Irrigation techniques	
	12	Manuring : Organic fertilizers. Use of Organic growth promoters	
IV		**Management and Maintenance of Garden**	08
	13	Common pests and diseases of vegetables	
	14	Natural pest control methods	
	15	Preparation of natural pest repellents	
	16	Maintenance of Vegetable Gardens	
V		**Value addition and Future Prospects**	09
	17	Harvesting and Post Harvesting Management	
	18	Inspection, Certification, Labelling procedure, Marketing & Export	

	19	Quality Control and certification procedures of Organic products in India	

Suggested Reading

1. B.Choudhary. (1967). Vegetables, National Book Trust India, New Delhi.
2. Bhattarai, Dhruba & Giri, Bhattarai & Schreinemachers, Pepijn. (2022). School Vegetable Gardening Concept, curriculum & action. ISBN No. 978-9937-0-0413-8
3. Bose, T. K., M. G. Som and J. Kabir. (1993). Vegetable crops.
4. Jitendra Singh (2004), Bosic Horticulture, Kalyain Publications, New Delhi
5. Ludhiana Singh, Umashankar, (2008). Indian Vegetables. Anmol Publications. Pvt.Ltd. New Delhi.
6. M.S.Dhaliwal, (2008). Handbook of Vegetable Crops. Kalyani Publishers.
7. P.Hazra, (2006).Vegetable science. Kalyani Publishers. Ludhiana
8. Pratibha Sharma, (2007). Vegetables: Disease Diagnosis and Biomanagement. Avishkar Publishers. Jaipur
9. Saini, S.G. (1997). A text book of vegetable production. Aman Publishing House, Meerut, U.P.
10. T. K. Bose, (2002). Vegetable Crops. Nayaprakash. Kolkata
11. T. R. Gopal Krishnan, (2007). Vegetable Crops. New India Publishing Agency. New Delhi.
12. Veeraraghavathatham, D., M. Jawaharlal, Seemanthini Ramadas. (1991). A guide on vegetable culture, A.E.Publication, Coimbatore.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand need for healthy lifestyle	U	PSO-1, 7
CO-2	Analyse different types and steps in vegetable gardening	R, U	PSO-4
CO-3	Utilize different techniques for proper Management and Maintenance of Garden	Ap	PSO-4, 7
CO-4	Examine different measures of post harvesting measures involved vegetable gardening	An	PSO-4, 7

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

Name of the Course: Vegetable Gardening

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

CO-1	1	1, 7	U	F, C	L	
CO-2	2	4	R, U	P	L	
CO-3	3	4, 7	Ap	P		P
CO-4	4	4, 7	An	M		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	**BOTANY**				
Course Code	**UK5SECBOT302**				
Course Title	**BIOFERTILIZERS AND BIOPESTICIDES**				
Type of Course	**SEC**				
Semester	**V**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	03	03 Hours	-	-	03 Hours
Pre-requisites	No Pre reuisites				
Course Summary	Students will understand and analyse the benefits of agriculture using ecofriendly fertilizers and pesticides. They will apply this knowledge and methodology in their home gardens. They will understand the global demand and premium price organic products fetch in the market.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Biofertilizers for Human welfare**	**06**
	1	Sustainable agricultural practices: Definition, status and scope	
	2	Current scenario of Indian agriculture and promotion of biofertilizers in India	
	3	Categories and types of biofertilizers	
	4	Major biofertilizers and target crops	
II		**Biofertilizers and Organic Manures**	**13**
	5	Organic Manures and Biofertilizers Structure and characteristic features of bacterial biofertilizers- Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia.	
	6	Cyanobacterial biofertilizers- Anabaena, Nostoc	
	7	Hapalosiphon and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza.	
	8	Plant based biofertilizers : Azollla	
	9	Commercially available botanical biopesticides – Pyrethrum, Eucalyptus essential oil.	
	10	Manufacturing of organic fertilizers using household waste. Methods to improve the quality of household compost – mineral additives and plant hormones.	
III		**Crop management using Biopesticides**	**05**
	11	Brief history and development of Biocontrol agents	
	12	Effectiveness of Integrated Pest Management and biopesticides	

