MAR IVANIOS COLLEGE

(AUTONOMOUS)

Affiliated to the University of Kerala,

Thiruvananthapuram

Kerala

SCHEME AND SYLLABUS FOR THE FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP)

MAJOR DISCIPLINE

BOTANY

(2025 onwards)

CONTENTS		
Sl No.	**CONTENT TITLE**	**Page**

PREAMBLE

National Education Policy (NEP 2020) envisions ‘higher education as playing an extremely important role in promoting human as well as societal wellbeing in developing India as envisioned in its Constitution - a democratic, just, socially conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all’ (Section 9.1). NEP also expects higher education ‘to develop good, thoughtful, well-rounded, and creative individuals, enabling an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and 21st century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects’ (Section 9.1.1). Hence, more than the creation of greater opportunities for individual employment, higher education represents the key to more vibrant, socially engaged, cooperative communities and a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation. (Section 9.1.3). NEP also identifies some of the major problems currently faced by the higher education system in India (Section 9.2) and envisions a complete overhaul and re-energizing of the higher education system to overcome these challenges and thereby deliver high-quality higher education, with equity and inclusion (Section 9.3). One of the major changes which the policy proposes is moving towards a more multidisciplinary undergraduate education (Section 9.3(b)) which develops all capacities of human beings -intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner (Section 11.3). In order to achieve this in its full potential, NEP visions the adjusting of the structure and lengths of degree programmes accordingly. “The undergraduate degree will be of either 3 or 4-year duration, with multiple exit options within this period, with appropriate certifications, e.g., a certificate after completing 1 year in a discipline or field including vocational and professional areas, or a diploma after 2 years of study, or a Bachelor’s degree after a 3-year programme. The 4-year multidisciplinary Bachelor's programme, however, shall be the preferred option since it allows the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.” (Section 11.9)

In accordance with the NEP 2020, the UGC formulated a new student-centric “Curriculum and Credit Framework for Undergraduate Programmes (CCFUP)” incorporating a flexible choice-based credit system, multidisciplinary approach, and multiple entry and exit options and establishing three Broad Pathways,

(a) 3-year UG Degree,

(b) 4-year UG Degree (Honors), and

(c) 4-year UG Degree (Honors) with Research)

Accordingly, the Kerala Higher Education Reforms Commission 2022, headed by Prof. Shyam B. Menon, has recommended a comprehensive reform in the undergraduate curriculum with the adoption of the 4-year undergraduate Programmes, which will bring undergraduate education in Kerala at par with the universities abroad. Consequently, Kerala State Curriculum Committee for Higher Education 2023 has been constituted, with Dr Suresh Das as Chairman, and they have proposed a model Kerala State Higher Education Curriculum framework for undergraduate education.

The University of Kerala has decided to introduce the Four Year Under Graduate Programmes (FYUGP) from the academic year 2024-2025 onwards in its teaching departments and all affiliated colleges, and has issued many draft documents and conducted college level awareness programmes about the same.

Mar Ivanios College, by virtue of its autonomy status, conferred in 2014 and extended in 2022, vide University Grants Commission (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023, has the power to review existing courses/programmes and, restructure, redesign and prescribe its own courses/programmes of study and syllabi and to formulate new courses/programmes within the nomenclature specified by UGC as per the Specification of Degrees 2014 as amended from time to time. Accordingly, the Board of Studies in Botany of Mar Ivanios College (Autonomous) proposed the implementation of the FYUGP scheme with effect from 2024 admission onwards and prepared the scheme and syllabi through many of the meetings and discussions. The Academic Council of the college which met on 30th April gave discussed the proposal and syllabi in detail and approved the same to be implemented from 2024 admission onwards, subject to the final directions of the University of Kerala.

The salient features of the syllabus prepared and presented by the Board of Studies include the following:

The curriculum is designed based on Outcome Based Education (OBE) approach.

The curriculum follows Choice-Based Credit System (CBCS): This system allows students to select courses from a prescribed list. A specified number of credits must be earned to award the degree

The curriculum follows the basic framework, course wise/programme-wise minimum/maximum credits set by the University of Kerala for FYUGP and

abides by the basic mandatory principles of **Four Year Under Graduate Programmes (UoK-FYUGP) Regulations, 2024.**

The curriculum offers comprehensive insights into Plant Biology, Ecology, Taxonomy, Physiology, Genetics, Plant Pathology, Plant Biotechnology

The course content, teaching methods, and learning outcomes align with the latest developments and advancements in the field.

It clubs Emerging Research, Technology, Interdisciplinary Approach and hands on training for an engaging learning experience

Graduate Attributes and Programme Outcomes (POs):

The National Higher Education Qualification Framework (NHEQF) envisages that students on completion of a programme of study must possess and demonstrate the expected graduate profile/attributes acquired through one or more modes of learning. The graduate profile/attributes indicate the quality and feature or characteristics of the graduate of a programme of study, including learning outcomes relating to the disciplinary area(s) relating to the chosen field(s) of learning and generic learning outcomes that are expected to be acquired by a graduate on completion of the programme(s) of study. The graduate profile/attributes include capabilities that help widen the current knowledge base and skills, gain and apply new knowledge and skills, undertake future studies independently, perform well in a chosen career, and play a constructive role as a responsible citizen in the society. The graduate profile/attributes are acquired incrementally and describe a set of competencies that are transferable beyond the study of a particular subject/disciplinary area and programme contexts in which they have been developed. Graduate profile/attributes are fostered through meaningful learning experiences made available through the curriculum and learning experience, the total college/university experience, and a process of critical and reflective thinking. Mar Ivanios College (Autonomous) is fully committed to ensuring the attainment of the necessary graduation attributes by the students. The college has clearly defined its *raison de'tre*, the philosophy of its existence, through the Motto "Truth Shall Liberate You" (*Veritas Vos Liberabit*) which refers to the ultimate enlightenment which can emerge only at the intersection of sharp intellect, sound physique, strong mind, staunch ethics, and profound spirituality. This is further made explicit through its Vision, Mission and Goals and the same expect all students who graduate from the college to:

- Have inculcated "the values of truth and charity for the protection and promotion of human dignity and of a cultural heritage, through teaching, research, and extension activities dedicated to society";
- Be co-creators of a vibrant academic community known for its innovation, intellectual rigour and social commitment;
- Be "intellectually trained, morally upright, socially committed, spiritually inspired and ecologically conscious young men and women who would be dedicated to working for the good of society, the nation and the world";
- Have acquired "global competencies and skills";
- Have inculcated a sense of harmony, equality and fraternity among youth, transcending religious, linguistic, regional or sectional diversities; and
- Have developed "scientific temper, humanism and the spirit of inquiry and reform".

Programme Outcomes are the expected student attributes achieved by a student after the student completes the FYUGP from any of the streams/pathways.

The Programme Outcomes (POs) for the FYUGP programmes across all streams and pathways, based on the above core philosophy, and in consonance with the National Higher Education Qualifications Framework (NHEQF) are given below:

By the end of the Four-Year Under-Graduate Programme, students will:

PO 1	Demonstrate the acquisition of all necessary knowledge and skills within their disciplinary/ multi-disciplinary areas of learning. These include the acquisition of: • comprehensive knowledge and coherent understanding of their chosen disciplinary/ interdisciplinary areas of study, their linkages with related fields, and the awareness of current trends in their chosen area of study; • essential knowledge for skilled work in chosen field(s), including self-employment and entrepreneurship skills; • proficiency in specialized areas within chosen fields of study, encompassing diverse practical skills applicable to different

	situations within those fields; • the ability to apply learned knowledge to novel situations, solve problems, and relate concepts to real-world scenarios rather than just memorizing curriculum content.
PO 2	Acquire problem-solving, critical thinking, analytical reasoning skills and demonstrate creativity in their thought processes by demonstrating the ability to: • solve different kinds of problems in familiar and non-familiar contexts both within and outside their disciplinary/ multidisciplinary areas of learning; • apply analytic thought to a body of knowledge, including the analysis and evaluation of policies, and practices, as well as evidence, arguments, claims, and beliefs; • analyse and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples. • the ability to plan, execute and report the results of an experiment or investigation; • adhere to scientific temper and ethics in their thought process; • adopt innovative, imaginative, lateral thinking, interpersonal skills and emotional intelligence; and • incubate entrepreneurial and start-up ideas.
PO 3	Develop a profound environmental dedication by fostering ecological awareness and engaging in actions that promote sustainable development by achieving the ability to • recognize environmental and sustainability issues, and participate in actions to promote sustainable development as well as mitigate the effects of environmental degradation, climate change, and pollution; • contribute to effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, sustainable development and living, and the preservation of life in all forms. • participate in community-engaged services/ developmental activities and thus exemplify the ideals of community engagement and service

	learning and deep social commitment.
PO 4	Accomplish perfect communication, teamwork, and leadership skills, particularly in academic and professional settings, while demonstrating nuance and attention to etiquette in all communicative contexts. This will enable them to: • listen carefully, and read texts and research documents, and present complex information with clarity and precision to different audiences; • express thoughts and ideas and communicate effectively through speech and writing using appropriate media; • communicate using language which is respectful of gender and minority orientations; • act together as a group or a team in the interests of a common cause and working efficiently as a member of a team; • inspire the team with a vision to achieve a stated goal, and use management skills to guide the team in the right direction.
PO5	Acquire the necessary skills, including 'learning to learn' skills, and foster innovative ideas to improve competence and employability, keeping pace with the evolving global landscape and technological advancements by demonstrating the ability to: • pursue learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social, and cultural objectives, and adapting to changing trades and demands of the workplace, including adapting to the changes in work processes in the context of the fourth industrial revolution, through knowledge/ skill development/reskilling; • work independently, identify appropriate resources required for further learning; • acquire organizational and time management skills to set self-defined goals and targets with timelines; • be a proactive life-long learner. • use ICT in a variety of learning and work situations; • access, evaluate, and use a variety of relevant information sources,

	and use appropriate software for analysis of data; • navigate cyberspaces by following appropriate ethical principles and cyber etiquette. • use cutting edge AI tools with equal commitment to efficiency and ethics. • think 'out of the box' and generate solutions to complex problems in unfamiliar contexts;
PO6	Develop research-related skills including the ability to conceptualize research hypotheses/projects and adopt suitable tools and methodologies for analysis with: • a keen sense of observation, inquiry, and capability for asking relevant/ appropriate research questions; • the ability to problematize, synthesize, and articulate issues and design research proposals; • the ability to define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and effect relationships; • the capacity to develop appropriate methodology and tools for data collection; • the appropriate use of statistical and other analytical tools and techniques; • the ability to plan, execute and report the results of an experiment or investigation; • the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work, regardless of the funding authority or the field of study
PO7	Assimilate a sound value system, a sense of autonomy, multicultural competence, social commitment, and the spirit of inclusivity and empathy by imbibing the spirit and the holistic ethos of the 'Multi-Dimensional Ivanian' (MDI) approach. This will enable them to: • embrace and practice constitutional, humanistic, ethical, and moral

	values in life, including universal human values of integrity, truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values; • identify ethical issues related to work, follow ethical practices and be objective, unbiased, and truthful actions in all aspects of work, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights; • exercise responsibility and demonstrate accountability in applying knowledge and/or skills in work and/or learning contexts appropriate for the level of the qualification, including ensuring safety and security at workplaces; • practice responsible global citizenship required for responding to contemporary global challenges, enabling learners to become aware of and understand global issues and to become active promoters of more peaceful, tolerant, inclusive, secure, and sustainable societies; • effectively engage in a multicultural group/society and interact respectfully with diverse groups; • identify with or understand the perspective, experiences, or points of view and emotions of another individual or group. • demonstrate gender sensitivity and adopt a gender-neutral approach, as also empathy for the less advantaged and the differently-abled including those with learning disabilities; • demonstrate proficiency in arts/ sports/ games, physical, mental and emotional fitness, entrepreneurial /organizational /pubic speaking/environmental/ community-oriented areas by actively participating in the wide range of co-curricular activities that are available to the students of Mar Ivanios College.

Programme Specific Outcomes (PSOs)- FYUGP IN BOTANY

PSO 1	Develop a comprehensive understanding and appreciation of plant life, its ecological significance, and applications for human well-being.
PSO 2	Apply analytical, research, and problem-solving skills to address complex botanical challenges.
PSO 3	Uphold ethical principles, integrity, and professionalism in botanical and applied plant sciences.
PSO 4	Demonstrate proficiency in laboratory techniques, modern tools, and interdisciplinary approaches in botany.
PSO 5	Develop sustainable and innovative solutions for environmental challenges through plant-based biotechnology.
PSO 6	Exhibit expertise in plant-based practices, conservation strategies, and biodiversity management and ecosystem restoration.
PSO 7	Develop skills in molecular diagnostics, bioinformatics, and modern laboratory techniques for microbe and plant-based research.

Course and Credit Structure of FYUGP

The pathway preferably followed by the department will be Major with Minor or Major with multiple disciplines of study.

The Course and Credit Structure of FYUGP MAJOR IN BOTANY is given below:

Sem	DSC (4 Cr)	DSE (4 Cr)	AEC (3 Cr)	SEC (3 Cr)	MDC (3 Cr)	VAC (3 Cr)	Internship (credit-2)/ Project/ Additional Courses (credit-12)	Total courses	Total credits
I	A-1 B-1 C-1		AEC (Eng)-1 AEC(OL)-2		MDC-1			6	21
II	A-2 B-2 C-2		AEC (Eng)-3 AEC(OL)-4		MDC-2			6	21
III	A-3 B-3 C-3	DSE A-1			MDC (Kerala Studies)-3	VAC-1		6	22
IV	A-4 A-5	DSE A-2		SEC-1		VAC-2 VAC-3	Internship	6	23
V	A-6 A-7 A-8	DSE A-3 DSE A-4		SEC-2				6	23
VI	A-9 A-10 A-11	DSE A -5 DSE A-6		SEC-3				6	23
Total	A (11) B (3) C (3)	6	4	3	3	3	1*	36	133
EXIT OPTION AVAILABLE AND STUDENTS WILL BE AWARDED UG DEGREE WITH A MAJOR IN A									
VII	A-12 A-13 B/C-4 B/C-5 B/C-6	DSE A-7						6	24
VIII	A-14 A-15						Research Project/ Internship Project or 03 courses -12Cr	2+ 1** /3***	20
Total	A(15) B(3) C (3) B/C (3)	7	4	3	3	3	1* + 1** / 3***	44 + 1* + 1**/ 3***	177

A – Major Discipline, B/C-Minor/Multiple discipline, * - Mandatory Internship at the end of Semester 4
** - Research Project/ Internship /Project as part of Honours with Research, *** - Additional courses of 4 credits each., Cr - Credits

The Course and Credit Structure of FYUGP MAJOR IN BOTANY AND BIOTECHNOLOGY (Interdisciplinary) is given below:

Sem	DSC (4 Cr)	DSE (4 Cr)	AEC (3 Cr)	SEC (3 Cr)	MDC (3 Cr)	VAC (3 Cr)	Internship (credit-2)/ Project/ Additional Courses (credit-12)	Total courses	Total credits
I	A-1 B-1 C-1		AEC (Eng)-1 AEC(OL)-2		MDC-1			6	21
II	A-2 B-2 C-2		AEC (Eng)-3 AEC(OL)-4		MDC-2			6	21
III	A-3 B-3 C-3	DSE A -1			MDC (Kerala Studies)-3	VAC-1		6	22
IV	A-4 B-4	DSE B-2		SEC-1		VAC-2 VAC-3	Internship	6	23
V	A-5 A-6 B-5	DSE A-3 DSE B-4		SEC-2				6	23
VI	A-7 B-6 B-7	DSE A-5 DSE B-6		SEC-3				6	23
Total	A (7) B (7) C (3)	A(3) B(3)	4	3	3	3	1*	36	133
EXIT OPTION AVAILABLE AND STUDENTS WILL BE AWARDED UG DEGREE WITH A MAJOR IN A									
VII	A-8 B-8 A/B - A/B- A/B-	DSE A-7						6	24
VIII	MOOC courses A -9, B -9						Research Project/ Internship Project or 03 courses -12Cr	2+ 1** /3***	20
Total	A (9) B (9)	7	4	3	3	3	1* + 1** / 3***	44 + 1* + 1**/ 3***	177

A, B – Major Disciplines, C-Minor/Multiple discipline, * - Mandatory Internship at the end of Semester 4
** - Research Project/ Internship Project as part of Honours with Research, *** - Additional courses of 4 credits each., Cr - Credits

Research group project for students exiting after UG 3 years: Students who propose to exit after 3 Year UG programme can do a group project with an extra two credits to obtain research experience in discipline-specific areas of the program. The BoS can decide the number of students for the group and the evaluation criteria.

Students will be able to take other pathways permissible under **University of Kerala Four Year Under Graduate Programmes (UoK-FYUGP) Regulations, 2024,** subject to the availability of courses/ faculty/infrastructure of the college.

The Board of Studies shall prepare and publish a list of online courses at different levels before the commencement of classes in the respective semester offered in various online educational platforms recognised by the academic council of the college, which can be opted by the students for acquiring additional credits.

Course Participation/Attendance-

A student shall be permitted to register for the end-semester evaluation of a specific course to acquire the credits only if the student has completed 75% of the prescribed classroom activities in physical, online, or blended modes, as stipulated by the BoS, including any makeup activities as specified by the faculty of that particular course.

The reasons/cases of permissible authorised leave shall be specified by the college, with the approval of the Academic Council, ratified by the Governing Body.

The condonation facility shall be availed as per the existing University/college norms.

Assessment and Evaluation

1. The assessment of a course shall combine a Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE).
2. For courses without practical/lab modules, 30% weightage shall be given for CCA and the remaining 70% of the weight shall be for the ESE.
3. CCA will have two sub-components: Formative Assessment (FA) and Summative Assessment (SA).
4. The CCA subcomponents will be given marks as per the following proportions:
   - Discipline specific summative assessment - 15% of the total

- Course attendance - 5 % of the total.
- Discipline specific formative assessment - 10% of the total.

5. The details of summative and formative assessment criteria, including that of attendance, will be specified by each course coordinator at the beginning of the semester, with the approval of the respective Head of the Department/BoS Chairperson and the Principal, and will be published on the college website.
6. For courses with practical/lab modules, 40% weightage shall be given for CCA and the remaining 60% of the weight shall be for the ESE.
7. In such cases specified in the item above, the CCA subcomponents will be given marks as per the following proportions:
   - Discipline specific summative assessment - 10% of the total
   - Course attendance (Formative) - 5 % of the total
   - Discipline specific formative assessment - 15% of the total.
   - Summative Assessment (Practical Record, Practical test, skill, etc). -10% of the total.

The above is given in detailed tabular form as follows:

Sl. No.	Activity	Percentage (%) of the total	
		Theory courses	Courses with practical
1.	Summative Assessment (written Test or any other discipline specific assessment tools like Open book test, Lab reports, problem-based assignments, individual or team project report, case study report, literature survey, book reviews, video/film/documentary productions, etc)	15	10
2.	Summative Assessment (Practical Record, Practical test, skill, etc)	-----------	10
3.	Formative Assessment (Attendance)	5	5
4.	Formative Assessment (Class room activities, observation of skills, viva voce, quiz, interview, oral presentations, in class	10	15

	discussions, computerized adaptive testing, group tutorial work, reflection writing assignments, field study reports, self and peer assessments, service-learning activities, etc.)		
	Total	30	40

8. The Course Coordinator shall be responsible for evaluating all the components of CCA for the course in question. Any grievances regarding the same shall be submitted to the Course Coordinator within 5 days of the publication of the same on the department notice board or official class group. If the grievance is not settled at the Course Coordinator level, the student is free to appeal to the Head of the Department, within the next 3 days, who will discuss the same in the Department Level Monitoring Committee (DLMC). If still needed, students can further appeal to the College Level Monitoring Committee (CLMC) or in essential situations the University Level Monitoring Committee (ULMC) in a time period as specified by these bodies.
9. Regarding evaluation, one credit will be evaluated for 20 marks in a semester; thus, a 4-credit course will be evaluated for 80 marks, and 3-credit courses for 60 marks. However, any changes to this if brought by the University will be followed.
10. The duration of the end semester examination of a course with 4 credits will be 2 hours and the same for a course with 3 credits may be 1.5 hours/2 hours.

Mark Distribution Table

Course	Credit		Marks		Lecture			Practical		
					CCA (30%)		ESE (70%)	CCA (40%)		ESE (60%)
	Lecture	Practical	Lecture	Practical	SA (50%)	FA (50%)		SA (50%)	FA (50%)	
4 credit courses	4	0	**80**	**0**	12	12	56	0	0	0
	3	1	**60**	**20**	9	9	42	4	4	12
	2	2	**40**	**40**	6	6	28	8	8	24
	1	3	**20**	**60**	3	3	14	12	12	36
	0	4	**0**	**80**	0	0	0	16	16	48
3 credit courses	**Credits**		**Marks**		**Lecture**			**Practical**		
					CCA (30%)		**ESE (70%)**	**CCA (40%)**		**ESE (60%)**
	Lecture	**Practical**	**Lecture**	**Practical**	**SA (50%)**	**FA (50%)**		**SA (50%)**	**FA (50%)**	
	3	0	**60**	**0**	9	9	42	0	0	0
	2	1	**40**	**20**	6	6	28	4	4	12
	1	2	**20**	**40**	3	3	14	8	8	24
	0	3	**0**	**60**	0	0	0	12	12	36

Letter Grades and Grade Point

1. A mark system is followed to evaluate each question. For each course in the semester, letter grades and grade points are introduced in a 10-point indirect grading system as per the guidelines given below.
2. The Semester Grade Point Average (SGPA) is computed from the grades to measure the student's performance in a given semester. The SGPA is based on the current term's grades, while the Cumulative Grade Point Average (CGPA) is based on the grades in all courses taken after joining the programme of study.
3. The weighted grade point will be mentioned in the student's final grade cards, issued by the college, based on the marks obtained.
4. The grades and grade points will be given as per the following format:

Letter Grade	Grade Point	Percentage of marks (X) (CCA + ESE together)	Class
O (Outstanding)	10	$X \geq 95\%$	FIRST CLASS WITH DISTINCTION
A+ (Excellent)	9	$85\% \leq X < 95\%$	
A (Very Good)	8	$75\% \leq X < 85\%$	
B+ (Good)	7	$65\% \leq X < 75\%$	FIRST CLASS
B (Above Average)	6	$55\% \leq X < 65\%$	
C (Average)	5	$45\% \leq X < 55\%$	SECOND CLASS
$\boldsymbol{P(Pass)}$	4	$35\% \leq X < 45\%$	THIRD CLASS
F (Fail)	0	X35%	FAIL
Ab (Absent)	0		FAIL

- For a course PASS, separate minimum of 35% is needed for CCA and ESE.
    - Less than 35% in either ESE or CCA is FAIL.

Computation of SGPA and CGPA

SGPA (Semester Grade Point Average) and CGPA (cumulative Grade Point Average) will be computed as follows:

1. The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in the semester. That is,

$$S_j = \frac{\Sigma(C_{ij} \times G_{ij})}{\Sigma C_{ij}}$$

where S_j is the SGPA in the $j^{th} semester,$

$C_{ij} isthenumberofcreditsforthei^{th} course \in thej^{th} semester$,and

$G_{ij} isthethegradepointscoredbythestudent \in thei^{th} course$ in the $j^{th} semester$.

2. The CGPA is also calculated in the same manner considering all the courses undergone by a student over all the semesters of a programme. That is,

$$CGPA = \frac{\Sigma(C_i \times S_i)}{\Sigma C_i}$$

where S_i is the SGPA in the $i^{th} semester$ and

$\sum C_i \, is the total number of credits \in the i^{th} semester$.

3. The SGPA and CGPA shall be rounded to 2 decimal points and reported in the transcripts

4. **Requirement for the successful completion of a Semester**: SGPA of 4 or above and a PASS in all the courses, that is, minimum total of 35% mark in each course (CCA + ESE), with a separate minimum of 35% mark for both CCA and ESE. Appropriate and permissible rules of rounding off numbers may be adopted as per decisions of the Academic Council.

Dr. Bindu Alex
Chairman BoS
Mar Ivanios College (Autonomous),
Thiruvananthapuram

Thiruvananthapuram
28-03-2025

List of Courses

COURSE CODE	COURSE TITLE	COURSE TYPE	CREDITS	HOUR DISTRIBUTION PER WEEK		
				L	T	P
SEMESTER I | Academic Level 100-199						
MIUK1DSCBOT 100.1	DIVERSITY OF PLANTS I	DSC	4	3	-	2
MIUK1DSCBOT 101.1	INTRODUCTORY BOTANY	DSC	4	3	-	2
MIUK1DSCBOT 102.1	PLANT SCIENCE- AN OVERVIEW	DSC	4	3	-	2
MIUK1MDCBOT100.1	ORGANIC FARMING	MDC	3	3	-	-
SEMESTER II | Academic Level 100-199						
MIUK2DSCBOT 150.1	DIVERSITY OF PLANTS II	DSC	4	3	-	2
MIUK2DSCBOT 153.1	MORPHOLOGY AND ANATOMY OF FLOWERING PLANTS	DSC	4	3	-	2
MIUK2DSCBOT 152.1	ART OF GARDENING	DSC	4	3	-	2
MIUK2DSCBOT 151.1	GREEN INITIATIVES WITH FUTURE PERSPECTIVES	DSC	4	3	-	2
MIUK2MDCBOT153.1	SUSTAINABLE TOURISM	MDC	3	3	-	-
SEMESTER III | Academic Level 200-299						
MIUK3DSCBOT 200.1	ANATOMY OF FLOWERING PLANTS	DSC	4	3	-	2
MIUK3DSCBOT 201.1	REPRODUCTIVE BOTANY OF FLOWERING PLANTS AND MICROTECHNIQUES	DSC	4	3	-	2
MIUK3DSCBOT202.1	PLANT LIFE: DIVERSITY, EVOLUTION, AND ECOLOGICAL SIGNIFICANCE	DSC	4	3	-	2

MIUK3DSCBOT 203.1	PLANT PATHOLOGY AND DEFENSE MECHANISM	DSC	4	3	-	2
MIUK3DSCBOT 204.1	BIODIVERSITY CONSERVATION AND DISASTER MANAGEMENT	DSC	4	3	-	2
MIUK3DSE BOT200.1	MICROTECHNIQUES AND BIOPHYSICS	DSE	4	3	-	2
MIUK3DSEBOT 201.1	ECONOMIC BOTANY ETHNOBOTANY AND IPR	DSE	4	3	-	2
MIUK3VACBOT200.1	WASTE MANAGEMENT	VAC	3	3	-	-
SEMESTER IV | Academic Level 200-299						
MIUK4DSCBOT 250.1	ANGIOSPERM MORPHOLOGY AND REPRODUCTIVE BOTANY	DSC	4	3	-	2
MIUK4DSCBOT 251.1	CELL AND EVOLUTIONARY BIOLOGY	DSC	4	3	-	2
MIUK4DSCBOT 252.1	LOWER CRYPTOGAMS AND PHYTOPATHOLOGY	DSC	4	3	-	2
MIUK4DSCBOT 253.1	MICROBIOLOGY	DSC	4	3	-	2
MIUK4DSCBOT 254.1	PHYTOCHEMISTRY	DSC	4	3	-	2
MIUK4DSEBOT 250.1	ETHNOBOTANY AND PHARMACOGNOSY	DSE	4	3	-	2
MIUK4SECBOT 250.1	MEDICINAL PLANT MERCHANDISING	SEC	3	2	-	2
MIUK4SECBOT251.1	FOOD PROCESSING	SEC	3	2	-	2
MIUK4SECBOT252.1	AQUAPONICS AND HYDROPONICS	SEC	3	2	-	2
SEMESTER V | Academic Level 300-399						
MIUK5DSCBOT 300.1	TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY	DSC	4	3	-	2

MIUK5DSCBOT 301.1	ENVIRONMENTAL SCIENCE	DSC	4	3	-	2
MIUK5DSCBOT 302.1	GENETICS	DSC	4	3	-	2
MIUK5DSCBOT 303.1	ARCHEGONIATES AND PALAEOBOTANY	DSC	4	3	-	2
MIUK5DSCBOT 304.1	ANGIOSPERM TAXONOMY AND MODERN TRENDS IN PLANT SYSTEMATICS	DSC	4	3	-	2
MIUK5DSEBOT 300.1	PLANT BIOTECHNOLOGY	DSE	4	3	-	2
MIUK5DSEBOT 301.1	FORESTRY AND PHYTOGEOGRAPHY	DSE	4	3	-	2
MIUK5DSEBOT 302.1	HORTICULTURE AND NURSERY MANAGEMENT	DSE	4	3	-	2
MIUK5SECBOT 300.1	MUSHROOM CULTIVATION	SEC	3	2	-	2
SEMESTER VI | Academic Level 300-399						
MIUK6DSCBOT 350.1	HORTICULTURE AND PLANT BREEDING	DSC	4	3	-	2
MIUK6DSCBOT 351.1	PLANT PHYSIOLOGY AND PHYTOCHEMISTRY	DSC	4	3	-	2
MIUK6DSCBOT 352.1	MOLECULAR BIOLOGY AND BIOINFORMATICS	DSC	4	3	-	2
MIUK6DSCBOT 353.1	PLANT FUNCTION AND DEVELOPMENT	DSC	4	3	-	2
MIUK6DSEBOT 350.1	FORENSIC BOTANY	DSE	4	3	-	2
MIUK6DSEBOT 351.1	RESEARCH METHODOLOGY AND BIOSTATISTICS	DSE	4	3	-	2
MIUK6DSEBOT 352.1	INTRODUCTION TO PLANT GENETICS AND GENOMICS	DSE	4	3	-	2
MIUK6SECBOT 350.1	PLANT FIBRE TECHNOLOGY	SEC	3	2	-	2
SEMESTER VII | Academic Level 400-499						
MIUK7DSCBOT 400.1	CARBON METABOLISM IN PLANTS	DSC	4	3	-	2
MIUK7DSCBOT 401.1	ADVANCED PLANT	DSC	4	3	-	2

	GENOMICS AND PROTEOMICS					
MIUK7DSCBOT 402.1	DEVELOPMENTAL BOTANY	DSC	4	3	-	2
MIUK7DSEBOT 400.1	AQUATIC BOTANY	DSE	4	3	-	2
MIUK7DSEBOT 401.1	INDUSTRIAL TISSUE CULTURE	DSE	4	3	-	2
Academic Level 300-399 (FOR MINOR)						
MIUK7DSCBOT 300.1	GERMPLASM MANAGEMENT	DSC	4	3	-	2
MIUK7DSCBOT 301.1	PHYTOREMEDIATION AND ENVIRONMENTAL BIOTECHNOLOGY	DSC	4	3	-	2
MIUK7DSCBOT 302.1	HERBAL TECHNOLOGY AND HERBAL COSMETICS	DSC	4	3	-	2
SEMESTER VIII | Academic Level 400-499						
MIUK8DSCBOT 450.1	ADVANCES AND APPLIED ASPECTS OF THALOPHYTES	DSC	4	3	-	2
MIUK8DSCBOT 451.1	ADVANCES AND APPLIED ASPECTS OF ARCHEGONIATES	DSC	4	3	-	2
MIUK8DSCBOT 452.1	BIOINFORMATICS	DSC	4	3	-	2
MIUK8DSCBOT 453.1	GEOSPATIAL ANALYSIS AND GIS FOR LIFE SCIENCES	DSC	4	3	-	2
MIUK8DSCBOT 454.1	COMPUTATIONAL BIOLOGY AND DATA VISUALIZATION	DSC	4	3	-	2
MIUK8DSCBOT 455.1	SCIENCE COMMUNICATION AND PUBLISHING IN BOTANY	DSC	4	3	-	2

SEMESTER I

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK1DSCBOT 100.1**				
Course Title	**DIVERSITY OF PLANTS 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
	4	3 hours		2 hours	5
Pre-requisites	Curiosity in plants				
Course Summary	This course introduces students to the rich diversity of plants, their historical significance, classification, and role in human culture and ecology. The get a deeper acquaintance with lower group of plants and also the diversity of Western Ghats.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Plant Diversity and Evolution**	**7**
	1	Origin and evolution of plants: Transition from aquatic to terrestrial life.	
	2	Contributions of botanists, with an emphasis on Indian scientists.	
	3	Botany as a mother science: Influence on medicine, art, literature, philosophy, and aesthetics.	
	4	Evolution of plant classification: Two-kingdom to Five-kingdom systems. Classification of Kingdom Plantae-	

		Non-Vascular Plants-Vascular Plants, Eichler Classification of plants.	
	5	Activity: Research and present a short biography of a renowned botanist.	
II		**Phycology – Diversity and Classification of Algae**	**9**
	6	Classification of algae by F.E. Fritsch.	
	7	Habitat, thallus organization, pigments, and reproduction.	
	8	Systematic position, structure, reproduction, and life cycle of:	
	9	Myxophyceae – *Nostoc* Chlorophyceae – *Oedogonium* Phaeophyceae – *Sargassum* Rhodophyceae – *Polysiphonia*	
III		**Mycology – Fungal Diversity and Classification**	**9**
	10	General characters, classification based on Ainsworth (1973).	
	11	Overview of fungal groups: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina.	
	12	Structure and life cycle of: *Rhizopus* (Zygomycotina) *Puccinia* (Basidiomycotina)	
	13	Economic importance of fungi.	
IV		**Lichenology – Symbiosis and Ecological Role**	**5**
	14	General characteristics and classification of lichens.	
	15	Structure, reproduction, and life cycle of *Usnea*.	
	16	Economic and ecological importance of lichens.	
V		**Western Ghats- Hottest of Hotspots**	**15**
	17	Biodiversity concepts: Definitions and importance.	
	18	India as a megadiverse nation: Biodiversity hotspots and their significance.	

	19	The Western Ghats: Geography, unique flora and fauna, threats, conservation challenges.	
	20	Biogeographical classification of India.	

Practicals (30 hrs)

1. Prepare a short biography on any one luminary in the field of plant science.
2. Open-ended Exploration across various domains such as agriculture, medicine, culture, art literature and ecology on the vital role of plants in human life.
3. Observation and identification algae mentioned in the syllabus using a microscope.
4. Observation and identification fungal specimens mentioned in the syllabus.
5. Observation and identification pf different types of lichens.
6. Collection, identification and documentation of algae, fungi and lichen (Any 2 from each group).
7. Study on phytogeographical regions of India.

References

1. Bold, H. C., Alexopoulos, C. J., & Delevoryas, T. (1987). *Morphology of plants and fungi* (5th ed.). Harper & Row.
2. Campbell, N. A., & Reece, J. B. (2014). *Biology* (10th ed.). Pearson.
3. Niklas, K. J. (1997). *The evolutionary biology of plants*. University of Chicago Press.
4. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). *Plant systematics: A phylogenetic approach* (4th ed.). Sinauer Associates.
5. Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2012). *Biology of plants* (8th ed.). W. H. Freeman.
6. Lee, R. E. (2018). *Phycology* (5th ed.). Cambridge University Press.
7. Graham, L. E., Graham, J. M., & Wilcox, L. W. (2009). *Algae* (2nd ed.). Benjamin Cummings.
8. Van den Hoek, C., Mann, D. G., & Jahns, H. M. (1995). *Algae: An introduction to phycology*. Cambridge University Press.
9. South, G. R. (1993). *Phycology and marine biology*. Academic Press.
10. Webster, J., & Weber, R. (2007). *Introduction to fungi* (3rd ed.). Cambridge University Press.

11. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). *Introductory mycology* (4th ed.). John Wiley & Sons.
12. Carlile, M. J., Watkinson, S. C., & Gooday, G. W. (2001). *The fungi* (2nd ed.). Academic Press.
13. Deacon, J. (2013). *Fungal biology* (4th ed.). Wiley-Blackwell.
14. Nash, T. H. (2008). *Lichen biology* (2nd ed.). Cambridge University Press.
15. Ahmadjian, V. (1993). *The lichen symbiosis*. John Wiley & Sons.
16. Gadgil, M., & Guha, R. (1995). *Ecology and equity: The use and abuse of nature in contemporary India*. Routledge.
17. Daniels, R. J. R. (2003). *Impact of tea cultivation on anurans in the Western Ghats*. Current Science, *85*(10), 1415-1422.
18. MoEFCC (Ministry of Environment, Forest, and Climate Change). (2018). *National biodiversity action plan (NBAP)*. Government of India.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the origin and evolution of plants and analyze the contributions of botanists to science and society.	R, U, An	1, 4
CO-2	Describe the diversity and classification of algae and evaluate their ecological significance.	U, An, E	1, 2
CO-3	Analyze fungal diversity, their life cycles, and assess their economic and ecological importance.	An, E	1, 5
CO- 4	Examine the symbiotic relationship in lichens and apply their ecological and economic relevance.	U, Ap, E	2, 6
CO-5	Assess the biodiversity of the Western Ghats and develop conservation strategies for its endemic species.	An, C	3, 5, 6

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

Name of the Course: DIVERSITY OF PLANTS I

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the origin and evolution of plants and analyze the contributions of botanists to science and society.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe the diversity and classification of algae and evaluate their ecological significance.	1, 6	1, 2	U, An, E	C, P	L,P
CO3	Analyze fungal diversity, their life cycles, and assess their economic and ecological importance.	2, 3	1, 5	An, E	C, P	L,P
CO4	Examine the symbiotic relationship in lichens and apply their ecological and economic relevance.	2, 5	2, 6	U, Ap, E	C, P	L,P
CO5	Assess the biodiversity of the Western Ghats and develop conservation strategies for its endemic species.	3, 7	3, 5, 6	An, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓		✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK1DSCBOT 101.1**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Needs curiosity and interest in plants.				
Course Summary	By the end of the course, students will be able to explain the steps in evolution of plants, interaction between plant and environment and plant and human and also understands the plant form and behaviour.				

Module	**Unit**	**Content**	**Hrs**
I		**An introduction to Plant life**	**5**
	1	What is life? What are 'living things? Characteristic features of living things. Hierarchal organization of living things. (from atoms- Molecules - Macromolecule- Organelle - Cell- Tissue- Tissue Systems – Organ - Organism - Population- Community- Ecosystem- Biosphere) (Brief account).	
	2	Plant Life- What is Botany? History of botany, the basic concept of botany, what are Plants? Characteristics of Plants.	
	3	Classification of plant kingdom, criteria of classification (plant body, vascular system, seed development).	

		Classification Based on Life Cycle. A. W. Eichler's System of Classification.	
	4	Activity- Chart preparation and exhibition of different types of plant.	
II	**Evolution of life**		**8**
	5	How did life evolve on earth? Fore runners of first cell. Earth's first organism- Archaebacteria. First eukaryotic cell. The theory of endosymbiosis.	
	6	Evolutionary history of plants on geological time scale. Evolution of land plants. Fossil evidence for plant evolution. Fossil plants- Fossil thallophytes, Fossil pteridophyte- *Rhynia, Lepidodendron*, Fossil Gymnosperm- *Lyginopteris*, Fossil angiosperms (brief account)	
	7	The evolution of seed plants: How did seed plants become today's dominant vegetation? What Features Contributed to the Success of the Angiosperms? Seed as a complex well protected package.	
	8	Activity: - Power point presentation of plant evolution	
III	**Plant Behavior**		**9**
	9	How do plants support our world? Plants are the foundation of ecosystem-primary producers (Autotrophic) synthesize food by Photosynthesis -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.	
	10	Plant form - shared characteristics of vascular plants, meristems-organization of vascular plant body-dermal tissue, ground tissue, vascular tissue. Root structure, organization of root tip, root anatomy (dicot and monocot), Modified roots Stem structure – stem anatomy (dicot and monocot), Modified	

<table>
<tr><td rowspan="2"></td><td></td><td>stem
Leaf structure- leaf anatomy (dicot and monocot), Stomata (anomocytic, anisocytic, paracytic, diacytic), modified leaves. Plants Defense– (against herbivorous and animals)- Structural defense – Barriers-cuticle, wax, bark; Adaptations- thorns, prickles, shrinkage (Mimosa), latex, trichomes, crystalliferous cells, and silica cells.)-Biochemical defense (alkaloids, phenolics, terpenes, and flavonoids) (Brief study)</td><td></td></tr>
<tr><td>11</td><td>Activity: Identification and collection of specimens plants with modifications</td><td></td></tr>
<tr><td rowspan="2">IV</td><td colspan="2">Plants and people</td><td>8</td></tr>
<tr><td>12</td><td>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.</td><td></td></tr>
<tr><td>V</td><td colspan="2">Evaluation</td><td>15</td></tr>
</table>

	13	Botanical Skills and Techniques 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.	

Practicals (30 hrs)

1. Study of fossil plants mentioned in the syllabus using permanent slides and photographs.
2. Identification of different types of plant cells through a light microscope.
3. Analyzing the anatomical feature of dicot and monocot plant -Root, stem and leaf
4. Study of different types of plant stomata
5. Identifying and recording different plant defense mechanisms (trichomes, cell inclusions)
6. Qualitative Identification of Secondary Metabolites- phenol- Ferric chloride test, alkaloids- Dragendorff' s reagent, flavonoids- concentrated hydrochloric acid (HCl) test, terpenes-Salkowski test
7. Prepare Killing and fixing agents, preserve and submit any five plant specimens.
8. Hands on training for free hand sectioning, staining and mounting of plant tissues.
9. Parts of Microscope and Photomicrography

References

1. Esau, K. (1977). *Anatomy of seed plants*. John Wiley & Sons.
2. Gatenby, J. B., & Beams, H. W. (Eds.). (1950). *Microtomist's vade-mecum (Bolles Lee): A handbook of the method of animal and plant microscopic technique*. J & A Churchill.
3. Hufford, T. L. (1978). *Botany: Basic concepts in plant biology*. Harper & Row Publishers.
4. Mauseth, J. D. (2003). *Botany: An introduction to plant biology*. Jones & Bartlett Publishers.