	13	Types: Macro and Microbial biocontrol agents	
IV	**Bioformulations**		**12**
	14	Definition, components (Active ingredient, carrier material, additive)	
	15	Types of bioformulations: Solid (granules, wettable powders, wettable granules, dust) liquid (suspension, concentrate), encapsulation.	
	16	Bioformulations for the uptake of nutrients like - Nitrogen, Phosphorus, Potassium, and Iron.	
	17	Bioformulations as biocontrol agents/ biopesticides: Bacterial, Fungal and Viral.	
V	**Value addition and current scenario**		**09**
	18	Commonly used biopesticide in Kerala -	
	19	Preparation pf Tobacco decoction, Neem oil emulsions,	
	20	Biofertilizers and Biopesticides -Storage, shelf life, quality control and marketing	
	21	FCO specifications and quality control of biofertilizers	

Suggested Reading

1. Arora, N. K., Mehnaz, S., & Balestrini, R. (Eds.). (2016). Bioformulations: for sustainable agriculture (pp. 1-283). Berlin: Springer.
2. Borkar, S. G. (2015). Microbes as bio-fertilizers and their production technology. Woodhead Publishing India Pvt, Ltd.
3. Dalavayi Haritha, M., Bala, S., & Choudhury, D. (2021). Eco-friendly plant based on botanical pesticides. Plant Archives, 21(1), 2197-2204.
4. El-Wakeil, N., Saleh, M., & Abu-hashim, M. (Eds.). (2020). Cottage industry of biocontrol agents and their applications: practical aspects to deal biologically with pests and stresses facing strategic crops (pp. 133-155). Springer International Publishing.
5. Giri, B., Prasad, R., Wu, Q. S., & Varma, A. (Eds.). (2019). Biofertilizers for sustainable agriculture and environment. Cham: Springer International Publishing.
6. Hall, F. R., & Menn, J. J. (1999). Biopesticides: use and delivery. Humana Press Inc..
7. Kaushik, B. D., Kumar, D., & Shamim, M. (Eds.). (2019). Biofertilizers and biopesticides in sustainable agriculture. CRC Press.
8. Nick, B. & Glare, T. (2020). Biopesticides for sustainable agriculture. Burleigh Dodds Science Publishing.
9. Nollet, L. M., &Rathore,H., S. (Eds.). (2023). Biopesticides handbook. CRC Press.
10. Rajeshwari, R., &Appanna, V. (Eds.). (2021). Biopesticides in Horticultural Crops. CRC Press.
11. Singh, D. (Ed.). (2014). Advances in plant biopesticides. Springer.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand need of sustainable agricultural practices	R	PSO-6

CO-2	Analyse different types of Biofertilizers and Organic Manures	An	PSO-4
CO-3	Make use of Biopesticides for Crop management	Ap	PSO-4
CO-4	Categorise various bioformulations commonly used in agriculture	An	PSO-1,4,6
CO-5	Evaluate commonly used biopesticide in Kerala	E	PSO-1,5

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

Name of the Course: Biofertilizers and Biopesticides
Credits: 3:0:0 (Lecture:Tutorial:Practical)