5. Pandey, S. N., & Chadha, A. (2010). *Textbook of botany: Plant anatomy and economic botany* (Vol. 3). Vikas Publishing House Pvt. Ltd.
6. Prasad, M. K., & Krishna Prasad, M. (1968). *Outlines of botanical microtechnique*. T. C. Radhamani.
7. Raven, P. H. (2005). *Biology of plants*. W. H. Freeman & Company.
8. Shukla, A. C., & Missra, S. P. (1975). *Essentials of Palaeobotany*. Vikas Publishing House Pvt. Ltd.
9. Siddiqui, K. A. (2003). *Elements of Palaeobotany*. Kitab Mahal Agencies.
10. Stern, K., Bidlack, J. E., & Jansky, S. H. (2003). *Introductory plant biology*. McGraw-Hill.
11. Stewart, W. N., & Rothwell, G. W. (2013). *Palaeobotany and the evolution of plants*. Cambridge University Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand different levels of organisation of life and gets an overview on plant science	U	1
CO -2	Understands the process of evolution of life on earth, recognize the major groups of plants and identify and discuss their evolution	U, An	1,2
CO-3	Evaluates the relationship between plant and environment, plant and other plants and animals, plant and human	U, An, E,C	1, 3,5
CO-4	Understands the importance of plants in human life	U	1
CO-5	Familiarizes with the techniques of preserving and studying plants	U, Ap	2,4

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	Understands different levels of organisation of life and gets an overview on plant science	1	1	U	C	L
2	Understands the process of evolution of life on earth, recognize the major groups of plants and identify and discuss their evolution	1	1,2	U, An	C	L,P
3	Evaluates the relationship between plant and environment, plant and other plants and animals, plant and human	2, 3	1, 3,5	U, An, E	F, P, M	L/ T
4	Understands the importance of plants in human life	1,4, 5	1	U	C	L/T
5	Familiarizes with the techniques of preserving and studying plants	1,6	2,4	U, Ap	P	L, P

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

Mapping of COs with PSOs and POs:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	-	-	-	-	-	-	3	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	3	2	-	-	-	-	-
CO3	-	1	3	-	-	-	-	3	-	2	-	3	-	-
CO4	3	-	-	1	2	-	-	3	-	-	-	-	-	-
CO5	3	-	-	-	-	3	-	-	2	-	3	-	-	-

Correlation Levels:- (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK1DSCBOT 102.1**
Course Title	**PLANT SCIENCE: AN OVERVIEW**
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
	4	3 hours	-	2 hours	5
Pre-requisites	Needs curiosity and interest in plants.				
Course Summary	The course aims to offer basic understanding about the plant cell structure and its composition and to explore the avenues offered for career in the field of Botany				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**The Plant Network**	**6**
	1	Plants as dynamic systems - Plant sociobiology - Interconnectedness and Adaptation in Open Systems (cooperation, communication, behaviors).	
	2	Social Learning and Memory in plants - mycorrhizal network, plant microbiome.	
	3	Kin Recognition and Altruism.	
	4	Activity: Review the latest literature and present a report.	

II		**Plant cell structure**	**8**
	5	Introduction to the plant cell – general structure (without detailed cytology) focusing on its distinction from animal cells.	
	6	Plant cell wall: composition and structure. Cell wall organization- gross structure, primary and secondary wall, pits, plasmodesmata,	
	7	Simple and permanent tissues: definition, classification, and functions.	
	8	Activity: Collect five different plants and study and record the structure of common cells in the collected plants.	
III		**Plants: An Overview**	**10**
	9	Tissue organization in plants: Epidermal, ground, and vascular tissue systems (Dicot and Monocot).	
	10	Primary structure of leaf, root, and stem (brief – main characters only). Stomata structure and function: Types - anomocytic, anisocytic, paracytic, diacytic, graminaceous.	
	11	Study of modifications of leaf, root, and stem and their functions.	
	12	Activity: Label the parts of a leaf, root, and stem using real plant samples.	
IV		**Interdisciplinary Reach of Botanical Science**	**6**
	13	Space Science - Space exploration, plant growth in microgravity, bioregenerative life support systems, and extraterrestrial agriculture.	
	14	Botanical applications in medicine and pharmacognosy.	
	15	Activity: Case study on "Artemisinin: The journey from natural product to Nobel Prize."	
V		**Exploring Botany and Plant Science Careers**	**15**
	16	Invited talks by eminent professionals	
	17	Recent advancements in plant-based industries: pharmaceuticals, biofuels, horticultural practices.	

	18	Emerging economic opportunities in plant-based entrepreneurship: vertical farming, plant-based foods, and herbal medicine, nursery management, seed production.	
	19	Activity: Business plan presentation for a plant-based startup idea.	

Practicals (30 hrs)

1. Explore the campus and its surroundings. Collect and document different types of plants and plant parts.
2. Photograph and analyse various plant modifications.
3. Identify different types of plant cells and tissues using a light microscope.
4. Study anatomical features of dicot and monocot plants - Root, stem, and leaf.
5. Examine different types of stomata.

References

1. Gagliano, M., Vyazovskiy, V. V., Borbély, A. A., Grimonprez, M., & Depczynski, M. (2016). Learning by association in plants. Scientific reports, 6(1), 38427.
2. Simard, S. W. (2018). Mycorrhizal networks facilitate tree communication, learning, and memory. In Memory and learning in plants (pp. 191-213). Springer, Cham.
3. Leopold, A. C. (2014). Smart plants: memory and communication without brains. Plant signaling & behavior, 9(10), e972268.
4. Esau, K. (1965). *Plant Anatomy*. Wiley Eastern, New York.
5. Evert, R. F., & Eichhorn, S. E. (2013). *Raven Biology of Plants* (8th ed.). W. H. Freeman and Company.
6. Mauseth, J. D. (2014). *Plant Anatomy* (2nd ed.). Jones & Bartlett Learning.
7. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant Physiology and Development* (6th ed.). Sinauer Associates.
8. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry & Molecular Biology of Plants*. Wiley Blackwell.
9. Smith, A. M., Coupland, G., Dolan, L., Harberd, N., Jones, J., Martin, C., & Amey, A. (2009). *Plant Biology*. Garland Science.
10. Capon, B. (2010). *Botany for Gardeners*. Timber Press.

11. Michael, O. S. (2015). *Artemisinin: The Journey from Natural Product to Nobel Prize*. Annals of Ibadan Postgraduate Medicine, 13(2), 113-117.
12. Karban, R., Shiojiri, K., Ishizaki, S., Wetzel, W. C., & Evans, R. Y. (2013). *Kin Recognition Affects Plant Communication and Defence*. Proceedings of the Royal Society B: Biological Sciences, 280(1756), 20123062.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the interconnected nature of plants and their adaptive strategies.	U	1, 6
CO -2	Identify different plant tissues and their functions.	R, U	1, 4
CO-3	Analyze plant anatomy and tissue organization.	An	1, 2, 4
CO-4	Investigate the interdisciplinary applications of botany.	E	1, 2, 4, 5
CO-5	Explore economic and entrepreneurial prospects in plant science.	E, C	3, 5

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

Name of the Course: PLANT SCIENCE: AN OVERVIEW

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial(T)/ Practical (P)
CO1	Understand the interconnected nature of plants and their adaptive strategies.	1,3	1, 6	U	C, M	L,P
CO2	Identify different plant tissues and their functions.	1,2	1, 4	R, U	F, C	L,P
CO3	Analyze plant anatomy and tissue organization.	1,2,6	1, 2, 4	An	C, P	L,P
CO4	Investigate the interdisciplinary applications of botany.	1,5,6	1, 2, 4, 5	E	C, M	L/T
CO5	Explore economic and	1,5,7	3, 5	E, C	M	L/T

	entrepreneurial prospects in plant science.					

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	-	2	-	-	-	-	3	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO3	3	3	-	-	-	2	-	3	2	-	2	-	-	-
CO4	2	-	-	-	2	3	-	2	2	-	2	2	-	-
CO5	2	-	-	-	3	-	3	-	-	3	-	3	-	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK1MDCBOT 100.1**				
Course Title	**ORGANIC FARMING**				
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
	3	3 hours	-	-	3
Pre-requisites	Interest in plant practices				
Course Summary	Will be able to understand the concept of organic farming, understand the scope and importance of organic farming and to ensure safe and a healthy food production.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of organic farming**	**6**
	1	Introduction, Need and benefits of organic farming.	
	2	Concepts & Systems – Definition, advantages & challenges, types (organic, conventional, integrated, mixed farming).	
	3	Sustainable Practices – Integrated and mixed farming, intercropping, crop rotation.	
	4	Activity – Visit to an organic farm for hands-on experience in organic product utilization.	

II	**Preparation and application of organic input**		**8**
	5	Organic Fertilizers – Need, benefits, and soil conversion methods.	
	6	Preparation Techniques – Composting, green pesticides (Panchagavya, Jeevamrutam), vermicomposting, Azolla cultivation.	
	7	Activity – Practical demonstration of organic inputs.	
III	**Role of micro organisms**		**10**
	8	Soil Microbiology & Biofertilizers – Importance, role, and sources (Bacteria, Cyanobacteria, Mycorrhiza, Phosphate Solubilizing Microorganisms).	
	9	Soil Health & Fertility – Soil composition, structure, humus, importance of humus and natural organic compounds in soil.	
	10	Activity – Application techniques of biofertilizers and green manure.	
IV	**Botanical and fungal biopesticides**		**6**
	11	Biological Control Agents – Characteristics and significance.	
	12	Types of Biopesticides – Advantages and disadvantages.	
	13	Biological Fungicides – Trichoderma, Pseudomonas, Fusarium; production and processing.	
	14	Bioinsecticides & Nematicides – Uses and applications.	
	15	Activity – Preparation of neem-based and other botanical pest control solutions.	
V	**Plant nutrients**		**15**
	16	Plant Nutrition & Growth – Impact of plant population and nutrient sources.	
	17	Nutrient Use Efficiency – Definition and influencing factors.	
	18	Activity – Preparation of organic compost (over-ground, pit, liquid, vermicompost – any one method).	

References

1. Alvares, C. (1996). *The organic farming source book*. The Other India Press.

2. Dongarjal, R. P., & Zade, S. B. (2019). *Insect ecology and integrated pest management*. Akinik Publications.
3. Gehlot, D. (2005). *Organic farming: Standards, accreditation, certification, and inspection*. Agrobios.
4. Gupta, M. (2004). *Organic agriculture development in India*. ABD Publishers.
5. Ministry of Agriculture, Department of Agriculture and Cooperation, INM Division. (n.d.). *Guideline of national project on organic farming*. Government of India.
6. Palaniappan, S. P., & Annadurai, K. (1999). *Organic farming: Theory and practice*. Scientific Publishers.
7. Rao, N. S. S. (2000). *Soil microbiology*. Oxford & IBH Publishers.
8. Sathe, T. V. (2004). *Vermiculture and organic farming*. Daya Publishers.
9. Sharma, A. K. (2002). *A handbook of organic farming*. Agrobios.
10. American Society of Agronomy. (n.d.). *Organic farming: The ecological system (Agronomy Monograph 54)*. ASA.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the principles, importance, and benefits of organic farming	U	1, 6
CO-2	Demonstrate the preparation and application of organic fertilizers, compost, and biofertilizers.	Ap, An	1, 4, 6
CO -3	Understand the role of soil microorganisms and their contribution to soil fertility in organic farming.	An, E	2, 5
CO-4	Evaluate the effectiveness of botanical and fungal biopesticides in pest management.	E	3, 5, 6
CO-5	Develop skills for nutrient management, compost preparation, and sustainable farming practices.	Ap, C	2, 4, 5

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)
CO1	Explain the principles, importance, and benefits of organic farming.	1,3	1, 6	U	C, M	L
CO2	Demonstrate the preparation and application of organic fertilizers, compost, and biofertilizers.	1, 5	1, 4, 6	Ap, An	P, C	L/T
CO3	Analyze the role of soil microorganisms and their contribution to soil fertility in organic farming.	1,2, 6	2, 5	An, E	C, M	L
CO4	Evaluate the effectiveness of botanical and fungal biopesticides in pest management.	1,2, 6	3, 5, 6	E	C, M	L
CO5	Develop skills for nutrient management, compost preparation, and sustainable farming practices.	1,3,5,	2, 4, 5	Ap, C	P, M	L/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	-	2	-	-	-	-	3	-	-	-	-	2	-
CO2	3	-	-	-	1	-	-	3	-	-	2	-	3	-
CO3	3	3	-	-	-	3	-	-	2	-	-	2	-	-
CO4	2	2	-	-	-	3	-	-	-	3	-	3	3	-
CO5	2	-	2	-	3	-	-	-	2	-	3	3	-	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓			✓
CO5	✓		✓	✓

SEMESTER II

Mar Ivanios College (Autonomous)

Discipline	**BOTAN Y**				
Course Code	**MIUK2DSCBOT 150.1**				
Course Title	**DIVERSITY OF PLANTS-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
	4	3 hours	-	2 hours	5
Pre-requisites	Have a grasp of the ecological roles and habitats of lower plants.				
Course Summary	The course include classification, morphology, life cycles, ecological roles, and economic significance of major plant groups. Students would compare the morphology, and life cycles of Bryophytes, Pteridophytes and Gymnosperms, identifying both similarities and differences among these group. Students are also introduced to the prokaryotic world.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Amphibians of the Plant Kingdom (Bryology)**	**9**
	1	Evolutionary significance of amphibious plants: From aquatic ancestors to land-dwelling plants.	
	2	Overview of Plant Kingdom and placement of Bryophytes. Amphibious nature of bryophytes. Morphology of Bryophytes. Alternation of generations in bryophytes.	
	3	General characters and classification by Smith (1959). Ecological and Economic importance of Bryophytes.	
	4	Morphology, anatomy, and reproduction of: *Riccia, Funaria*	

	5	Activity: Collection of Bryophyte and Pteridophyte specimens.	
II	**How plants colonised land?**		**4**
	6	Evolution of Tracheary elements, Vascular systems, Stelar evolution, Pollen types, Pollen morphology, Wind pollination and Insect pollination, Seed habit.	
III	**Pteridophytes - The First Vascular Plants**		**9**
	7	General characters of Pteridophytes. Life cycle of Pteridophytes and alternation of generation. Economic importance of Pteridophytes.	
	8	Classification of pteridophytes. Fossil pteridophyte -*Rhynia*	
	9.	Morphology of Gametophyte and Sporophyte, Structure of Cones, Life cycle of *Psilotum*, *Selaginella, Pteris*	
IV	**Gymnosperms: Seed-producing plants**		**8**
	10	Evolutionary significance of gymnosperms: Transition from spore-producing to seed-producing plants. Classification of Gymnosperms (Sporne, 1965). Fossil Gymnosperms- An overview of extinct gymnosperms. Mentioning living fossils.	
	11	Affinities of gymnosperms with pteridophytes and angiosperms.	
	12	Morphology of Sporophyte and Gametophyte (Pollen grain & Ovule) , Structure of Cones. *Cycas, Pinus*	
	13	Economic importance of Gymnosperms.	
V	**Diversity of Plants: Prokaryotic world**		**15**
	14.	Geological time scale with special reference to plant evolution.	
	15.	Viruses, Fungi and Lichens, Bacteria, Archaea and Eukaryotes. General account, Emphasize distinguishing characters.	
	16	Viruses: Virion types: Helical, Icosahedral, Icosahedral with tail, helical encapsulated, Giant Viruses.	
	17.	Bacterial Cell Structure: Fundamental differences between	

		Archaea and bacteria, Shape and size, Plasma membranes, Cell wall, Gram-positive and gram-negative bacteria.	

Practicals (30 hrs)

1. Differentiating gram-positive and gram-negative bacteria using Gram staining (Demonstration only).
2. Collection, recording, and preservation of the various plant groups from nearby ecosystems.
3. Morphological and anatomical study of *Riccia* and *Funaria*.
4. Familiarisation of various stelar types: protostele, actinostele, siphonostele, solenostele (*Marselia* rhizome), dictyostele (*Pteris* petiole), atactostele (Grass stem).
5. Morphological and anatomical study of *Psilotum*, *Selaginella, Pteris.*
6. Morphological and anatomical study of *Cycas* and *Pinus*

References

1. Shaw, A. J., & Goffinet, B. (2000). *Bryophyte biology*. Cambridge University Press.
2. Smith, A. J. E. (1978). *The moss flora of Britain and Ireland*. Cambridge University Press.
3. Vanderpoorten, A., & Goffinet, B. (2009). *Introduction to bryophytes*. Cambridge University Press.
4. Gradstein, S. R., Churchill, S. P., & Salazar-Allen, N. (2001). *Guide to the bryophytes of tropical America*. The New York Botanical Garden Press.
5. Gifford, E. M., & Foster, A. S. (1989). *Morphology and evolution of vascular plants* (3rd ed.). W.H. Freeman & Company.
6. Parihar, N. S. (1965). *An introduction to Pteridophyta*. Central Book Depot.
7. Kramer, K. U., & Green, P. S. (1990). *The families and genera of vascular plants: Pteridophytes and Gymnosperms*. Springer.
8. Moran, R. C. (2004). *A natural history of ferns*. Timber Press.
9. Ranker, T. A., & Haufler, C. H. (Eds.). (2008). *Biology and evolution of ferns and lycophytes*. Cambridge University Press.
10. Sporne, K. R. (1965). *The morphology of gymnosperms*. Hutchinson & Co.

11. Stewart, W. N., & Rothwell, G. W. (1993). *Palaeobotany and the evolution of plants* (2nd ed.). Cambridge University Press.
12. Taylor, T. N., Taylor, E. L., & Krings, M. (2009). *Palaeobotany: The biology and evolution of fossil plants* (2nd ed.). Academic Press.
13. Beck, C. B. (2010). *An introduction to plant structure and development: Plant anatomy for the twenty-first century* (2nd ed.). Cambridge University Press.
14. Willis, K. J., & McElwain, J. C. (2014). *The evolution of plants* (2nd ed.). Oxford University Press.
15. Singh, H. (1978). *Embryology of gymnosperms*. Gebrüder Borntraeger.
16. Brock, T. D. (2012). *Brock biology of microorganisms* (13th ed.). Pearson.
17. Madigan, M. T., Bender, K. S., Buckley, D. H., & Sattley, W. M. (2020). *Brock biology of microorganisms* (16th ed.). Pearson.
18. Prescott, L. M., Harley, J. P., & Klein, D. A. (2016). *Microbiology* (10th ed.). McGraw-Hill.
19. Pace, N. R. (2009). *Mapping the tree of life: Genomics and the domain of Bacteria and Archaea*. Trends in Microbiology, *17*(8), 401-407.
20. Woese, C. R., Kandler, O., & Wheelis, M. L. (1990). *Towards a natural system of organisms: Proposal for the domains Archaea, Bacteria, and Eucarya*. Proceedings of the National Academy of Sciences, *87*(12), 4576-4579.
21. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An introduction* (13th ed.). Pearson.
22. Carlile, M. J., Watkinson, S. C., & Gooday, G. W. (2001). *The fungi* (2nd ed.). Academic Press.
23. Webster, J., & Weber, R. (2007). *Introduction to fungi* (3rd ed.). Cambridge University Press.
24. Nash, T. H. (2008). *Lichen biology* (2nd ed.). Cambridge University Press.
25. Suttle, C. A. (2007). *Marine viruses—Major players in the global ecosystem*. Nature Reviews Microbiology, *5*(10), 801-812.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the evolutionary transition of plants from aquatic to terrestrial environments and analyze the significance of bryophytes as amphibians of the plant kingdom.	1, 4	R, U, An
CO-2	Describe the adaptations and structural evolution of vascular plants and evaluate their role in plant colonization on land.	1, 2	U, An, E
CO -3	Analyze the characteristics, life cycles, and classification of pteridophytes and gymnosperms and assess their evolutionary importance.	1, 5	An, E
CO-4	Examine the classification, structure, and economic significance of gymnosperms and compare their affinities with pteridophytes and angiosperms.	2, 6	U, Ap, E
CO-5	Assess the diversity of plant-like organisms, including bacteria, archaea, fungi, and viruses, and develop a comparative understanding of their distinguishing features.	3, 5, 6	An, C

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

Name of the Course: DIVERSITY OF PLANTS -II

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the evolutionary transition of plants from aquatic to terrestrial environments and analyze the significance of bryophytes as amphibians of the plant kingdom.	1, 2	1, 4	R, U, An	F, C	L/T