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

University of Kerala

Discipline	**BOTANY**				
Course Code	**UK5SECBOT303**				
Course Title	**URBAN GARDENING AND LANDSCAPING**				
Type of Course	**SEC**				
Semester	**V**				
Academic Level	**300 - 399**				
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	Through this SEC, students will acquire knowledge about gardening and landscaping as a growing business venture. They will understand the growing demand in present day. The course may motivate the students to get into gardening and landscaping startups.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Gardening and Nursery techniques**	04
	1	Introduction to gardening and landscaping	
	2	Horticultural practices related to gardening – training, pruning and thinning	
II		**Garden and Gardening**	12
	3	Types of plants in landscaping	
	4	Aquatic ornamentals.	
	5	Different types of gardening and suitable plants used in each type - landscape and home gardening, terrace gardening, indoor gardening, vertical gardens, aquatic gardens.	
	6	Special Types : Rockery, Terrarium, and Bonsai (brief account only)	
III		**Tools and Management**	10
	7	Garden tools & implements	
	8	Garden components and adornments – Brief account	
	9	Bed preparation and Irrigation methods	
	10	Fertilizer application- different fertilizers, biofertilizers, vermicomposting,	
	11	Different irrigation methods	
	12	Management of pests and diseases.	
IV		**Principles of Landscaping**	10
	13	Principles of Landscape design	
	14	Steps in developing a Landscape Design	
	15	Different plants for landscapes	
	16	Maintenance of Landscape designs	
	17	Different types of Garden in India	

V	**Value Addition and Future Prospects**		**09**
	18	Landscape design for different places such as offices, educational Institutions and bus stations.	
	19	Commercial production of ornamental plants- Orchids, Aroids, heliconia, Bromeliads	
	20	Value addition: Extraction and purification of essential oils, perfumes, (GAP) dehydration of flower and floral craft, cascade, pot, buttons etc.	

Suggested Reading

1. Agrwal, P.K. 1993. Hand Book Of seed Technology, Dept, Of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
2. Arora, JS. 2006. Introductory Ornamental Horticultural. Kalyani.
3. Bhattacharjee, SK. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ.
4. Bose, TK. Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping. Naya prokash.
5. Chadha, KL & Chaudhury B. 1992. Ornamental Horticulture in India. ICAR .
6. Chadha, KL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House.
7. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
8. Janick Jules. 1979. Horticultural Science (3rd Ed), W. H. Freeman and Co. San Franciso, USA
9. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications. Nagercoil.
10. Randhawa, GS & Mukhopadhya, A. 1986. Floriculture in India. Allied Publ.
11. Reddy, S. Janakiram, B. Balaji, T. Kulkarni, S & Misra, RL. 2007. High-techFloriculture. Indian Society of ornamental Horticulture, New Delhi.
12. Sandhu, M.K. 1989. Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand Horticultural practices related to gardening	R	PSO-2, 4
CO-2	Differentiate various types of gardening	U	PSO-2, 4
CO-3	Make use of tools and Management	Ap	PSO-4, 6
CO-4	Understand basic principles of Landscaping	R	PSO-2, 4
CO-5	Formulate landscape design for different places and commercial production of ornamental plants	C	PSO-2, 4

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

Name of the Course: Urban Gardening and Landscaping

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	1	2, 4	R	F	L	
CO-2	2	2, 4	U	C	L	
CO-3	3	4, 6	Ap	P		P
CO-4	4	2, 4	R	C	T	
CO-5	5	2, 4	C	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	**BOTANY**				
Course Code	**UK6SECBOT301**				
Course Title	**HERBAL COSMETICS**				
Type of Course	**SEC**				
Semester	**VI**				
Academic Level	**300 - 399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	No Pre requisites				
Course Summary	India is considered as the mother of Ayurverda and herbal products. This SEC empower students to gain knowledge about herbal products and ayurveda as demand of such products increases day by day in global market. Through this course students can learn different formulations and methods for the manufacture of herbal products. In future they can start their own earning using this knowledge.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Herbal Cosmetics**	06
	1	Cosmetics- Classification and categories	
	2	Brief history of herbal cosmetics	
	3	Difference between herbal and synthetic cosmetics products, benefits of herbal cosmetic products	
		Challenge in formulating herbal cosmetics	
II		**Prerequisites for Herbal Cosmetics**	09
	4	Raw materials, machinery and equipment used in preparation of herbal cosmetics	
	5	Processes used in the preparation of herbal cosmetics	
	6	Plants used in skin care products like scrub, packs , moisturizer etc	
	7	Plants used in hair care products like oil, shampoo, conditioner etc.	
III		**Preparation of Herbal Cosmetics**	12
	11	Preparation of scrub, face packs, face wash, soap, moisturizer, sunscreen	
	12	Preparation of shampoo, hair oil, hair conditioners, hair dye	
	13	Preparation of toothpaste, tooth powder, kajal, lipstick, lip balm and deodorant	
IV		**Aromatherapy : an art of healing**	09