CO2	Describe the adaptations and structural evolution of vascular plants and evaluate their role in plant colonization on land.	1, 6	1, 2	U, An, E	C, P	L/T
CO3	Analyze the characteristics, life cycles, and classification of pteridophytes and gymnosperms and assess their evolutionary importance.	2, 3	1, 5	An, E	C, P	L
CO4	Examine the classification, structure, and economic significance of gymnosperms and compare their affinities with pteridophytes and angiosperms.	2, 5	2, 6	U, Ap, E	C, P	L,P
CO5	Assess the diversity of plant-like organisms, including bacteria, archaea, fungi, and viruses, and develop a comparative understanding of their distinguishing features.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓		✓	✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK2DSCBOT 153.1**				
Course Title	**MORPHOLOGY AND 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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge of plant structure and function				
Course Summary	The course provides a foundational understanding on the structure, form and the internal cellular level organisation of flowering plants, an important plant group.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Plant Morphology**	**8**
	1	Definition and Scope of Plant Morphology, Classification of plants based on growth forms (Herb, Shrub, Tree, Creeper, Climber), Basic Morphological Terms and Plant Parts- Root, Stem, Leaf, Flower, Fruit, and Seed.	
	2	Root Morphology- Structure and Types of Roots (Tap root, Fibrous root, Adventitious roots), Modifications of Roots (Storage, Climbing, Breathing roots), Functions of Roots, Root Development and Growth	

	3	Stem Morphology- Structure of Stem and its Modifications (Support, Storage, Protection), Types of Stems (Herbaceous, Woody, Aerial, Underground), Growth of Stems (Apical and Lateral Growth, Primary and Secondary Growth), Functions of Stems	
	4	Leaf Morphology - Structure and Types of Leaves (Simple, Compound, Sessile, Petiolate)**,** Modifications of Leaves (Storage, Insectivorous, Climbing)**,** Leaf Venation and Phyllotaxy**,** Functions of Leaves and Leaf Anatomy	
	5	Activity- Collect plant specimens with morphological modifications.	
II		**Morphology of the reproductive parts of angiosperms**	**6**
	6	Flower Morphology **-**Definition and Function of Flowers**,** Floral Parts (Sepals, Petals, Stamens, Pistils)**,** Types of Inflorescences (Raceme, Cyme)**,** Pollination Mechanisms**,** Flower Symmetry and Fusion of Floral Parts	
	7	Fruit and Seed Morphology**-** Types of Fruits (Simple, Aggregate, Multiple), Fleshy fruit, dry fruit (dehiscent and indehiscent), Seed Structure (Seed Coat, Embryo, Cotyledons)**,** Types of Seeds and Methods of Seed Dispersal**,** Germination of Seeds	
	8	Activity- Collect different types of dry fruits	
III		**Introduction to Plant Anatomy**	**8**
	9	Definition and Scope of Plant Anatomy, The Importance of Anatomical Study in Understanding Plant Growth	
	10	Study of Plant Tissues-Meristematic and Permanent Tissues (Simple and complex)	
	11	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).	
	12	Activity- Photograph/ Drawings of of different tissues in plants	
IV		**Primary structure of the plant body**	**8**
	13	Primary structure of root (dicot *vs* monocot)	
	14	Primary structure of stem (dicot *vs* monocot)	
	15	Primary structure of leaf (dorsiventral *vs* isobilateral)	
V		**Secondary Growth and Wood Anatomy**	**15**
	16	Secondary Growth in Dicot Stem and Root Cambium activity, formation of annual rings, heartwood and sapwood. Periderm: Cork, phelloderm, phellogen, lenticel.	
	17	Anomalous secondary growth in the stem. Examples *Bignonia, Boerhaavia, Dracaena*.	
	18	Wood Anatomy Types of wood (softwood, hardwood) Importance of wood anatomy in taxonomy and industry.	
	19	Activity- Collect and document herbs and shrubs that show secondary thickening	

Practical (30 hrs)

1. Root Morphology
   - Observation and Study of Root Types (Tap root, Fibrous root, Adventitious roots)
   - Study of Modifications of Roots (Storage roots, Climbing roots)
2. Stem Morphology
   - Study of Stem Modifications (Tubers, Rhizomes, Bulbs, etc.)
   - Observation of Growth Patterns in Stems (Primary and Secondary Growth)
3. Leaf Morphology
   - Study of Simple and Compound Leaves
   - Examination of Leaf Modifications (Insectivorous leaves, Tendrils)
   - Study of Leaf Venation Patterns and Phyllotaxy
4. Flower Morphology
   - Dissection and Study of Flowers
   - Study of Different Types of Inflorescences

- Floral Symmetry

5. Fruit and Seed Morphology
   - Dissection and Study of Different Fruit Types (Simple, Aggregate, Multiple)
   - Study of Seed Structure
6. Plant Tissue Study
   - Preparation of hand sections for studying Plant Tissues (Xylem, Phloem, Parenchyma, etc.)
   - Observation of Simple and Complex Tissues.
   - Study of Tissue Organization in Roots, Stems, and Leaves

7: Comparative Study of Anatomical Structures
   - Comparison of Primary and Secondary Structure of Roots, Stems, and Leaves
   - Observation of cross sections of Root, Stem, and Leaf under the Microscope

References

1. Bell, A. D., & Bryan, A. (2009). *Plant form: An illustrated guide to flowering plant morphology*. Timber Press.
2. Cutler, D. F., Botha, T., & Stevenson, D. W. M. (2008). *Plant anatomy: An applied approach*. John Wiley & Sons Ltd.
3. Eames, A. J., & MacDaniels, L. H. (1947). *An introduction to plant anatomy* (2nd ed.). McGraw Hill.
4. Esau, K. (2006). *Anatomy of seed plants* (2nd ed.). Wiley Eastern.
5. Fahn, A. (1995). *Plant anatomy*. Elsevier Science and Technology.
6. Pandey, B. P. (1997). *Plant anatomy*. S Chand & Co.
7. Pandey, B. P. (2012). *Plant anatomy*. S Chand Publishing.
8. Pandey, B. P. (2017). *Plant morphology*. S Chand Publishing.
9. Roy, P. (2006). *Plant anatomy*. New Central Book Agency (P) Ltd.
10. Vashista, P. C. (1984). *Plant anatomy*. Pradeep Publications.

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.	U	1, 5
CO-2	Remember the taxonomical terminology and	R	2, 4

	acquire the skills to describe flowering plants in technical terms.		
CO-3	Understand the composition, internal structure & architecture of plants	U	1, 5
CO-4	Develop skills for microscopic specimen preparation and examine the internal anatomy of plant systems and organs	Ap	4, 6
CO-5	Understand, analyse, and identify the modification of internal structure with respect to environmental adaptations	An,C	3, 5, 7

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

Name of the Course: MORPHOLOGY AND 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)
CO1	Ability to identify the vegetative parts of angiosperms and understand their variation.	1, 3	1, 5	U	C	L,P/T
CO2	Remember the taxonomical terminology and acquire the skills to describe flowering plants in technical terms.	1, 2	2, 4	R	C, F	L
CO3	Understand the composition, internal structure & architecture of plants	1, 3	1, 5	U	C	L,P
CO4	Develop skills for microscopic specimen preparation and examine the internal anatomy of plant systems and organs	3, 6	4, 6	Ap	P	L,P
CO5	Understand, analyse, and identify the	3, 5,	3, 5, 7	An,C	M	L/T

	modification of internal structure with respect to environmental adaptations	7				

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	-	2	-	-	-	-	3	-	-	-	2	-	-
CO2	3	2	-	-	-	-	-	-	3	2	-	-	-	-
CO3	3	-	3	-	2	-	-	3	-	-	-	3	2	-
CO4	-	-	3	-	-	3	-	-	-	-	3	-	2	-
CO5	-	-	3	-	2	-	3	-	-	3	-	3	-	3

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK2DSCBOT 152.1**				
Course Title	**ART OF GARDENING**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Interest in gardening				
Course Summary	Students will be able to learn gardening, qualities of successful gardener, and also familiarize with various types of plants, seeds, fertilizers, pesticides, different tools & equipment used in the gardening work and their use.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to gardening**	**5**
	1	Understanding Flowers – Types (simple, inflorescence), significance in gardens.	
	2	Garden Design Basics – Concepts, components, elements, and principles of gardening.	
	3	Gardener's Role – Essential qualities of a successful gardener.	
	4	Activity: Collect and prepare a floral herbarium.	

II	**Types of gardens**		**10**
	5	Garden Types – Flowering, herbal, butterfly, kitchen/vegetable, indoor, foliage, seasonal flower, water, vertical, rock gardens.	
	6	Specialty Gardens – Medicinal, meditation, balcony, raised, and religious gardens.	
	7	Field Study – Visit a regional garden to study plant selection, seeds, fertilizers, and pest management.	
III	**Introduction to landscaping**		**10**
	8	Landscaping Scope & Importance – Key elements and designs.	
	9	Garden Plant Classification – Annuals, biennials, perennials, herbs, shrubs, trees, climbers, creepers, succulents, cacti, ferns, gymnosperms, palms, orchids, bulbous ornamentals.	
	10	Garden Features – Pergolas, topiary, hedges, edges, trellises, pathways, fountains.	
	11	Activity: Design and submit a landscape layout.	
IV	**Garden Accessories**		**5**
	12	Containers & Nursery Management – Portrays, pots, and container types.	
	13	Tools & Implements – Spades, rakes, shears, pruning saws, pole pruners, mowers, brush cutters, tillers.	
	14	Activity: Document and analyze various garden tools.	
V	**Gardening Practices**		**15**
	15	Pruning Techniques – Burlapping, crown thinning, crown raising, crown reduction, pinching, thinning, heading back.	
	16	Weeding & Maintenance – Methods and applications.	
	17	Nursery Management – Layout and structures (greenhouse, shade house, rain shelter, mist chamber, potting shed, composting shed).	
	18	Activity: Hands-on training in nursery setup and composting techniques.	

Practicals (30 hrs)

1. Visit to a local nursery.
2. Dissection and Study of Flowers
    a. Study of Different Types of Inflorescences
    b. Floral Symmetry
3. Identifying of important ornamental trees, shrubs, climbers and creepers, hedge and edge plants, ferns, cacti and succulents from a reputed nursery.
4. Identifying different garden tools.

References

1. Acquaah, J. (2009). *Horticulture: Principles and practices* (4th ed.). PHI Learning Pvt. Ltd.
2. Rao, M. K. (1991). *Textbook of horticulture*. Macmillan India Ltd.
3. Gangulee, H. C., & Kar, A. K. (2004). *College botany* (Vol. II). New Central Book Agency.
4. Sharma, V. K. (1999). *Encyclopaedia of practical horticulture* (Vols. I-IV). Deep and Deep Publications Pvt. Ltd.
5. Iyengar, G. S. (1990). *Complete gardening in India*. IBH, India.
6. Swarup, V. (n.d.). *Indoor gardening*. Indian Council of Agricultural Research (ICAR), New Delhi.
7. Nambison, K. M. P. (1992). *Design elements of landscape gardening*. Oxford & IBH Publications, New Delhi.
8. Pratibha, & Trivedi, P. (1990). *Beautiful shrubs*. ICAR, New Delhi.
9. Pratibha, & Trivedi, P. (1987). *Home gardening*. ICAR, New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental concepts of gardening, types of flowers, and principles of garden design, and analyze the role of a gardener.	U,An	1, 6
CO-2	Identify and classify different types of gardens, specialty gardens, and apply knowledge through field study and plant selection.	U, Ap	1, 6

CO -3	Analyze landscaping techniques, classification of garden plants, and garden features, and design a landscape layout.	An, C	2, 5
CO-4	Examine various garden tools, accessories, and nursery management practices and evaluate their role in efficient gardening.	U, E	3, 4
CO-5	Assess advanced gardening practices, including pruning, weeding, and nursery management, and develop hands-on skills in composting and nursery setup.	U,An	2, 4, 5

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

Name of the Course: ART OF CARDENING

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the fundamental concepts of gardening, types of flowers, and principles of garden design, and analyze the role of a gardener.	1, 2	1, 4	U,An	F, C	L
CO2	Identify and classify different types of gardens, specialty gardens, and apply knowledge through field study and plant selection.	2, 3	1, 2	U, Ap	C, P	L,P
CO3	Analyze landscaping techniques, classification of garden plants, and garden features, and design a landscape layout.	2, 5	2, 5	An, C	C, P	L,P
CO4	Examine various garden tools, accessories, and nursery management practices and evaluate their role in efficient gardening.	3, 6	3, 6	U, E	C, M	L
CO5	Assess advanced gardening	3, 7	3, 5,	An, C	C, M	L,P/T

	practices, including pruning, weeding, and nursery management, and develop hands-on skills in composting and nursery setup.		6			

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	Botany				
Course Code	MIUK2DSCBOT 151.1				
Course Title	GREEN INITIATIVES WITH FUTURE PERSPECTIVE				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Conscience on environmental protection and sustainable living.				
Course Summary	The course provides students with a comprehensive understanding of environmental challenges, sustainable development principles, and practical solutions for building a greener and more sustainable future.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction**	**5**
	1	Importance of green initiatives, sustainability concepts, historical context, sustainable development goals (SDGs), Triple Bottom Line, holistic sustainability principles and strategies.	
II		**Policies**	**6**
	2	Policy frameworks and governance: Role of government (funding, research, international cooperation), NGOs	

		(advocacy, monitoring, capacity building), cooperatives (community engagement, resource management). Environmental Impact Assessment (EIA) and its significance.	
III		**Green initiatives**	**10**
	3	Energy sector: Appliance upgrades, LED lighting, insulation, solar, wind, hydro, biomass energy (overview only).	
	4	Transportation: Electric vehicles (EVs), public transport, bicycle sharing, alternative fuels, walkability, urban green spaces.	
	5	Zero waste: 3Rs (Reduce, Reuse, Recycle), package-free stores, composting, reusable containers, zero-waste schools/businesses.	
IV		**Green building technology**	**9**
	6	Sustainable design: Passive design, net-zero buildings, biophilic design, green infrastructure, resilient design, healthy materials.	
	7	Green solutions: Living walls, green roofs, permeable pavements, urban forests (benefits overview).	
V		**Considerations**	**15**
	8	Challenges: Cost, awareness gaps, policy inconsistencies, infrastructure limitations, behavioral barriers, supply chain complexities, financial constraints.	
	9	Future perspectives: Low-carbon economy, carbon pricing, precision agriculture, biomimicry, regenerative design, circular economy, global collaboration.	
	10	Carbon footprint: Calculation and reduction strategies.	
	11	sustainable lifestyle changes.	

Practicals (30 hrs)

1 An institutional visit to Energy Management Cell (EMC), Sreekaryam, TVM

2 Collection and sorting and processing of waste, and production of biogas or biofuels.

3 Making use of knowledge obtained through syllabi, awareness campaigns to the builders, locals and school students

4 Convert organic waste such as weeds, plant parts etc. into useful products

5 Students can conduct a waste audit to quantify and categorize the types of waste generated by their colleges, university and community.

6 Students can participate in tree planting on road sides, industrial areas and urban areas.

References

1. Boyle, G. (2012). *Renewable energy: Power for a sustainable future*.
2. Klass, D. L. (1998). *Biomass for renewable energy, fuels, and chemicals*.
3. Black, W. R. (2010). *Sustainable transportation: Problems and solutions*.
4. Johnson, B. (2013). *Zero waste home: The ultimate guide to simplifying your life by reducing your waste*.
5. McDonough, W., & Braungart, M. (2002). *Cradle to cradle: Remaking the way we make things*.
6. Kraemer, C. (2007). *Recycling and waste management guide to the internet*.
7. Hootman, T. (2012). *Net zero energy design: A guide for commercial architecture*.
8. Toensmeier, E. (2016). *The carbon farming solution: A global toolkit of perennial crops and regenerative agriculture practices for climate change mitigation and food security*.
9. Lehmann, S. (2014). *The low-carbon city: Transforming urban systems*.
10. Allen, J. G., & Macomber, J. D. (2020). *Healthy buildings: How indoor spaces drive performance and productivity*.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain key sustainability concepts, SDGs, and the Triple Bottom Line.	U	1, 5
CO-2	Analyze policy frameworks, governance, and EIA in sustainability.	An	2, 6
CO -3	Evaluate green initiatives in energy, transport, and waste management.	E	1, 5, 6

CO-4	Assess green building technologies and eco-friendly infrastructure.	Ap	4, 6
CO-5	Identify challenges and propose future sustainability solutions.	C	3, 5, 7

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

Name of the Course: GREEN INITIATIVES WITH FUTURE PERSPECTIVE

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain key sustainability concepts, SDGs, and the Triple Bottom Line.	1, 3	1, 5	U	C	L
CO2	Analyze policy frameworks, governance, and EIA in sustainability.	2, 3	2, 6	An	C, P	L
CO3	Evaluate green initiatives in energy, transport, and waste management.	3, 5	1, 5, 6	E	P	L,P
CO4	Assess green building technologies and eco-friendly infrastructure.	3, 6	4, 6	Ap	P, C	L,P
CO5	Identify challenges and propose future sustainability solutions.	3, 5, 7	3, 5, 7	C	M	L/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	-	2	-	-	-	-	3	-	-	-	2	-	-
CO2	-	3	2	-	-	-	-	-	3	-	-	-	2	-
CO3	-	-	3	-	2	-	-	3	-	-	-	3	2	-
CO4	-	-	3	-	-	3	-	-	-	-	3	-	2	-
CO5	-	-	3	-	2	-	3	-	-	3	-	3	-	3

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	BOTANY				
Course Code	MIUK2MDCBOT 153.1				
Course Title	SUSTAINABLE TOURISM				
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
	3	3 hours	-	-	3
Pre-requisites	Ability to appreciate nature in all its form				
Course Summary	Aim to equip students with a comprehensive understanding of various aspects related to sustainable tourism.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Environmental science**	**8**
	1	Fundamentals of Ecology - Basic Laws & ideas in Ecology.	
	2	Function and Management of Ecosystem.	
	3	Ecological Succession Eco-regions; Vegetation types; Protected areas; Endemism and biodiversity hotspots.	
	4	Biodiversity and its Conservation-Pollution. Ecological Foot Prints. Relationship between Tourism & Ecology.	
	5	Activity: Nature walks or hikes to explore natural habitats, observe wildlife, and learn about the local flora and fauna.	

II	**Introduction to Sustainable Tourism**		**9**
	6	Definition-Concept of Sustainable tourism- Forces which promote Sustainable Tourism– Principles of Sustainable Tourism- Dimensions of Sustainable tourism– The steps involved in Sustainable tourism planning- The various approaches to sustainable tourism - Key sustainability themes in the built environment.	
	7	Threats and benefits of sustainable tourism. Resources and products of Sustainable tourism, Commercialization of Sustainable tourism.	
	8	Case Studies based on both private sector and public sector projects.	
	9	Sustainable tourism- Vistas- Agrotourism/ Farm tourism, ecotourism, Mass Tourism, Alternative Tourism, & Responsible Tourism.	
	10	Activity: Exploring rivers, lakes, or coastal areas to experience natural landscapes from a different perspective while minimizing disturbance to the environment and to report whether it is sustainable or not, if not suggestions.	
III	**Ecotourism**		**6**
	11	Evolution of ecotourism, Principles, Trends and Functions of Ecotourism, Mass Tourism Vs Ecotourism -Typology of Eco-tourists.	
	12	Sustainable Ecotourism - Resource Management, Socio-economic Development. Eco-friendly Facilities and Amenities - Carrying Capacity.	
	13	Present scenario, Future prospects (year-round ecotourism);	
	14	Sustainability of ecotourism; Ecotourism in developed countries.	
	15	Activity: Conduct tree planting and reforestation programmes in your locality with barcoding and continuous evaluation and protection.	
	Community participation		**7**

IV	16	Community based ecotourism: case studies; Joint Forest management, Role of NGOs.	
	17	Agencies Concerned with Ecotourism promotion - Role of agencies concerned with Ecotourism – International Ecotourism Society, UNWTO, UNDP, WWF - Department of Forest and Environment - Government of India, ATREE, EQUATIONS.	
	18	Ecotourism Activities and Impacts -Western Views of Ecotourism -Quebec Declaration 2002 - Kyoto Protocol 1997 - Oslo Declaration 2007	
	19	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.	
	20	**Activity:** Visit to a local village to engage with local communities and learn about their traditions, lifestyles, and conservation practices.	
V	**International Certification Programs in Sustainable Tourism and Economic Benefits**		**15**
	21	Green Key, Earth Check, Green Globe, The Global Sustainable Tourism Council (GSTC), Blue Flag	
	22	Life Cycle Assessment (LCA) in tourism- Goal and scope definition, inventory analysis, impact assessment, interpretation	
	23	Application of LCA in Different Areas of Tourism- Accommodation, Transportation, Tourism Activities and Experiences, Destination. Management Benefits of LCA in Tourism	
	24	Economic benefits of sustainable tourism- Job Creation, Diversification of Local Economies, Long-Term Economic Growth, Increased Local Spending, Preservation of Natural and Cultural Resources, Improved Infrastructure, Encouragement of Responsible Investment, Increased Tax	

		Revenue, Marketing of Local Culture and Products, Mitigation of Seasonal Fluctuations.	

References

1. Bramwell , B. and Lane , B. 1993 . Sustainable tourism: An evolving global approach Journal of Sustainable Tourism , 1 (1) : 1 – 5 .
2. Butler , R.W. 1999 . Sustainable tourism: A state of the art review . Tourism Geographies , 1 (1) : 7 – 25 .
3. Clarke , J. 1997 . A framework of approaches to sustainable tourism . Journal of Sustainable Tourism , 5 (3) : 224 – 233 .
4. Farrell , B. and Twining-Ward , L. 2005 . Seven steps towards sustainability: Tourism in the context of new knowledge . Journal of Sustainable Tourism , 13 (2) : 109 – 122
5. Hardy , A.L. and Beeton , R.J.S. 2001 . Sustainable tourism as maintainable tourism: Managing resources for more than average outcomes . Journal of Sustainable Tourism , 9 (3) : 168 – 192 .
6. Mowforth , M. and Munt , I. 2003 . Tourism and sustainability: Development and new tourism in the Third World , London : Routledge
7. Sustainable tourism value chain analysis as a tool to evaluate tourism's contribution to the sustainable development goals and local Indigenous.communities
8. Odeeth Lara-Morales and Amelia Clarke ., Published online: 30 Nov 2022
9. World Tourism Organization (WTO) . 1998 . Guide for local authorities on developing sustainable tourism , Madrid : World Tourism Organization
10. Gurung, H. B. (Ed.). (2018). Sustainable Tourism Practices in the Indian Himalayas. Springer.
11. Kumar, S. (2019). Sustainable Tourism Development in Kerala: A Study on Community Participation and Tourism Impacts. In Proceedings of the International Conference on Tourism Research (ICTR), pp. 183-189.
12. Mathew, K. J., & Sinha, S. (2018). Community-Based Sustainable Tourism Initiatives: A Case Study of Kumarakom in Kerala, India. In Sustainable Development and Biodiversity (pp. 355-365). Springer.
13. Pillai, S. K., & Sreekumar, T. T. (2016). Community Participation in Sustainable Tourism Development: A Study of Kerala. International Journal of Social Science and Economic Research, 1(11), 3799-3813.

14. Rajan, K. S. (2017). Impact of Sustainable Tourism Development on Local Livelihoods in Kerala: A Case Study of Kumarakom. Journal of Social and Economic Development, 19(2), 231-252.
15. Suresh, N. (2015). Community Participation in Sustainable Tourism Development: A Case Study of Thekkady, Kerala. In Sustainable Tourism: Challenges and Opportunities (pp. 207-221). Springer.
16. Thampi, B. V. (2014). Tourism and Environment: A Case Study of Sustainable Tourism in Kerala. IOSR Journal of Humanities and Social Science, 19(2), 52-57.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO 1	Understand the significance of ecosystem, biodiversity, threats to ecosystem and biodiversity and need for conservation.	U	1, 6
CO 2	Equips students with a comprehensive understanding of various aspects related to sustainable tourism.	U, Ap	6
CO 3	Student understand the cultural and social dimensions of tourism and learn how tourism can positively or negatively affect local communities, cultures, and traditions.	R, U	3
CO-4	Students get familiar with policies, regulations, and planning strategies aimed at promoting sustainable tourism development at local, national, and international levels.	U, E	1
CO 5	Apply sustainable principles to the different sectors of tourism	U, Ap	6

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

Name of the Course: SUSTAINABLE TOURISM

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the significance of ecosystem, biodiversity, threats to ecosystem and biodiversity and need for conservation.	3	1, 6	U	F	L
CO2	Equips students with a comprehensive understanding of various aspects related to sustainable tourism.	1	6	U, Ap	F, C	L/T
CO3	Student understand the cultural and social dimensions of tourism and learn how tourism can positively or negatively affect local communities, cultures, and traditions.	7	3	R, U	C, P	L/T
CO4	Students get familiar with policies, regulations, and planning strategies aimed at promoting sustainable tourism development at local, national, and international levels.	1	1	U, E	F	L
CO5	Apply sustainable principles to the different sectors of tourism	2	6	U, Ap	M	L

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	-	-	3	-	-	-	-	2	-	-	-	-	3	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	-	-	-	-	-	-	3	-	-	3	-	-	-	-
CO4	3	-	-	-	-	-	-	3	-	-	-	-	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-	-	3	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓		✓	✓

SEMESTER III

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK3DSCBOT 200.1**				
Course Title	**ANATOMY OF FLOWERING PLANTS**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Understanding of the basic principles of plant biology,				
Course Summary	This course help to analyze the structure and function of various parts of plants from cellular to systemic levels.				

Detailed Syllabus :

Module	Unit	Content	Hrs
I		**Tissues**	**5**
	1	Cell wall organization- gross structure, primary and secondary wall, pits, plasmodesmata, microscopic and submicroscopic structures, Extra cell wall material- lignin suberin, non-living inclusions of the cell. Meristems - Definition, Classification based on origin, position, growth patterns, functions. Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory	

	2	Organization of root apex in dicots & monocots.	
	3	Permanent tissues – definition, classification (Simple, Complex and Secretory tissues)	
II		**Tissue systems**	**5**
	4	Epidermal tissue systems-stomata - structure and functions – Types	
	5	Ground tissue systems	
	6	Vascular tissue systems	
	7	Activity- Photograph/ Drawings of Epidermal outgrowths of different plants.	
III		**Internal structure I**	**9**
	8	Primary Structure – Root, stem and leaf (Dicot & Monocot)	
	9	Activity- Document a) Different properties of wood (Nature, porosity, durability, colour, texture, industrial value) from nearby wood industry. b) Count the age of wood present in nearby wood mills	
IV		**Internal structure II**	**11**
	10	Secondary Structure- Formation and activity of cambial ring, Secondary vascular tissue, Periderm formation – lenticels , Annual rings, Heart wood and sap wood, hard wood and soft wood, tyloses, ring porous wood and diffuse porous wood	
	11	Secondary Thickening –Dicot stem, dicot root.	
	12	Activity- Collect and document herbs and shrubs that show secondary thickening	
V		**Anomalous Secondary Growth**	**15**
	13	Anomalous secondary thickening – *Bignonia, Boerhaavia*	
	14	Activity- Document the variation in secondary thickening amongst various ecotypes of *Bignonia, Boerhaavia*	

Practicals (30 hrs)

1. Non-living inclusions- cystoliths, raphids, sphaero-raphide (druses), aleurone garins, starch grains (eccentric, concentric, compound)
2. Simple permanent tissues- parenchyma, aerenchyma, collenchyma, chlorenchyma, sclerenchyma.
3. Primary structure- Dicot stem- *Centella*, Monocot stem- Grass
4. Internal structure- Dicot and Monocot leaf
5. Secondary structure – Stem (Normal type) – *Vernonia*
6. Secondary structure –Root (Normal type)- *Carica papaya*, Aerial root-*Ficus*
7. Anomalous secondary thickening – *Bignonia, Boerhaavia*
8. Epidermal structures- stomata- anomocytic, anisocytic, paracytic, diacytic and graminaceous

References

1. Cutler, D. F., Botha, T., & Stevenson, D. W. M. (2008). *Plant anatomy: An applied approach*. John Wiley & Sons Ltd.
2. Eames, A. J., & MacDaniels, L. H. (1947). *An introduction to plant anatomy* (2nd ed.).
3. Esau, K. (1965). *Plant anatomy*. Wiley Eastern.
4. Esau, K. (2006). *Anatomy of seed plants* (2nd ed.). Wiley Eastern.
5. Fahn, A. (1995). *Plant anatomy*. Elsevier Science and Technology.
6. Pandey, B. P. (1997). *Plant anatomy*. S. Chand & Co.
7. Pandey, B. P. (2012). *Plant anatomy*. S. Chand Publishing.
8. Roy, P. (2006). *Plant anatomy*. New Central Book Agency (P) Ltd.
9. Vashista, P. C. (1984). *Plant anatomy*. Pradeep Publications.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the structure, composition, and organization of plant cell walls and meristems.	R, U, An	1, 4
CO-2	Describe the classification and functions of plant tissue systems and analyze their structural	U, An	1, 2

	adaptations.		
CO -3	Compare the primary structures of roots, stems, and leaves in monocots and dicots and evaluate their functional differences.	An, E	1, 5
CO-4	Analyze secondary growth processes, including cambial activity, periderm formation, and annual ring development.	An, Ap, E	2, 6
CO-5	Assess anomalous secondary growth patterns and document variations among plant species.	An, C	3, 5, 6

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)
CO1	Explain the structure, composition, and organization of plant cell walls and meristems.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe the classification and functions of plant tissue systems and analyze their structural adaptations.	1, 6	1, 2	U, An	C, P	L
CO3	Compare the primary structures of roots, stems, and leaves in monocots and dicots and evaluate their functional differences.	2, 3	1, 5	An, E	C, P	L
CO4	Analyze secondary growth processes, including cambial activity, periderm formation, and annual ring development.	2, 5	2, 6	An, Ap, E	C, P	L,P
CO5	Assess anomalous secondary growth patterns and document variations among plant species.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK3DSCBOT 201.1**
Course Title	**REPRODUCTIVE BOTANY OF FLOWERING PLANTS AND MICROTECHNIQUES**
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
	4	3 hours	-	2 hours	5

Pre-requisites	Basic understanding of plant biology at the higher secondary school level.
Course Summary	Reproductive botany covers the study of plant reproduction, pollination, fertilization and seed development. Micro technique involves microscopic methods for studying plant structures and processes.

Detailed Syllabus :

Module	Unit	Content	Hrs
I		**Structural Organization of Flowers and Reproductive Structures**	**10**
	1	Anther and Palynology: Development, structure, and functions of the anther wall; microsporogenesis; structure and types of pollen grains; pollen wall organization; Male Germ Unit (MGU); NPC system; scope of palynology.	
	2	Ovule Development**:** Structure, types of ovules; megasporogenesis (tenuinucellate and crassinucellate); modes of	

		megagametogenesis (monosporic, bisporic, and tetrasporic); organization and ultrastructure of the mature embryo sac.	
II		**Pollination Mechanisms and Adaptations**	**8**
	3	Types of Pollination**:** Self-pollination vs. cross-pollination—significance, advantages, and disadvantages.	
	4	Pollination Adaptations: Entomophily, anemophily, hydrophily, zoophily (birds, squirrels, bats, and snails with one example each).	
	5	Contrivances to Cross-Pollination**:** Dicliny, self-sterility, dichogamy, heterostyly, and herkogamy (one example each).	
III		**Fertilization and Embryo Development**	**5**
	6	Fertilization Process: Pollen germination, pollen tube entry, double fertilization, and its significance.	
	7	Embryo and Endosperm Development: Structure of dicot and monocot embryos; types and functions of endosperm.	
	8	Polyembryony: Brief account and significance.	
IV		**Microtechniques – Tissue Processing and Sectioning**	**7**
	9	Introduction to Microtechniques: Fixation, killing agents, and dehydration (ethyl alcohol and other agents).	
	10	Sectioning Techniques: Hand sections, serial sections; microtome types (rotary, sledge—applications only).	
	11	Types of Micropreparations: Whole mount, maceration, smear, and squash techniques	
V		**Staining, Mounting, and Practical Applications**	**15**
	12	Staining Techniques: Principles of staining; types of stains (safranin, hematoxylin, fast green, acetocarmine); vital stains and mordants (examples).	
	13	Types of Staining: Single and double staining methods.	
	14	Mounting and Media: Semi-permanent (glycerine) and permanent (DPX, Canada balsam).	
	15	Practical Applications: Preparation of stained sections and micropreparations.	

Practicals (30 hrs)

1. Dissection and display of floral structures from different flower types.
2. Identification of cross-sections of anther, embryo sac, and embryo.
3. Study of different ovule types.
4. Hands-on experience with fixatives, stains, and mounting media.
5. Demonstration of smear and squash techniques.
6. Microtome sectioning (demonstration only).
7. Preparation of single-stained hand sections (permanent demonstration).

References

1. Bhojwani, S. S., & Bhatnagar, S. P. (2019). *The Embryology of Angiosperms* (6th ed.). Vikas Publishing House.
2. Eames, A. J. (1961). *Morphology of the Angiosperms*. McGraw-Hill.
3. Johri, B. M. (1984). *Embryology of Angiosperms*. Springer.
4. Maheshwari, P. (1950). *An Introduction to the Embryology of Angiosperms*. McGraw-Hill.
5. Raghavan, V. (2006). *Double Fertilization: Embryo and Endosperm Development in Flowering Plants*. Springer.
6. Shivanna, K. R., & Rangaswamy, N. S. (1992). *Pollen Biology: A Laboratory Manual*. Springer.
7. Sass, J. E. (1951). *Botanical Microtechnique* (2nd ed.). Iowa State University Press.
8. Johansen, D. A. (1940). *Plant Microtechnique*. McGraw-Hill.
9. Krishnamurthy, K. V. (1988). *Methods in Plant Histochemistry*. S. Viswanathan Printers & Publishers.
10. Yeung, E. C. T., Stasolla, C., Sumner, M. J., & Huang, B. Q. (2015). *Plant Microtechniques and Protocols*. Springer.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the structural organization of floral organs and reproductive structures in angiosperms.	U	1, 4
CO-2	Describe the processes of microsporogenesis, megasporogenesis, pollination, and fertilization in	U	1, 2

	flowering plants.		
CO -3	Analyze pollination mechanisms, adaptations, and their ecological significance.	An	2, 5
CO-4	Demonstrate knowledge of micro techniques, including sectioning, staining, and mounting methods.	Ap	4,7
CO-5	Design and prepare microscopic slides of reproductive structures using appropriate micro techniques.	C	4, 7

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

Name of the Course: REPRODUCTIVE BOTANY OF FLOWERING PLANTS AND MICROTECHNIQUES

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

CO No.	**CO**	**PO**	**PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L) /Tutorial (T)/ Practical (P)**
CO1	Explain the structural organization of floral organs and reproductive structures in angiosperms.	1	1, 4	U	C	L
CO2	Describe the processes of microsporogenesis, megasporogenesis, pollination, and fertilization in flowering plants.	1, 2	1, 2	U	C	L
CO3	Analyze pollination mechanisms, adaptations, and their ecological significance.	2, 3	2, 5	An	C, P	L
CO4	Demonstrate knowledge of microtechniques, including sectioning, staining, and mounting methods.	4,6	4,7	Ap	P	L,P/T
CO5	Design and prepare microscopic slides of reproductive structures using appropriate microtechniques.	5,6	4, 7	C	P, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	-	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	2	-	-	-	-	-	3	2	-	-	-	-	-
CO3	-	3	3	-	-	-	-	-	3	-	-	2	-	-
CO4	-	-	-	3	-	2	-	-	-	-	3	-	-	3
CO5	-	-	-	-	3	3	-	-	-	-	3	-	-	3

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓		✓	✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK3DSCBOT 202.1**				
Course Title	**PLANT LIFE: DIVERSITY, EVOLUTION, AND ECOLOGICAL SIGNIFICANCE**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Students require foundational knowledge in plant biology.				
Course Summary	Course aims to provide an in-depth understanding of the diversity, evolution, morphology, and ecological significance of plants.				

Detailed Syllabus

Module	Unit	Content	Hrs
I		**Introduction to Plant Diversity**	**6**
	1	Overview of Plant Kingdom, Classification and hierarchy of plant groups, Importance of plants in ecology, economy, and human welfare	
	2	Plant Evolution, Origin of plants from algae, Major evolutionary transitions: aquatic to terrestrial life, development of vascular tissues, seed evolution, and flowering plants	
		Algae and Bryophytes	**8**

II	3	Introduction to Algae- Definition, classification, and types of algae (Green, Red, Brown), Importance of algae in ecosystems and human use	
	4	Morphology and Physiology of Algae- Structure of algae: thallus, pigments, cell wall, Reproduction in algae: vegetative, asexual, and sexual	
	5	Introduction to Bryophytes-Characteristics of bryophytes: non-vascular, small, and simple, Classification of bryophytes: liverworts, hornworts and mosses.	
	6	Reproduction and Life Cycle of Bryophytes- Gametophytic and sporophytic generation, Role of water in reproduction.	
III		**Pteridophytes and Gymnosperms**	**9**
	7	Introduction to Pteridophytes- Characteristics: vascular tissues, seedless reproduction, Types: club mosses, horsetails and ferns.	
	8	Life Cycle of Pteridophytes-Alternation of generation, Structure and function of sporangia and sori	
	9	Introduction to Gymnosperms- Characteristics: seed producing, vascular plants, exposed seeds, Major groups: Cycads, Conifers, Ginkgos, and Gnetophytes.	
	10	Reproduction in Gymnosperms- Structure of cones: male and female cones, Pollination and fertilization in gymnosperms	
IV		**Angiosperms**	**7**
	11	Introduction to Angiosperms- Definition and characteristics of flowering plants, Classification and diversity of angiosperms: monocots vs. dicots	
	12	Morphology of Angiosperms-Structure of flowers, fruits, and seeds, Pollination mechanisms (wind, insect, bird, water)	
	13	Economic and Ecological Importance of Angiosperms- Role in agriculture, medicine, and ecosystem functioning	
V		**Ecological significance, conservation of plants**	**15**
	14	Comparative Anatomy-Differences and similarities in plant	

		structures: roots, stems, leaves, Vascular tissue and its evolution across plant groups	
	15	Evolution of Plant Reproductive Structures- Comparison of reproduction in algae, bryophytes, pteridophytes, gymnosperms, and angiosperms	
	16	Role of Plants in Ecosystems-Plants as primary producers and their role in food chains, Plants in carbon cycling and oxygen production	
	17	Adaptations to Different Environments- Xerophytic, hydrophytic, and mesophytic adaptations, Ecological niches of different plant groups	
	18	Threats to Plant Diversity- Habitat destruction, climate change, invasive species, Overexploitation and its impact on plant populations.	
	19	Conservation Strategies-Protected areas, *ex situ* conservation (seed banks, botanical gardens), Role of sustainable agriculture and forestry in plant conservation	

Practicals (30 hrs)

1. Algae Identification and Study
    - Observing and identifying algal specimens belonging to green, brown and red algal groups
2. Bryophyte Study
    - Observation of gametophyte and sporophyte generations of bryophytes
    - Study of their morphology and reproductive structures
3. Pteridophyte Study
    - Collection and identification of fern species
    - Study of sori, sporangia, and reproductive structures
    - Dissection of fern fronds and other parts to observe internal vascular tissues
4. Gymnosperms Study
    - Collection and identification of conifers and other gymnosperms
    - Study of male and female cones
5. Angiosperm Study

- Flower dissection to study reproductive organs (anthers, pistils)
- Identification of monocots and dicots using leaf venation and anatomy

6.Ecological Studies

- Study of plant adaptations in different ecosystems (forest, desert, aquatic)

7. Plant Conservation

- Visit to a botanical garden or conservation area to observe endangered plant species

References

1. Pandey, S. N., & Chadha, A. (1993). *A textbook of botany (Vol. III).* Vikas Publishing House.
2. Crawley, M. J. (Ed.). (2009). *Plant ecology.* John Wiley & Sons.
3. Kochhar, S. L. (2016). *Economic botany.* Cambridge University Press.
4. Bharucha, E. (2002). *The biodiversity of India (Vol. 2).* Mapin Publishing Pvt Ltd.
5. Sivarajan, V. V. (1991). *Introduction to the principles of plant taxonomy.* Oxford & IBH Publishing.
6. Mallick, P., & Chatterjee, S. (2024). *Textbook of algae.* Techsar Pvt. Ltd.
7. Parihar, N. S. (1977). *An introduction to pteridophytes.* Central Book Depot.
8. Balakrishnan, N. P., Chakrabarty, T., Sanjappa, M., Lakshminarasimhan, P., & Singh, P. (2012). *Flora of India (Vol. 23, pp. 193-194).* Botanical Survey of India.
9. Chaffey, N. (2014, May 8). *Raven biology of plants* (8th ed.). In R. F. Evert & S. E. Eichhorn (Eds.), WH Freeman/Palgrave Macmillan.
10. Shaw, A. J., & Goffinet, B. (Eds.). (2000). *Bryophyte biology.* Cambridge University Press.
11. Mauseth, J. D. (2014). *Botany: An introduction to plant biology.* Jones & Bartlett Publishers.
12. Graham, L. E., Graham, J. M., & Wilcox, L. W. (2020). *Plant biology.* Prentice Hall.
13. Willis, K. J., & McElwain, J. C. (2014). *The evolution of plants.* Oxford University Press.