	14	Introduction and origin of Aromatherapy, plants used in aromatherapy- *Lavendula offinalis*, *Citrus limon*, *Geranium sps*, *Eucalyptus globulus*, *Menta sps*, *Cananga odorata*. Sandle	
	15	Methods of extraction of essential oils.	
	16	Therapeutic activity of essential oils.	
	17	Sanitary practices in cosmetic preparation	
V	**Value addition in Cosmetology**		**09**
	18	Basic idea of storage of raw material, production, preparations, production management, packaging and labeling, marketing and pricing of herbal cosmetics	
	19	Quality assurance and ISO certification	

Suggested Reading

1. Das K, Dang R, Machale MU, Ugandar RE, Lalitha BR. Evaluation for safety assessment of formulated vanishing cream containing aqueous Stevia extract for topical application. Indian Journal of Novel Drug Delivery.2012; 4(1):43-51.
2. Deep C, Saraf S (2008) Novel approaches in herbal cosmetics. J Cosmet Dermatol 7:89– 95
3. Devi, Nisha & Kumar, Arvind & Garg, Mr & Hussain, Abid & Khathuriya, Rajesh. (2018). A REVIEW ON HERBAL COSMETICS. World Journal of Pharmaceutical Research. 7. 298-310. 10.20959/wjpr20188-11845.
4. Handbook on herbal products. (Vol.1 and 2)NIIR Board of Technologists, Delhi. ISBN NO. 978-8186623480.
5. Himadri Panda. (2015). Herbal cosmetics Handbook .3rd revised edition. Asia Pacific Business Press Inc. 978-8178330808.
6. Kokate, .CK, Purohit AP, Gokhale SB. Pharmacognosy Text Book, Nirali Publication.
7. Kumar, Davinder & Rajora, Gajendra & Parkash, Om & Himanshu, Mamta & Antil, Virender & Kumar, Virender. (2016). Herbal cosmetics: An overview. 36. 2456-421.
8. Mendhekar S Y, Thorat P B, Bodke N N, Jadhav SL, Gaikwadd D. Formulation And Evaluation Of Gel Containing Neem, Turmeric, Aloe Vera, Green Tea And Lemon Extract With Activated Charcoal And Honey. 2017;12(4):439-443.ISSN 394-3211.
9. Tripathi, Vaibhav & Jhade, Deenanath & Usman, Md.Rageeb. (2021). A Practical Book of Herbal Cosmetics. Publisher: S. VIKAS AND COMPANY (Medical Publishers). ISBN No. 97815-43344-80-6

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand history, types and different aspects of cosmetology	U	PSO-1, 6
CO-2	Analyse different plants and methodology adopted in making of herbal cosmetics	An	PSO-6

CO-3	Evaluate aromatherapy as an alternate procedure for healing.	E	PSO-1,7
CO-4	Prepare a project proposal for commercial production of hermal products	C	PSO-1,7, 9