Course Outcomes

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

CO-1	Understand and classify the major plant groups and their evolutionary significance	1, 4	U, An
CO-2	Analyze plant morphology across diverse plant groups	1, 2	An, E
CO -3	Apply ecological principles to understand the role of plants in ecosystems	2, 5	Ap, An
CO-4	Understand the importance of plant conservation and biodiversity	3, 6	U, E
CO-5	Conduct practical experiments and fieldwork to study plant diversity	3, 5, 6	Ap, C

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

Name of the Course: PLANT LIFE: DIVERSITY, EVOLUTION, AND ECOLOGICAL SIGNIFICANCE

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand and classify the major plant groups and their evolutionary significance.	1, 2	1, 4	U, An	F, C	L/T
CO2	Analyze plant morphology across diverse plant groups.	2, 3	1, 2	An, E	C, P	L/P
CO3	Apply ecological principles to understand the role of plants in ecosystems.	3, 5	2, 5	Ap, An	C, P	L/P
CO4	Understand the importance of plant conservation and biodiversity.	2, 6	3, 6	U, E	C, M	L/P
CO5	Conduct practical experiments and fieldwork to study plant diversity.	3, 7	3, 5, 6	Ap, C	P, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	-	3	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓	✓	✓	✓

Discipline	**Botany**				
Course Code	**MIUK3DSCBOT 203.1**				
Course Title	**PLANT PATHOLOGY AND DEFENSE MECHANISM**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Awareness about diseases in plants				
Course Summary	This course provides an in-depth exploration of plant-pathogen interactions, defense mechanisms and pathogen virulence, and advanced techniques in disease diagnosis and management.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to plant pathology**	**5**
	1	Importance, definition and concepts of plant pathology, History and growth of plant pathology, biotic and abiotic causes of plant diseases.	
	2	Growth, reproduction , survival and dispersal of important plant pathogens, role of environment and host nutrition on plant diseases.	
	3	Host-Pathogen interaction, recognition, concept and infection, symptomology, disease development- role of enzymes, toxins, growth, defense strategies, phenolic, phytoalexins, Pr proteins, Elicitors, Altered plant metabolism as affected by plant pathogen	
	4	Prevenntion and control of plant diseases-Role of Quarentine	

II		**Ecology of Plant pathogens**	**10**
	5.	Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, host exudates, soil and root inhabiting fungi, bacteria, actinomycetes.	
	6	History of plant viruses, shape, size, composition, structure and physical properties of viruses. Symptomatology of important plant viral diseases, transmission, virus vector relationship. Mechanism of resistance and management of plant viruses.	
	7	History and introduction to phyto-pathogenic bacteria and other fastidious prokaryotes. Importance of phyto-pathogenic bacteria	
	8	Fungal flora that causes plant diseases.(Any two types)	
	9	Activity:- study any one common plant disease caused by bacteria, virus, fungus, their symptoms and control measures.	
III		**Disease resistance in plants**	**5**
	10	Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centers as sources of resistance.	
	11	Disease escapes, disease tolerance, disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.	
	12	Host defense system, morphological and anatomical resistance, preformed chemicals in host defense, post inflectional chemicals in host defense, phytoalexins, hypersensitivity and its mechanisms.	
	13	Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.	
IV		**Post harvest diseases**	**10**
	14	Concept of post harvest diseases, definitions, importance with	

		reference to environment and health.	
	15	Types of post harvest problems both by biotic and abiotic causes.	
	16	Integrated approach in controlling diseases and improving the shelf life of produce with special reference to mycotoxicogenic fungi, knowledge of Codex Alimentarious	
	17	Factors governing post harvest problems both as biotic and abiotic, role of physical environment, agro-ecosystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens, pathogens and antagonist and their relationship, role of bio-control agents and chemicals in controlling post-harvest diseases.	
V		**Biological control of plant diseases**	**15**
	18	Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.	
	19	Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control	
	20	Preparation of biopesticides, Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents.	

Practicals (30 hrs)

1. Identification of plant diseases by examining symptomatic plant samples and herbarium specimens.

2. Preparation of fungicides mentioned in the syllabus.
3. Evaluate different disease management strategies through field or greenhouse trials.
4. Test the efficacy of chemical, biological, and cultural control methods on disease incidence and severity.

References

1. Mehrotra, R. S., & Aggarwal, A. (2007). *Plant pathology* (3rd ed.). McGraw-Hill Education.
2. Rai, J. P., & Singh, A. K. (2014). *Plant diseases: Identification and management*.
3. Schumann, G. (1991). *Plant diseases: Their biology and social impact*.
4. Agrios, G. N. (1997). *Plant pathology* (4th ed.). Academic Press.
5. Sharma, P. D. (2011). *Plant pathology*. Rastogi Publications..

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the principles, history, and concepts of plant pathology and analyze host-pathogen interactions.	R, U, An	1, 4
CO-2	Describe the ecology of plant pathogens and evaluate their role in disease development and plant health.	U, An, E	1, 2
CO -3	Analyze mechanisms of disease resistance in plants and assess strategies for resistance management.	An, E	1, 5
CO-4	Examine post-harvest diseases, their causes, and apply integrated management strategies for disease control.	U, Ap, E	2, 6
CO-5	Assess biological control methods in plant disease management and develop strategies for biopesticide production and application.	An, C	3, 5, 6

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

Name of the Course: **PLANT PATHOLOGY 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)
CO1	Explain the principles, history, and concepts of plant pathology and analyze host-pathogen interactions.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe the ecology of plant pathogens and evaluate their role in disease development and plant health.	1, 6	1, 2	U, An, E	C, P	L
CO3	Analyze mechanisms of disease resistance in plants and assess strategies for resistance management.	2, 3	1, 5	An, E	C, P	L
CO4	Examine post-harvest diseases, their causes, and apply integrated management strategies for disease control.	2, 5	2, 6	U, Ap, E	C, P	L,P
CO5	Assess biological control methods in plant disease management and develop strategies for biopesticide production and application.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓		✓	✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK3DSCBOT 204.1**
Course Title	**BIODIVERSITY CONSERVATION AND DISASTER MANAGEMENT**
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
	4	3 hours	-	2 hours	5

Pre-requisites	Curiosity to know the management practices in conservation and during disaster
Course Summary	The course aims to foster an appreciation for the beauty and value of the natural world and inspire students to become stewards of biodiversity in their personal and professional lives. Students learn methods for assessing and mitigating risks associated with different types of disasters. The course covers the strategies for preparing individuals, communities, and organizations to effectively respond to disasters.

Detailed Syllabus:

Module	Unit	Content	Hrs
		Biodiversity	**10**
	1	Importance of Biodiversity, levels of biodiversity- species, genetic and ecosystem diversity, threats to biodiversity- habitat loss and fragmentation, exotic species, Man and wild	

I		life conflict, overexploitation, IUCN categories of threaten species	
	2	IUCN, Red data Book; Extinct and Threatened species-endangered, Rare; Endangered and endemic plant species of India.	
	3	Ramsar sites, Terrestrial and marine hotspots of biodiversity; hotspots of biodiversity in India.	
II		**Conservation of biodiversity**	**7**
	4	Principles and importance of conservation biology; In- situ conservation of biodiversity sanctuaries, national parks, sacred groves ,biosphere reserves	
	5.	Ex-situ conservation of biodiversity: Principles and practices, field gene banks, seed banks and cryopreservation	
	6	Approaches for biodiversity conservation: tropical forests, wetlands and aquatic ecosystems	
	7	Activity – Visit to a research institution and submit a report	
III		**Conservation Practices in India and World**	**6**
	8	Biodiversity convention. International and national efforts to conserve biodiversity. Socio-cultural aspects of biodiversity. Aichi Biodiversity targets, Biotechnological needs for biodiversity conservation. Traditional knowledge and biodiversity conservation.	
	9	Organizations involved in conservation IUCN, WWF, UNEP, UNESCO, General account on activities of DBT, BSI, NBPGR, Biodiversity register.	
	10	Stockholm Conference, Montreal Protocol, CITES, Biodiversity policy and legislation.	
		Disaster Management	**7**
	11	Introduction, Definition and terminologies; scope and concept of disaster management.	
	12	Disaster- Types of Disaster- Natural & anthropogenic	
	13	Natural and Environmental disasters-a brief description of the	

IV		following disasters- Earth quake, flood, coastal disasters, landslides, tsunami (role of mangroves in controlling tsunami disaster), cyclone, dam collapse, nuclear disaster, chemical , disaster, biological disaster..	
	14	Disaster management – four phases – mitigation, preparedness, responses, recovery. Emergency procedures and warning systems, application of GIS	
	15	Activity- Visit to an affected area	
V		**Mitigation efforts**	**15**
	16	UN draft resolution on Strengthening of Coordination of Humanitarian Emergency Assistance	
	17	Role and responsibilities of various agencies and mitigation strategies.	
	18	Regulation/guidelines for disaster tolerance building structure	
	19	Rehabilitation Work, Constraints in Monitoring and Evaluation	
	20	Education and Training in Health Management of Disasters	

Practicals (30 hrs)

1. Field Survey of college campus for studying plant species diversity.
2. *Ex- situ* conservation of plant species using *in vitro* technique.
3. Microproagation of an endangered plant species.
4. Green pod (embryo) culture of orchids.
5. Prepare a report on case studies of natural hazards in India
6. .Visit to a nearby botanical garden or other relevant sites and submit a report .
7. Study of plant density by quadrant method.

References

1. Bolt, B. A. (1988). *Earthquakes*. W. H. Freeman and Company.
2. Carter, N. W. (1992). *Disaster management: A disaster manager's handbook*. Asian Development Bank.
3. Chandel, K. P. S., Shukla, G., & Sharma, N. (1996). *Biodiversity in medicinal and aromatic plants in India: Conservation and utilization*. National Bureau of Plant Genetic Resources.

4. Council of Scientific and Industrial Research. (1986). *The useful plants of India*. Publication and Information Directorate, CSIR.
5. Gautam, A. (1994). *Earthquake: A natural disaster*. Ashok Publishing House.
6. Nair, M. N. B., et al. (Eds.). (1998). *Sustainable management of non-wood forest products*. Faculty of Forestry, University Putra Malaysia.
7. Sahni, P., & Malagola, M. (Eds.). (2003). *Disaster risk reduction in South Asia*. Prentice-Hall of India.
8. Sharma, V. K. (Ed.). (1995). *Disaster management*. IIPA.
9. Singh, J. S., Singh, S. P., & Gupta, S. R. (2006). *Ecology, environment and resource conservation*. Anamaya Publishers.
10. Singh, T. (2006). *Disaster management: Approaches and strategies*. Akansha Publishing House.
11. Sinha, D. K. (2006). *Towards basics of natural disaster reduction*. Research Book Centre.
12. Smith, K. (2001). *Environmental health: Assessing risk and reduction disaster* (3rd ed.). Routledge.
13. Soule, M. E. (Ed.). (1986). *Conservation biology: The science of scarcity and diversity*. Sinauer Associates.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the levels of biodiversity, threats, and conservation priorities and analyze endangered species and biodiversity hotspots.	R, U, An	1, 4
CO-2	Describe conservation approaches and evaluate the role of in-situ and ex-situ conservation strategies in biodiversity management.	U, An, E	1, 2
CO -3	Analyze global and national conservation efforts and assess policy frameworks, international conventions, and traditional knowledge for biodiversity protection.	An, E	1, 5

CO-4	Examine types of disasters, their environmental impact, and apply mitigation and preparedness strategies for disaster management.	U, Ap, E	2, 6
CO-5	Assess disaster response and rehabilitation efforts and develop mitigation strategies for sustainable environmental management.	An, C	3, 5, 6

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

Name of the Course: BIODIVERSITY CONSERVATION AND DISASTER MANAGEMENT

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the levels of biodiversity, threats, and conservation priorities and analyze endangered species and biodiversity hotspots.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe conservation approaches and evaluate the role of in-situ and ex-situ conservation strategies in biodiversity management.	1, 6	1, 2	U, An, E	C, P	L
CO3	Analyze global and national conservation efforts and assess policy frameworks, international conventions, and traditional knowledge for biodiversity protection.	2, 3	1, 5	An, E	C, P	L
CO4	Examine types of disasters, their environmental impact, and apply mitigation and preparedness strategies for disaster management.	2, 5	2, 6	U, Ap, E	C, P	L,P/T
CO5	Assess disaster response and rehabilitation efforts and develop	3, 7	3, 5, 6	An, C	C, M	L,P/T

	mitigation strategies for sustainable environmental management.					

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK3DSEBOT 200.1**
Course Title	**MICROTECHNIQUE AND BIOPHYSICS**
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
	4	3 hours	-	2 hours	5

Pre-requisites	Basic knowledge in instrumentation
Course Summary	Understanding the interdisciplinary relationship between physical and biological sciences. Ability to identify and work on different instruments and understand different separation techniques.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to microtechnique**	**9**
	1	Microscopic techniques - simple and compound microscope– phase contrast; dark field illumination and electron microscopes (SEM and TEM). Micrometry	
II		**Specimen preparation**	**7**
	2.	Killing and fixation agents – Carnoy's formula, Farmers formula, FAA.	
	3.	Dehydration – reagents.	

	4.	Sectioning - hand and microtome– rotary and sledge.	
	5.	Stains and staining techniques - double staining. General account; Stains: safranin, haematoxylin, acetocarmine.	
	6.	Mounting media - DPX and Canada balsam.	
	7.	Whole mounts - cytological methods: maceration, smear and squash preparation	
III		**Introduction to Biophysics**	**4**
	8.	Principles and applications of Colorimeter, Spectrophotometer (UV-Visible)- Principle, -Working and uses	
IV		**Biophysical techniques**	**10**
	9.	Centrifugation: Principle, types of centrifuges, types of rotors (swinging bucket, fixed angle), Density gradient and Differential centrifugation. Applications	
	10.	Basic knowledge of the separation methods: -Chromatography (Column chromatography, paper chromatography and TLC), Electrophoresis (PAGE and AGE).	
	11.	Principles and applications of pH meter, measurement of pH	
V		**Applications**	**15**
	12	Overview of microtechnique, historical perspective, importance in various fields.	
	13	Micrometry, Camera lucida	
	14	Cryobiology–cryopreservation, freeze drying(lyophilisation) and its applications.	
	15	Applications of Microtechnique- Medical diagnostics, Biomedical research, material science and Forensic science.	
	16	Applications of Biophysics- Biophysical methods in drug discovery and development ; medical diagnostic and imaging, emerging trends and future directions in biophysics research	

Practicals (30 hrs)

1. Familiarize stains, fixatives and mounting media
2. General awareness of Micro technique - maceration, smears &squash

3. Demonstration of microtome sectioning and hand sectioning
4. Measurement of specimens using micrometer
5. Photomicrography and Camera lucida drawings (Demonstration only).
6. Preparation of solutions of known concentrations using pure samples and stock solutions.
7. Separation of plant pigments by paper chromatography/TLC.
8. Preparation of buffer.
9. Measurement of pH.
10. Construct the absorption spectrum of any sample

References

1. DonaldA.Johansen (1940) Plant Microtechnique- Mac Graw Hill Book company
2. Elizabeth Allman (2004). Mathematical Methods in Biology, Cambridge University Press India Pvt. Ltd
3. Gieryn T.F. (1999). Cultural Boundaries of Science, Univer. Chicago Press.
4. Newton RG (2000) The truth of Science, 2nd edition, Harward University Press
5. Pattabhi V & Gautham N (2011). Biophysics, Narosa publishers
6. Peter Grey (2018) Hand book of microtechnique-Mac Graw Hill Bookcompany
7. Prasad and Prasad (1972). Outlines of Botanical Microtechnique, Emkay publishers ,Delhi
8. Willard H. H., J .A. Dean, L. L. Merritt and F. A. Settle (2011) Instrumental
9. methods of analysis, CBS Publishers and Distributors N. Delhi DonaldA.Johansen (1940) Plant Microtechnique- Mac Graw Hill Book company

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the principles and working mechanisms of microscopic techniques and analyze their applications in biological research.	R, U, An	1, 4
CO-2	Describe specimen preparation techniques and apply staining and sectioning methods for microscopic analysis.	U, Ap, An	1, 2
CO -3	Understand the principles of biophysics and evaluate its role in spectrophotometry and colorimetry applications.	U, An, E	1, 5
CO-4	Analyze the principles and applications of separation techniques such as centrifugation, chromatography, and electrophoresis.	An, Ap, E	2, 6
CO-5	Assess the applications of microtechnique and biophysics in medical diagnostics, research, and forensic sciences and develop innovative approaches for their use.	An, C	3, 5, 6

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

Name of the Course: MICROTECHNIQUE AND BIOPHYSICS

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the principles and working mechanisms of microscopic techniques and analyze their applications in biological research.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe specimen preparation techniques and apply staining and	1, 6	1, 2	U, Ap, An	C, P	L/P

	sectioning methods for microscopic analysis.					
CO3	Understand the principles of biophysics and evaluate its role in spectrophotometry and colorimetry applications.	2, 3	1, 5	U, An, E	C, P	L
CO4	Analyze the principles and applications of separation techniques such as centrifugation, chromatography, and electrophoresis.	2, 5	2, 6	An, Ap, E	C, P	L,P/T
CO5	Assess the applications of microtechnique and biophysics in medical diagnostics, research, and forensic sciences and develop innovative approaches for their use.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓			✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK3DSEBOT 201.1**				
Course Title	**ECONOMIC BOTANY 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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic understanding of plant sciences and an interest in ethnobotany and economic botany.				
Course Summary	This course provides an overview of the economic importance of plants, their role in traditional and modern medicine, and their cultural significance. It also covers ethnobotany, with a focus on indigenous knowledge systems in Kerala, and the role of plants in various industries. Additionally, the course explores Intellectual Property Rights (IPR) in relation to plant genetic resources, patents, and traditional knowledge protection.				

Detailed Syllabus :

Module	Unit	Content	Hrs
I		**Introduction to Ethnobotany and Economic Botany**	**8**
	1	Ethnobotany and Indigenous Knowledge- Concept, scope, and objectives of ethnobotany. Ethnobotany of indigenous communities in Kerala: *Kani, Kurumbar, Kurichiya* Methods for collecting ethnobotanical data (brief overview)	

	2	Role of Ethnobotany in Modern Medicine
		• Ethnobotanical plants and their medicinal uses along with habitat and morphology:
		  ○ *Curculigo orchioides*
		  ○ *Emilia sonchifolia*
		  ○ *Vitex negundo*
		  ○ *Gloriosa superba*
		  ○ *Pongamia pinnata*
		  ○ *Biophytum sensitivum*
		• Role of ethnobotany in modern medicine with special examples:
		  ○ *Rauvolfia serpentina*
		  ○ *Trichopus zeylanicus* (*Jeevani*)	

II	**Origin of Cultivated Plants and Economic Uses of Plants**		**8**
	3	Crop Domestication and Evolution • Vavilov's Concept of Centers of Origin of cultivated crop plants • Introduction to domestication and evolution of new crop varieties: Rice, Wheat, and Potato	
	4	Role of Plants in the Environment and Society • Air purification (Photosynthesis) • Plants in rituals and festivals • Pollution removal: Phytoremediation and its types • Pollution indicators: Lichens • Nutrient source: Litter manure	
III	**Food Crops and Cash Crops**		**8**
	5	Major Food Crops • Cereals: Wheat & Rice (with special reference to indigenous rice varieties: Pokkali, Navara, Jeerakasala) • Millets: Ragi, Jowar, Bajra (nutritional importance) • Legumes: Chickpea, Pigeon pea	

	6	Commercially Important Plants
		• Narcotics: Poppy, Cannabis
		• Masticatory Plants: Areca nut, Tobacco
		• Cash Crops:
		  ○ Beverages: Tea (*Morphology, uses, and processing*)
		  ○ Natural Rubber: (*Morphology, tapping, and processing*)	

IV	**Medicinal Plants and Phytochemicals**		**6**

	7	Traditional and Herbal Medicine
		• Plant-based medicinal systems: Ayurveda, Siddha, Unani, and Folk Medicine
		• Herbal Basket (Botanical source, part used, and medicinal properties):
		  ○ *Ocimum sanctum*
		  ○ *Adhatoda vasica*
		  ○ *Zingiber officinale*
		  ○ *Curcuma longa*
		  ○ *Aloe vera*
		  ○ *Andrographis paniculata*
		  ○ *Coleus forskohlii*
		  ○ *Acorus calamus*
		  ○ *Boerhavia diffusa*
		  ○ *Oldenlandia corymbosa*	

	8	**Phytochemicals and Active Principles**
		• Nature of active compounds from:
		  ○ *Rauwolfia* (Alkaloids)
		  ○ *Cinchona* (Quinine)
		  ○ *Vinca* (Vinblastine, Vincristine)	

V	**Lower Plants in Economic Botany and Intellectual Property Rights (IPR)**		**15**
	9	Economic Importance of Lower Plants • Algae: *Ulva, Codium* (Food), *Chondrus*	

		(Carrageenan - gelling agent) • Fungi: *Agaricus, Lycoperdon, Morchella*	
	10	Intellectual Property Rights (IPR) and Plant Genetic Resources • Concept of IPR in plant sciences • Patents, Traditional Knowledge, and Biopiracy Case studies of IPR and plant genetic resources	

Practicals (30 hrs)

1. Ethnobotany and Indigenous Knowledge
    - Field visit to study ethnobotanical practices of indigenous communities (Kani, Kurumbar, Kurichiya).
    - Survey and documentation of medicinal plants used in local traditions.
    - Hands-on training in methods of ethnobotanical data collection (interviews, herbarium preparation).
2. Economic Importance of Plants
    - Identification and morphological study of major food crops (Wheat, Rice, Millets, Legumes).
    - Analysis of nutritional content in selected cereals and legumes.
    - Processing and extraction of active principles from medicinal plants (*Curcuma longa*, *Aloe vera*, *Rauvolfia serpentina*).
3. Phytochemistry and Medicinal Plants
    - Extraction of alkaloids from *Rauvolfia serpentina* and *Cinchona*.
    - Study of essential oils from *Ocimum sanctum* and *Zingiber officinale*.
    - Microscopic examination of plant tissues used in medicine (*Acorus calamus*, *Andrographis paniculata*).
4. Lower Plants in Economic Botany
    - Identification of economically important algae (*Ulva, Codium, Chondrus*).
    - Study of fungi used in food and industry (*Agaricus, Lycoperdon, Morchella*).
    - Extraction of carrageenan from *Chondrus crispus*.
5. Intellectual Property Rights (IPR) and Plant Genetic Resources
    - Case study on patents and biopiracy related to medicinal plants.
    - Workshop on plant variety protection and IPR laws.

- Study of plant-based patents using publicly available patent databases.

References

1. Bell, A. D., & Bryan, A. (2009). *Plant form: An illustrated guide to flowering plant morphology*. Timber Press.
2. Cutler, D. F., Botha, T., & Stevenson, D. W. M. (2008). *Plant anatomy: An applied approach*. John Wiley & Sons Ltd.
3. Eames, A. J., & MacDaniels, L. H. (1947). *An introduction to plant anatomy* (2nd ed.). McGraw Hill.
4. Esau, K. (1965). *Plant anatomy*. Wiley Eastern.
5. Esau, K. (2006). *Anatomy of seed plants* (2nd ed.). Wiley Eastern.
6. Fahn, A. (1995). *Plant anatomy*. Elsevier Science and Technology.
7. Pandey, B. P. (2012). *Plant anatomy*. S Chand Publishing.
8. Pandey, B. P. (2017). *Plant morphology*. S Chand Publishing.
9. Roy, P. (2006). *Plant anatomy*. New Central Book Agency (P) Ltd.
10. Simpson, B. B., & Ogorzaly, M. C. (2001). *Economic botany: Plants in our world* (3rd ed.). McGraw-Hill.
11. Schultes, R. E., & von Reis, S. (1995). *Ethnobotany: Evolution of a discipline*. Timber Press.
12. Kumar, N., & Janardhanan, K. (2019). *Intellectual property rights: Protection and management of traditional knowledge*. Springer.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Define ethnobotany, its scope, and its role in indigenous knowledge and modern medicine.	U	1, 5
CO-2	Explain the origin, domestication, and economic significance of cultivated plants.	U, E	2, 6
CO -3	Describe major food, cash, and medicinal crops, including their uses and processing.	U, E	1, 5, 6
CO-4	Assess the economic importance of lower plants in	C, An	4, 6

	food, medicine, and industry.		
CO-5	Understand Intellectual Property Rights (IPR) and their relevance to plant genetic resources.	U	3, 7

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

Name of the Course: ECONOMIC BOTANY ETHNOBOTANY AND IPR

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Define ethnobotany, its scope, and its role in indigenous knowledge and modern medicine.	1, 3	1, 5	U	C	L
CO2	Explain the origin, domestication, and economic significance of cultivated plants.	1, 3	2, 6	U, E	C	L
CO3	Describe major food, cash, and medicinal crops, including their uses and processing.	1, 3, 5	1, 5, 6	U, E	C, P	L,P/T
CO4	Assess the economic importance of lower plants in food, medicine, and industry.	3, 6	4, 6	C, An	C, P	L,P/T
CO5	Understand Intellectual Property Rights (IPR) and their relevance to plant genetic resources.	5, 7	3, 7	U	M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	-	2	-	-	-	-	3	-	-	-	2	-	-
CO2	3	-	2	-	-	-	-	-	3	-	-	-	2	-

CO3	3	-	3	-	2	-	-	3	-	-	-	3	2	-
CO4	-	-	3	-	-	3	-	-	-	-	3	-	2	-
CO5	-	-	3	-	2	-	3	-	-	3	-	3	-	3

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK3VACBOT 200.1**				
Course Title	**WASTE MANAGEMENT**				
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
	3	3 hours	-	-	3
Pre-requisites	Interest in environmental conservation practices.				
Course Summary	To learn various aspects of waste management. To learn recovery of products from waste to compost, integrated waste management. To create clean and green environment.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Waste Generation and Characterization**	**6**
	1	Classification of waste generation aspects, collection, storage, transport and disposal of waste, waste processing techniques and source reduction, product recovery and recycling. Waste collection and Waste disposal.	
	2	Mechanical Treatment Material Recovery Facility, Recycling and Recovery, Processing and Treatment of Waste.	
	3	Biological methods for waste processing: Composting, Bio	

		methanation, Biodiesel, Biohydrogen, Mechanical Biological Stabilization Processing and Treatment of waste.	
	4	Incineration, Residues and its utilization, co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel, solid recover fuel. Technologies Under Development, Bio-fuels and bio-chemicals, Bio CNG, Technologies for Smart Waste Collection, use of SCADA systems for waste management, technical options for Construction and Demolition Waste Management.	
II		**Waste Processing Techniques**	**6**
	5	Purpose of processing-Improving efficiency of SWM system, Recovering material for reuse, Recovering conversion products and energy.	
	6	Component separation- Air separation, Conventional chute type, Zigzag air classifier, Open inlet vibrator type, Magnetic separation, screening	
	7	Drying and dewatering	
	8	Source reduction, Product recovery, recycling	
III		**Composting**	**9**
	9	Introduction, Objectives, Benefits of composting, fermentation	
	10	Composting- Principles of composting- manual and mechanized methods.	
	11	Types of Composting - Backyard composting, Other Methods of Composting & Diversion – Grass cycling, Vermicomposting, Food Digesters, Commercial Compost Haulers.	
	12	Compost types, Compost feedstock, Compost starting mixes Composting methods Compost maturity	
	13	Composts and soil ecosystem resilience, Organic matter storage and transformation, Storage, transport and	

		transformation of nutrients, Soil structure, aggregate stability, water storage and transport	
	14	Microbiology of the composting process:- What are microorganisms? Where do the microorganisms in the compost come from? Why do microorganisms do it? What microorganisms need to be able to do all the work? How do microorganisms do it?	
IV	**Sustainable methods**		**9**
	15	Vermi composting	
	16	Aerobic composting	
	17	Activity- different types of sustainable composting	
V	**Regulatory and legal Frame work for waste management**		**15**
	18	Introduction: -Overview of waste management in India, importance of legal and regulatory frameworks, Difference between Regulatory and Legal frameworks, Legal Landmarks in the History of Waste management in India, Institutional framework on solid waste management in India	
	19	Waste Management Laws in India, The Environmental Protection Act, The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, The Plastic Waste (Management and Handling) Rules, 2011, Bio-Medical Waste (Management and Handling) Rules, 1998, The E- Waste (Management and Handling) Rules, 2011, The Batteries (Management and Handling) Rules, 2001.	
	20	Solid waste management rules 2016, Regulatory and Legal policy making in Waste Management	

References

1. Bilitewski, B., Hard, H. G., Marek, K., Weissbach, A., & Boeddicker, H. (1994). *Waste management*. Springer.
2. Nicholas, P., & Cheremisinoff, P. D. (2005). *Handbook of solid waste management and waste minimization technologies*. Elsevier Science.

3. Tchobanoglous, G., Theisen, H., & Vigil, S. A. (1993). *Integrated solid waste management*. McGraw-Hill Publishers.
4. White, F. R., Franke, P. R., Hindle, M., & McDougall, P. (2001). *Integrated solid waste management: A life cycle inventory*. John Wiley & Sons.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the classification, collection, and processing of waste and analyze waste recovery and recycling techniques.	R, U, An	1, 4
CO-2	Describe waste processing techniques and evaluate separation, drying, and material recovery methods.	U, An, E	1, 2
CO -3	Analyze composting principles and microbial involvement and assess their role in soil health and nutrient cycling.	An, E	1, 5
CO-4	Examine sustainable waste management techniques, including composting and apply different sustainable composting methods.	U, Ap, E	2, 6
CO-5	Assess the regulatory framework for waste management in India and develop strategies for policy implementation and compliance.	An, C	3, 5, 6

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

Name of the Course: WASTE MANAGEMENT

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the classification, collection, and processing of waste and analyze waste recovery and recycling techniques.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe waste processing techniques and evaluate separation, drying, and material recovery methods.	1, 6	1, 2	U, An, E	C, P	L
CO3	Analyze composting principles and microbial involvement and assess their role in soil health and nutrient cycling.	2, 3	1, 5	An, E	C, P	L
CO4	Examine sustainable waste management techniques, including composting and apply different sustainable composting methods.	2, 5	2, 6	U, Ap, E	C, P	L/T
CO5	Assess the regulatory framework for waste management in India and develop strategies for policy implementation and compliance.	3, 7	3, 5, 6	An, C	C, M	L/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓			✓

SEMESTER IV

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK4DSCBOT 250.1**				
Course Title	**ANGIOSPERM MORPHOLOGY AND REPRODUCTIVE BOTANY**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge about flower and its parts				
Course Summary	This course helps to study the reproductive processes and structures of plants. It encompasses various aspects of plant reproduction, including the formation of gametes, pollination mechanisms, fertilization, seed development, and dispersal.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of Plant Morphology**	**7**
	1	Plant habit	
	2	Root system- modifications with examples (-Storage, aerial, pneumatophores, buttress)	
	3	Stem- Habit, modification - Acaulescent, Caulescent, Cespitose Prostrate, Repent, Decumbent, Arborescent,	

		Suffrutescent (Definition with examples only)	
	4	Leaves - Leaf base, leaf lamina, and petiole	
	5	Activity- a) Examine and compare the morphology of different types of leaves, stem and fruits. b) Visit to JNTBGRI and document the plants.	
II		**Floral Structure and Diversity**	**7**
	6	Flower as a modified shoot	
	7	Parts of flower- arrangements, relative position, numeric plan, cohesion, adhesion, symmetry of flower, aestivation, placentation types	
	8	Types of inflorescence	
	9	Activity- Collect, dry and preserve parts of flower showing the various types of adhesion and cohesion and prepare display cards	
	10	Technical description of flowers- floral diagram, floral formula	
III		**Fruit Classification and Botanical Significance**	**5**
	11	Fruit types- simple aggregate and multiple, albuminous and exalbuminous	
	12	Activity: Make digital presentation of fruits based on botanical structure and origin	
IV		**Reproductive Development in Angiosperms**	**11**
	13	Structure and development of Anthers and microspore.	
	14	Structure of Ovary, Megaspores- Types of Ovules	
	15	Structure of Embryo - Dicot- (development) and Monocot	
	16	Activity: Exploration of the diversity of anther morphology in flowers (photographs / drawings)	
V		**Pollination, Fertilization, and Seed Development**	**15**
	17	Double fertilization, Barriers to fertilization	
	18	Endosperm types (cellular, nuclear and helobial)	
	19	Embryo sacs –Types (Monosporic, Bisporic and tetrasporic)	
	20	Pollination and its mechanisms	

	21	Adaptations for pollination	
	22	Activity: Minor report on the co-evolutionary interactions between plants and pollinators on any particular plant of choice.	

Practical (30 hrs)

1. Identify flowers, fruits and inflorescence. Collect the suitable plants from your campus.
2. Study on various types of inflorescence, flowers and fruits with vivid record of practical work
3. Pollen morphoforms (colpate, porate and colporate) -photographs/ permanent slides
4. Structure of anther and embryo

References

1. Gangulee, H. C., Das, J. S., & Dutta, C. (1982). *College botany* (5th ed.). New Central Book Agency.
2. Lawrence, G. H. M. (1951). *Introduction to plant taxonomy*. Macmillan.
3. Simpson, M. G. (2006). *Plant systematics*. Elsevier Academic Press.
4. Rao, A. T. (n.d.). *Morphology of angiosperms*.
5. Bhojwani, S. S., Dantu, P. K., & Bhatnagar, S. P. (2014). *The embryology of angiosperms*. Vikas Publishing.
6. Johri, B. M. (2011). *Embryology of angiosperms*. Springer.
7. Maheshwari, P. (2011). *An introduction to the embryology of angiosperms*. McGraw Hill.
8. Pandey, A. K. (2000). *Introduction to embryology of angiosperms*. CBS Publishers & Distributors.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify plant morphological structures and analyze their adaptive significance.	R, U, An	1, 2
CO-2	Illustrate floral structures and evaluate the significance of cohesion, adhesion, and symmetry.	U, Ap, E	1, 4
CO-3	Compare fruit types and create a digital presentation on their classification.	An, C	1, 5
CO-4	Describe reproductive structures and demonstrate their developmental variations.	U, Ap, E	2, 4
CO-5	Analyze pollination and fertilization mechanisms and construct a report on plant-pollinator interactions.	An, E, C	3, 6

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

Name of the Course: ANGIOSPERM MORPHOLOGY 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)
CO1	Identify plant morphological structures and analyze their adaptive significance.	1, 2	1, 2	R, U, An	F, C	L
CO2	Illustrate floral structures and evaluate the significance of cohesion, adhesion, and symmetry.	1, 4	1, 4	U, Ap, E	C, P	L,P
CO3	Compare fruit types and create a digital presentation on their classification.	1, 5	1, 5	An, C	C, P	L,P/T
CO4	Describe reproductive structures and demonstrate their developmental	2, 6	2, 4	U, Ap, E	C, P	L,P

	variations.					
CO5	Analyze pollination and fertilization mechanisms and construct a report on plant-pollinator interactions.	3, 7	3, 6	An, E, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	2	-	-	-	-	-
CO2	3	-	-	2	-	-	-	3	-	-	2	-	-	-
CO3	3	-	-	-	3	-	-	3	-	-	-	2	-	-
CO4	-	2	-	-	-	3	-	-	2	-	3	-	-	-
CO5	-	-	3	-	-	-	2	-	-	3	-	-	3	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓	✓	✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK4DSCBOT 251.1**				
Course Title	**CELL AND EVOLUTIONARY BIOLOGY**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	A good understanding of basics in cell and evolution are vitally important.				
Course Summary	The course offers deeper understanding on cell and its organelles emphasizing on chromatin and further offers insights into evolutionary biology				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of Cell Organelles**	**5**
	1	History, Scope and Progress of cell	
	2	The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).	
	3	Structure and function of Cell wall, cell membrane, endoplasmic reticulum, Ribosomes, Lysosomes, Mitochondria, chloroplast and Nucleus.	

	4	Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.	
	5	**Activity:** Examine the photographs and draw different cell organelles.	
II	**Structure and Organization of Nucleus and Nuclear Material**		**10**
	6	Chromosome and its structure, eukaryotic chromosomes and its organization, Classification of chromosomes based on position and number of centromere, Chromatids and Chromatin- composition and structure, euchromatin and heterochromatin - Constitutive and Facultative heterochromatin, karyotype, Idiogram, Nucleoproteins – histones, non-histones, nucleosomes.	
	7	Types of chromosomes- Prokaryotic and eukaryotic chromosomes, autosomes and sex chromosomes.	
	8	Special Chromosomes- Giant chromosomes -Polytene and Lamp brush (structure and functions) and supernumerary chromosomes - B chromosomes.	
	9	Cell division and Cell cycle – Mitosis and Meiosis – Significance. Cell cycle, Regulation of cell cycle	
	10	Activity**:** Seminar on chromosomal aberrations	
III	**Introduction to Evolutionary Biology**		**6**
	11	Neo Darwinism, Modern synthetic theory.	
	12	Evidences of evolution- Physical – Paleontological, Morphological and anatomical, Biological- Embryological, Biogeographical and Molecular Biology.	
	13	Adaptive radiations - Patterns of Evolution- Parallel, Convergence, Divergence, Progressive, Retrogressive.	
IV	**Agents of Evolution**		**9**
	14	Isolation - Geographical Isolation (Ecological, Habitat, Temporal, Behavioural, Mechanical or Chemical) Reproductive Isolation (Pre-zygotic and Post - zygotic)	

	15	Mutation - Transition mutation, Transversion mutation, Silent Mutation, Missense Mutation, Nonsense Mutation, Frame Shift Mutation	
	16	Migration and Genetic drift.	
	17	Speciation - Allopatric, Peripatric, Parapatric, Sympatric and Artificial	
V		**Evolutionary Ecology**	**15**
	18	Adaptation, Co- evolution, Endemic species, allele frequencies, genotype frequencies, Predator -prey relationship, Host – parasite interactions, Biological species concept (Advantages and limitations), Mass extinction.	
	19	Hybridization and Evolution, Polyploidy and Evolution, Genetic drift, Anagenesis and Cladogenesis	
	20	Activity: Investigating Co-evolutionary Relationships Choose a plant-animal or predator-prey pair that exhibits co-evolutionary traits. Analyze how these interactions have led to specific adaptations in each species, and discuss their implications on ecosystem dynamics.	

Practicals (30 hrs)

1. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo*.
2. Make acetocarmine squash preparation of onion root tip and identify different stages of Mitosis.
3. Calculate Mitotic Index of root tips prepared by squash preparation.

References

1. Aggarwal, S. K. (2009). *Foundation course in biology* (2nd ed.). AneBooks Pvt. Ltd.
2. Cohn, N. S. (1964). *Elements of cytology*. Brace and World Inc.
3. Darnell, J., Lodish, H., & Baltimore, D. (1991). *Cell and molecular biology*. Lea and Febiger.

4. De Robertis, E. D. P., & Robertis, E. M. P. (1991). *Cell and molecular biology*. Scientific American Books.
5. Hall, B. K. (2012). *Evolutionary developmental biology*. Springer Science & Business Media.
6. Janet, I., & Wallace, M. (2017). *Karp's cell and molecular biology*. John Wiley & Sons, Inc.
7. Keller, E. F., & Lloyd, E. A. (Eds.). (1992). *Keywords in evolutionary biology*. Harvard University Press.
8. Niklas, K. J. (1997). *The evolutionary biology of plants*. University of Chicago Press.
9. Roy, S. C., & De, K. K. (1997). *Cell biology*. New Central Books.
10. Sober, E. (Ed.). (1994). *Conceptual issues in evolutionary biology*. MIT Press.
11. Swanson, C. P. (1957). *Cytology and genetics*. Englewood Cliffs.
12. Taylor, P. (2008). *Biological sciences*. Cambridge University Press India Pvt. Ltd.
13. Verma, P. S., & Agarwal, V. K. (2004). *Cell biology, genetics, molecular biology, evolution & ecology*. S. Chand & Co..

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the structure and functions of cell organelles and illustrate membrane transport mechanisms.	R, U, Ap	1, 4
CO-2	Classify different types of chromosomes and analyze their structural organization and role in heredity.	U, An	1, 2
CO -3	Compare evolutionary theories and evaluate the evidences supporting evolution.	An, E	1, 5
CO-4	Differentiate agents of evolution and assess their impact on speciation.	U, E	2, 6
CO-5	Analyze co-evolutionary relationships and construct a report on their ecological significance.	An, C	3, 5, 6

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

Name of the Course: CELL AND EVOLUTIONARY BIOLOGY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the structure and functions of cell organelles and illustrate membrane transport mechanisms.	1, 2	1, 4	R, U, Ap	F, C, P	L,P
CO2	Classify different types of chromosomes and analyze their structural organization and role in heredity.	1, 6	1, 2	U, An	C, P	L
CO3	Compare evolutionary theories and evaluate the evidences supporting evolution.	2, 3	1, 5	An, E	C, P	L
CO4	Differentiate agents of evolution and assess their impact on speciation.	2, 5	2, 6	U, E	C, P	L
CO5	Analyze co-evolutionary relationships and construct a report on their ecological significance.	3, 7	3, 5, 6	An, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓		✓	✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK4DSCBOT 252.1**
Course Title	**LOWER CRYPTOGAMS AND PHYTOPATHOLOGY**
Type of Course	**DSC**
Semester	**IV**
Academic Level	**200 – 299**

<table>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3 hours</td><td>-</td><td>2 hours</td><td>5</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Basic Knowledge of plant diversity and plant classification</td></tr>
<tr><td>Course Summary</td><td colspan="5">The course familiarizes students with lower cryptogams, their diversity, structure, and life cycle; and their economic and ecological significance. Students will get an idea about plant diseases and their management.</td></tr>
</table>

Detailed Syllabus:

<table>
<tr><th>Module</th><th>Unit</th><th>Content</th><th>Hrs</th></tr>
<tr><td rowspan="3">I</td><td colspan="2">Phycology</td><td>11</td></tr>
<tr><td>1</td><td>General characteristics and classification of algae (Fritch,1935) up to class level- Thallus organization and Pigment composition- Economic importance of algae.</td><td rowspan="2"></td></tr>
<tr><td>2</td><td>Significant features, thallus structure, and life cycle of algae in the following groups with special reference to the type mentioned:
Cyanophyceae (Nostoc)</td></tr>
</table>

		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**	**3**
	5	General account, ecological and economic importance, types of Lichen - Crustose, Foliose and Fruticose.	
	6	Morphology, anatomy, and reproduction of *Usnea*	
IV		**Plant pathology**	**6**
	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		**Biological control of plant diseases**	**15**
	10	Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.	
	11	Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere	

		colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control	
	12	Preparation of biopesticides, Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents.	