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

Name of the Course: Herbal Cosmetics

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	1	1, 6	U	F	L, T	
CO-2	2	6	An	C	L	P
CO-3	3	1,7	E	P	L	P
CO-4	4	1,7, 9	C	M		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	**BOTANY**				
Course Code	**UK6SECBOT302**				
Course Title	**INDOOR GARDENING AND TERRARIUM TECHNIQUES**				
Type of Course	**SEC**				
Semester	**VI**				
Academic Level	**300 - 399**				
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	Through this SEC, students will acquire knowledge about indoor gardening and terrarium techniques. These branches of gardening are highly demanding in our country especially in urban cities. The course may motivate the students to get into indoor garden and terrarium designing startups.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Gardening overview**	12
	1	Gardening – Introduction, Principles of gardening making, Components of Garden	
	2	Tools and implements for gardening	
	3	Manures and Fertilizers: Farmyard manure, Compost, Biofertilizers, Chemical fertilizers	
	4	Fungicides and Pesticides	
II		**Indoor Gardening**	12
	5	Principles and components of indoor gardening. Significance, indoor plants for air purification	
	6	Factors in Indoor gardening	
	7	Growing medium and types of containers for indoor plants and designing. List of plants for indoor gardening *Sanseveria*, Money Plant, ZZ Plant, Peace Lilly.	
	8	Methods of Indoor gardening - Hanging baskets, Window boxes, Terrarium / bottle gardening, Miniature gardening, Vertical gardening for indoors, Bonsai and Kokedama	
	9	Bonsai: definition, types and styles, art of making bonsai – Indoor bonsai, Bonsai styles, Plants suitable for indoor bonsai, Pots and containers for bonsai.	
III		**Terrarium / bottle gardening**	12
	10	History and types of Terrariums	
	11	Materials required and Plants used for terrarium making	
	12	Different steps in the preparation of terrariums	

	13	Different types and selection of plants for terrarium	
	14	Management of terrariums	
IV	**Management of Indoor gardens and Terrarium**		**09**
	15	Common pests and plant diseases	
	16	Natural pest control methods and preparation of natural pest repellents	
	17	Irrigation and maintenance	
	18	Challenges and value addition in Indoor gardening	
	19	Garden designing as a career.	

Suggested Reading

1. Amy Bryant Aiello and Kate Bryant. (2011). Terrarium Craft: Create 50 Magical miniature Worlds. Publisher. Timber Press. ISBN No. 978-1604692341.
2. Diana Yakeley (2007). Indoor Garden: A New Approach to Growing and Displaying Plants in the Home and Through the Year. Publisher. Aquamarine. ISBN No. 978-1903141595.
3. Maria Colletti (2015). Terrariums – Garden under glass: Designing, Creating, and Planting Modern Indoor Gardens. Publisher. Cool Springs Press. ISBN No. 978-1591866336
4. Natalie Bernhisel-Robinson. (2014). The Living Wreath. Publisher. Gibbs M. Smith Inc. ISBN No. 978-1423632641
5. Sarah Whittingham. (2009). The Victorian Fern Craze. Polisher. Shire Publications. ISBN No. 978-0747807469.
6. Shane Powers. (2013). Bring the Outdoors In.: Garden Projects for Decorating and Styling Your Home. Publisher. Chronicle Books. ISBN No. 978-1452107547.
7. Sharon Asakawa., John Bagnasco., Robyn Foreman., Shaun Buchanan. (2014). Planting design for Cactus & Succulents: Indoor and Outdoor projects for unique, easy care plants in all climates. Publisher. Cool Springs Press. ISBN No. 978-1591865612.
8. Tovah Martin and Kindra Clineff (2012). The Unexpected Houseplant: 220 Extraordinary Choices for Every Spot in Your Home. Publisher. Timber Press. ISBN No. 978-1604692433
9. Tovah Martin. (2009). The New Terrarium: Creating Beautiful Displays for Plants and Nature. Publisher. Clarkson Potter. ISBN No. 978-0307407313

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand basics of gardening and its types	R	PSO-4
CO-2	Analyse principles and components of indoor gardening, its significance and role of indoor plants for air purification	U	PSO-4
CO-3	Evaluate different types of plants and requirements for indoor gardening and terrariums.	An	PSO-4, 8
CO-4	Analyse different strategies for maintenance of terrariums	E	PSO-8, 9

CO-5	Prepare suitable design of indoor garden and terrarium	C	PSO-8, 11

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

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	1	4	R	F	T, L	
CO-2	2	4	U	P	T	P
CO-3	3	4, 8	An	F	T	P
CO-4	4	8, 9	E	C	T	P
CO-5	5	8, 11	C	M	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	**BOTANY**				
Course Code	**UK6SECBOT303**				
Course Title	**HYDROPONICS AND AQUAPONICS**				
Type of Course	**SEC**				
Semester	**VI**				
Academic Level	**300 - 399**				
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	This SEC empower students to gain knowledge about alternative plant culture methods, as demand of such methods increases day by day due to various reasons. In future they can start their own earning using this knowledge.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Hydroponics**	06
	1	Principles and practices of hydroponic systems	
	2	Applications of hydroponic systems for sustainable food production	
	3	Basic solution chemistry and plant physiology principles and their impact on hydroponic optimization	
II		**Techniques in Hydroponics**	12
	5	Media used for Hydroponics: Rock wool, Perlite, Pumice, Vermiculite, Sand, Gravel, Polystyrene packing peanuts, wood fibre.	
	4	Types of hydroponic systems: Static solution culture, Continuous – flow Solution culture, Aeroponics, Passive sub-irrigation, Ebb and flow, Dutch bucket, Deep water culture, Bubbleponics.	
	6	Hydroponics in Green house	
III		**Introduction and overview of Aquaponics**	06
	07	Definition, History and Principles of Aquaponics.	
	08	Merits and demerits of Aquaponics	
	09	Working of Aquaponics	
IV		**Aquaponic Systems and maintenance**	12
	10	Components of Aquaponics systems	
	11	Types : Circulating and Non-circulating Aquaponics systems	
	12	Setting up and maintenance of an Aquaponics	
	13	Aquaponics plants and animals	
	14	Water quality Maintenance	
	15	Pest and disease management	
	16	Troubleshooting (Fish mortality, blockages and leaks and water quality issues)	

V	**Value addition and current scenario**		**09**
	17	Specific cases of hydroponic production practices of major vegetables (leafy greens, culinary herbs, and fruit crops such as tomatoes and strawberries)	
	18	Commercial Aspects of hydroponics and aquaponics	
	19	Safety measures, certification standards and government policies regarding and aquaponics	
	21	Government Schemes for hydroponics and aquaponics	

Suggested Reading

1. Andy Jacobson. (2016). Hydroponics: The Essential Hydroponics Guide: A Step-By-Step Hydroponic Gardening Guide to Grow Fruit, Vegetables, and Herbs at Home.
2. John Mason. (2000). Commercial Hydroponics. Simon & Schuster Australia. ISBN No. 978-0684872025
3. James Coble. (2015). DIY Hydroponics Gardening: How to Make Your First Hydroponics System without Spending too Much Money or Time. CreateSpace Independent Publishing Platform. ISBN No. 978-1517096465.
4. John Syrocki. B. (1961). Experimenting With Hydroponics College of Education, State University of New York, Brockport Downloaded from http://online.ucpress.edu/abt/articlepdf/23/7/444/17689/4439697
5. Keith Roberto. (2015). How To Hydroponics. 4th Edition. Future Garden Inc. ISBN No. 978-0967202617.
6. Howard M. Resh, (2012). Hydroponic Food Production: A Definitive Guidebook for the Advanced Home Gardener and the Commercial Hydroponic Grower. Taylor & Francis Group, Seventh Edition. ISBN No. 978-1439878675.
7. Howard M. Resh. (2011). Hydroponics for the Home Grower. ISBN No. 978-1482239256
8. J. Benton Jones. (2004) Hydroponics: A Practical Guide for the Soilless Grower (2nd Edition). ISBN No. 9780849331671.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand principles and applications of hydroponics	R	PSO- 4, 6
CO-2	Examine different techniques in Hydroponics	An	PSO- 4, 7
CO-3	Identify different components and types of Aquaponics systems	U	PSO- 4,11
CO-4	Evaluate commercial Aspects of hydroponics and aquaponics	E	PSO- 4,11

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

Name of the Course: Hydroponics and Aquaponics

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	1	4, 6	R	F	L	
CO-2	2	4, 7	An	C	L	P
CO-3	3	4,11	U	P	L	P
CO-4	4	4,11	E	F	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 :

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