Practicals (30 hrs)

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

References

1. Vasishta, B. R., Sinha, A. K., & Kumar, A. (2016). *Botany for degree students*.
2. Gupta, V. K., & Paul, T. S. (2004). *Fungi & plant diseases*. Kalyani Publishers.
3. Misra, A., & Agrawal, P. R. (1978). *Lichens*. Oxford & IBH.
4. Sharma, P. D. (2004). *The fungi* (2nd ed.). Rastogi Publications.
5. Agrios, G. N. (2005). *Plant pathology*. Elsevier.
6. Smith, G. M. (1972). *Cryptogamic botany* (Vols. 1 & 2). Tata McGraw-Hill Publishing Co. Ltd.
7. Vasista, P. R. (2017). *Botany for degree students: Algae*. S. Chand Publications.
8. Mehrotra, R. S., & Aggarwal, A. (2007). *Plant pathology* (3rd ed.). McGraw-Hill Education.
9. Rai, J. P., & Singh, A. K. (2014). *Plant diseases: Identification and management*.

10. Schumann, G. (1991). *Plant diseases: Their biology and social impact*.
11. Sharma, P. D. (2011). *Plant pathology*. Rastogi Publications.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyze the classification, thallus organization, pigment composition and life cycles of major algal groups, and evaluate their ecological and economic significance.	An, E	1,2,4,6
CO-2	Compare structural and reproductive features of major fungal groups and interpret life cycles of representative genera with reference to their economic importance.	U, An	1, 2,4,6,7
CO -3	Examine morphology, anatomy and reproductive strategies of lichens, and assess their ecological roles and applied significance.	An, E	1,2,4,5,6,7
CO-4	Analyze plant disease development using host–parasite interaction and disease triangle concepts, and evaluate symptoms, disease cycles and management strategies.	An, E	1,2,4,5,6
CO-5	Evaluate biological control mechanisms and design sustainable disease management approaches using bioagents, biopesticides and integrated farming systems.	E, C	1-7

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

Name of the Course: LOWER CRYPTOGAMS AND PHYTOPATHOLOGY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Analyze the classification, thallus organization, pigment composition	1, 2, 3,5	1,2,4 ,6	An, E	F, C	L,P

	and life cycles of major algal groups, and evaluate their ecological and economic significance.					
CO2	Compare structural and reproductive features of major fungal groups and interpret life cycles of representative genera with reference to their economic importance.	1, 2, 3,5,6	1, 2,4,6 ,7	U, An	C, P	L/P
CO3	Examine morphology, anatomy and reproductive strategies of lichens, and assess their ecological roles and applied significance.	2- 6	1,2,4 ,5,6, 7	An, E	C, P	L,P
CO4	Analyze plant disease development using host–parasite interaction and disease triangle concepts, and evaluate symptoms, disease cycles and management strategies.	1-6	1,2,4 ,5,6	An, E	C	L/T
CO5	Evaluate biological control mechanisms and design sustainable disease management approaches using bioagents, biopesticides and integrated farming systems.	1-7	1-7	E, C	C	L/T

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO7**
CO1	3	1	2	-	1	-	-	1	1	-	1	-	2	-
CO2	2	3	2		1	2	-	2	3	-	2	-	2	1
CO3	2	3	3	1	2	2	-	2	3	-	2	2	3	1
CO4	2	3	3	1	2	2	-	1	3	-	1	2	3	-
CO5	2	3	3	2	3	3	1	2	3	1	2	3	3	2

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK4DSCBOT 253.1**
Course Title	**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
	4	3 hours	-	2 hours	5

Pre-requisites	Basic knowledge about life forms
Course Summary	This course provides a comprehensive understanding of the principles and practices in microbiology. By exploring the fascinating world of microorganisms, students gain insights into their diverse roles in nature and society and develop the skills needed to address current and future challenges in microbiology.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of Microbiology**	**5**
	1	Overview of microbiology; Historical perspective; Contributions of microbiologists; Biology of microorganisms, Microbial nomenclature and classification.	
	2	Microbial cell- structure and function- Prokaryotic and eukaryotic cell structure; Microbial nutrition, growth, factors affecting microbial growth, methods for measuring microbial	

		growth, Determination of cell count by hemocytometry and metabolism.	
	3	Strategies for microbial control and prevention: - physical (e.g., heat, radiation), chemical (e.g., disinfectants, antimicrobial agents), and biological (e.g., antibiotics, bacteriophages)	
II		**Microbial Diversity**	**10**
	4	Bacteria: general characteristics, Morphological classification, classification based on staining reaction; Types- archaebacteria, eubacteria, wall-less forms -mycoplasma; Cell structure; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction), Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).	
	5	General Properties of other viruses, viroids and prions ; Filamentous DNA phages, Single stranded RNA phages, Virus of Plants; HIV, Vaccinia and Simian virus of animals, Insect virus, lytic and lysogenic cycle.	
III		**Pathogenic Microorganisms**	**5**
	6	Key bacterial pathogens and diseases (e.g., *Mycobacterium tuberculosis*, *Salmonella* spp., *Staphylococcus aureus*)	
	7	Important viral pathogens (e.g., influenza virus, HIV, hepatitis viruses, SARS viruses)	
	8	Fungal pathogens (e.g., *Candida albicans*, *Aspergillus* spp.)	
	9	Protozoan pathogens and diseases (e.g., *Plasmodium* spp. for malaria, *Entamoeba histolytica, PPLO*)	
IV		**Environmental Microbiology**	**10**
	10	Soil Microbiology- Soil microorganisms, the rhizosphere - Distribution of microbes; Role of microbes in soil fertility, Nitrogen fixation; Biofertilizers.	
	11	Aquatic microbiology- Microorganisms as indicators of water quality: coliforms and faecal coliforms; role of microbes in sewage and domestic waste water treatment systems (Brief	

		account only).	
	12	Microbes in/on human body (Microbiomics) & animal (ruminants) body, Microbial succession in decomposition of plant organic matter,	
V		**Microbial Biotechnology**	**15**
	13	Scope of microbes in industry and environment; institutes of microbial research; Role of microorganisms in fermentation, Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, Use of viral vectors in cloning and expression, Gene therapy and Phage display	
	14	Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.	
	15	Microbial production of industrial products -enzyme (amylase); organic acid (citric acid); alcohol (ethanol); antibiotic (penicillin)	
	16	Food and Dairy microbiology - Food and microorganisms, Food spoilage and food poisoning, Microorganisms in milk, food preservation methods - physical methods; chemical methods, antibiotics and bacteriocins.	

Practicals (30 hrs)

1. Electron micrographs/Photographs of viruses – T-Phage (Bacteriophage) and TMV; Lytic and Lysogenic Cycle.
2. Bacterial identification by using temporary or permanent slides. Electron micrographs of bacteria, binary fission, endospore, conjugation, Gram staining method
3. Principles and functioning of instruments in microbiology laboratory -autoclave, laminar air flow, incubators and types of fermenters.
4. Isolation of microorganisms from water and soil - Serial dilution method. Determination of BOD, COD, TDS and TOC of water samples (Industrial visit)
5. Determination of coliforms in water samples by using eosin methylene blue (EMB) medium

6. An industrial visit/ microbiology research lab visit.

References

1. Durieux, A. (2009). *Applied microbiology*. Springer International Edition.
2. Pelzar, M. J. Jr., Chan, E. C. S., & Krieg, N. R. (2010). *Microbiology: An application-based approach*. McGraw-Hill Education Pvt. Ltd.
3. Baveja, C. P. (2017). *Textbook of microbiology*. Arya Publications.
4. Tortora, G. J., Funke, B. R., & Case, C. L. (2007). *Microbiology* (9th ed.). Pearson Benjamin Cummings.
5. Dubey, R. C., & Maheswari, D. K. (2012). *A textbook of microbiology*. S. Chand & Co.
6. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology*. Elsevier.
7. Gunasekharan, G. (2007). *Laboratory manual of microbiology*. New Age Publishers.
8. Heritage, L. (2007). *Introductory microbiology*. Cambridge University Press India Pvt. Ltd.
9. Patel, A. H. (2008). *Industrial microbiology*. McMillan India Limited.
10. Schlegel, H. G. (2008). *General microbiology*. Cambridge University Press India Pvt. Ltd.
11. Mohapatra, P. K. (2008). *Textbook of environmental microbiology*. New Delhi.
12. Bertrand, J. C., Caumette, P., Lebaron, P., Matheron, R., Normand, P., & Sime-Ngando, T. (2015). *Environmental microbiology: Fundamentals and applications*. Springer.
13. Casida, J. R. (2016). *Industrial microbiology*. New Age International Publishers.
14. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). *Microbiology: An introduction* (13th ed.). Pearson Education, Inc..

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe microbial classification, cell structure, and strategies for microbial control.	R, U, Ap	1, 4
CO-2	Classify bacterial and viral groups and analyze their role in agriculture, industry, and medicine.	U, An	1, 2
CO -3	Compare key microbial pathogens and evaluate their impact on human health.	An, E	1, 5
CO-4	Examine the role of microbes in environmental processes and apply microbiological techniques for assessing soil and water quality.	U, Ap, E	2, 6
CO-5	Analyze the applications of microbes in biotechnology and create reports on microbial products and industrial applications.	An, C	3, 5, 6

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

Name of the Course: MICROBIOLOGY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Describe microbial classification, cell structure, and strategies for microbial control.	1, 2	1, 4	R, U, Ap	F, C, P	L,P
CO2	Classify bacterial and viral groups and analyze their role in agriculture, industry, and medicine.	1, 6	1, 2	U, An	C, P	L
CO3	Compare key microbial pathogens and evaluate their impact on human health.	2, 3	1, 5	An, E	C, P	L
CO4	Examine the role of microbes in environmental processes and apply microbiological techniques for assessing soil	2, 5	2, 6	U, Ap, E	C, P	L,P

	and water quality.					
CO5	Analyze the applications of microbes in biotechnology and create reports on microbial products and industrial applications.	3, 7	3, 5, 6	An, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓		✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	MIUK4DSCBOT 254.1				
Course Title	**PHYTOCHEMISTRY**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge about plant secondary metabolites				
Course Summary	Students understand the basic principles of phytochemistry, including the classification of plant compounds, their biosynthesis, and their uses. Students explore the chemical diversity of natural products derived from plants, including their chemical structures, properties, and sources. Students study about the medicinal plants, including their identification, cultivation, harvesting, and pharmacological properties.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction and scope of phytochemistry**	**5**
	1.	Introduction to phytochemistry	
	2.	Basics of phytochemistry	
	3.	Sources of drugs from plants	

	4.	Application of phytochemistry	
	5	Quality control and analysis of phytochemicals	
II		**Primary metabolites**	**7**
	6.	Molecules and life	
	7.	Carbohydrates - Classification, occurrence, structure and functions of monosaccharides (glucose and fructose), oligosaccharides (sucrose and maltose), polysaccharides (starch and cellulose), glycosidic bonds – Enzymatic hydrolysis of glycosidic bonds – amylases and invertases.	
	8.	Amino acids- classification based on polarity, structure - Amphoteric property of Amino acids	
	9.	Peptide formation–Aminoacid metabolism–reductive amination and transamination	
	10.	Proteins – Structure, classification, properties and function; Role of bonds in stabilizing protein structure - hydrolysis of proteins	
III		**Secondary Metabolites**	**8**
	11.	Introduction to secondary metabolites: Definition, classification, properties and test for identification of Alkaloids, Glycosides, Flavonoids, Tannins, Volatile oil and Resins	
	12.	Cultivation of medicinal plants and factors influencing cultivation of medicinal plants.	
	13.	Activity – Preparation of herbarium for five medicinal plants	
IV		**Extraction and isolation of Phyto-constituents**	**10**
	14.	Different methods of extraction	
	15.	Role of solvents for extraction procedure	
	16.	Preliminary phytochemical screening	
	17.	Fractionation of phytochemicals	
		Analytical Techniques	**15**
	18.	Application of latest techniques like spectroscopy, Chromatography and Electrophoresis in isolation	

V	19.	Purification and identification of crude drugs	
	20.	Bioactivity of phytochemicals	

Practicals (30 hrs)

1. Qualitative analysis of carbohydrate
2. Identification tests for Proteins
3. Quantitative analysis of reducing sugars
4. Preliminary phytochemical screening
5. Collection and identification of medicinal plants
6. Qualitative analysis of primary and secondary metabolites
7. Estimation of flavonoid
8. Separation of secondary metabolites by different methods
9. Cytotoxic effect of different samples

References

1. Jain, J. L., Jain, S., & Jain, N. (2016). *Fundamentals of biochemistry*. S. Chand & Co.
2. Jain, J. L. (2005). *Fundamentals of biochemistry* (6th ed.). S. Chand & Company.
3. Wilson, K., & Walker, J. (2008). *Principles and techniques of biochemistry and molecular biology* (6th ed.). Cambridge University Press India Pvt. Ltd.
4. Lehninger, A. L. (2012). *Principles of biochemistry* (6th ed.). W. H. Freeman & Co.
5. Plummer, D. T. (2006). *An introduction to plant biochemistry* (3rd ed.). Tata McGraw-Hill.
6. Saini, A. K., D'souza, M. R., Gireesh Babu, K., Singh, A., & Premalatha, S. J. (2024). *Textbook of pharmacognosy and phytochemistry-I*. Shashwat Publication.
7. Shah, B. N. (2009). *Textbook of pharmacognosy and phytochemistry*. Elsevier India.
8. Raaman, N. (2006). *Phytochemical techniques*. New India Publishing.
9. Harborne, A. J. (1998). *Phytochemical methods: A guide to modern techniques of plant analysis*. Springer Science & Business Media.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the fundamental concepts of phytochemistry and analyze its applications in drug discovery and quality control.	R, U, An	1, 4
CO-2	Classify primary metabolites and examine their biochemical roles in plant metabolism.	U, Ap, An	1, 2
CO -3	Differentiate secondary metabolites and evaluate their medicinal significance.	An, E	1, 5
CO-4	Apply extraction and isolation techniques for phyto-constituents and demonstrate phytochemical screening methods.	Ap, E	2, 6
CO-5	Analyze phytochemical compounds using advanced analytical techniques and construct reports on bioactive plant compounds.	An, C	3, 5, 6

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

Name of the Course: PHYTOCHEMISTRY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the fundamental concepts of phytochemistry and analyze its applications in drug discovery and quality control.	1, 2	1, 4	R, U, An	F, C	L
CO2	Classify primary metabolites and examine their biochemical roles in plant metabolism.	1, 6	1, 2	U, Ap, An	C, P	L
CO3	Differentiate secondary metabolites and evaluate their medicinal significance.	2, 3	1, 5	An, E	C, P	L

CO4	Apply extraction and isolation techniques for phyto-constituents and demonstrate phytochemical screening methods.	2, 5	2, 6	Ap, E	C, P	L,P/T
CO5	Analyze phytochemical compounds using advanced analytical techniques and construct reports on bioactive plant compounds.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓		✓	✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK4DSEBOT 250.1**				
Course Title	**ETHNOBOTANY AND PHARMACOGNOSY**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	General awareness about Ethnobotany and pharmacognosy				
Course Summary	The goal of this course is to introduce students to the fascinating world of the relationship between people and plants. The course offers a unique and multidisciplinary approach that includes plant structure and function. Plant diversity and the uses of the plants by people around the world.				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs**
I		**Relevance of Ethnobotany**	**6**
	1	Introduction, relevance, scope and status. Classify international, National and Reginaol (J.W.Harshberger, E.K.Janakiammal, S.K.Jain, K.S.Manilal,V.V. Sivarajan &P.Pushpangadan)- any two. Centres of ethnobotanical studies in India, AICRPE, FRLHT and their contributions to ethnobotany of India.	
	2	Study in a brief about Tribal/Folk communities of Kerala state	

		focussing on Anthropololgy, Customs and beliefs (Koraga, Kurichiya, Adiyan, Paniya, Cholanaikan, Kadar, Kurumba, Kuruman, Kani, Ulladan) .	
	3	Role of ethnomedicine and its scope in modern times.	
	4	Activity: Collection of information on traditional methods of treatments using crude drugs, utilization practices. Collect information about spiritual plant species.	
II		**Fundamentals of Ethnobotany**	**8**
	5	Ethnobotany- Concepts and scope, The factors and Endogenous regulations	
	6	Ethnic groups from ancient literature. Methods and techniques used in Ethnobotany- Field visit to collect datas. Collect information about culture. (Documentation- Audio, video, Photographs, Interview, Questionnaire).	
	7	Impact of ethnobotany in herbal-medicine industry, land-use development, agriculture, forestry, betterment of rural livelihood and education. Biodiversity and conservation of some useful medicinal plants. Plant used in ethno medicines eg. *Trichopus, Ocimum, Aegle, Phyllanthus neruri.*	
III		**Pharmacognosy**	**9**
	8	Pharmocognosy definition, scope and applications in herbal medicine. Methods of collection, process and storage of medicinal and aromatic plants. the holistic concepts of drug administration - description of Sapta padarthas in Dravya guna.	
	9	Plants used by ethnic groups as food, medicines, (ethnomedicine), beverages, fodder, fibre, resins, oils, fragrances and other uses. NWFP-Non wood forest products, animal products, minerals, artefacts and rituals used by tribal and folk communities of Kerala.	
	10	Ethnobotany and ethnopharmacology as a tool to protect interests of ethnic groups and rural development.	
	11	Activity: - Collect information about 15 plant drugs	
IV		**Ethnobotany and Conservation**	**7**

	12	Ethnobotany and conservation of plant resources, Importance of ethnobotany in Environmental Conservation.	
	13	Sacred grooves	
	14	Ethnobotanical importance in folklore	
V		**Importance of Pharmacognosy**	**15**
	15	Relevance of pharmacognosy and the study of sources of crude Systems of indigenous medicines and their availability, natural medicinal resources in use. Types of plant drug and their pharmacognostic study *a.* Root drugs - *Rauwolfia serpentina, Asparagus racemosus, Withania somnifera, Sida cordifolia, Desmodium gangeticum*. *b.* Rhizome drugs – *Zingiber officinale* *c.* Leaf drugs – *Andrographis paniculata, Lawsonia inermis, Justicia adhatoda* *d.* Bark drugs –*Terminalia arjuna, Holarrhena antidysenterica* *e.* Flower drugs - *Sesbania grandiflora, Hibiscus rosasinensis, Syzygium aromaticum* f. Seed drugs: *Myristica fragrans, Mucuna pruriens* *g.* Fruit drug: *Cuminum cyminum, Phyllanthus emblica, Piper nigrum* *h.* Whole plant drugs: *Catharanthus roseus, Phyllanthus amarus.*	
	16	Difference between herbal/ botanicals and pharmaceutical medicine. Role of ethnopharmacology in drug development. Indigenous traditional drugs and their market adulteration – *Boerhaavia diffusa, Clitoria ternatea, Ocimum, Myristica fragrans and Sida cordifolia.*	
	17	Activity: Production of new medicine or cosmetics and submit.	

Practicals (30 hrs)

1. Quantitative estimation of phenol and flavonoids
2. Documentary preparation of ethnic groups in India.
3. Familiarize with at least 5 folk medicines and study the medicinal application.
4. Observe the plants of ethnobotanical importance in your area.
5. Visit to an Ayurveda college or Ayurvedic centre, Field study/Institutional visit

Reference

1. Jain, K. (n.d.). *Glimpses of ethnobotany*. Oxford and IBH Publishing Company.
2. Jain, S. K. (1987). *A manual of ethnobotany*. Scientific Publishers.
3. Cotton, C. M. (1996). *Ethnobotany: Principles and applications*. John Wiley & Sons Ltd.
4. Shah, B. N. (2009). *Textbook of pharmacognosy and phytochemistry*. Elsevier India.
5. Jain, S. K. (1986). Ethnobotany. *Interdisciplinary Science Reviews*, *11*(3), 285-29

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the relevance, scope, and contributions to ethnobotany and analyze its role in traditional medicine.	R, U, An	1, 4
CO-2	Classify ethnobotanical practices and apply documentation methods for field research.	U, Ap, An	1, 2
CO -3	Examine the principles of pharmacognosy and evaluate the applications of medicinal plants in ethnic communities.	U, An, E	1, 5
CO-4	Analyze the role of ethnobotany in conservation and assess the significance of sacred groves and folklore.	An, E	2, 6
CO-5	Differentiate pharmacognostic plant drugs and	An, C	3, 5, 6

	construct reports on their medicinal applications.		

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

Name of the Course: ETHNOBOTANY AND PHARMACOGNOSY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Describe the relevance, scope, and contributions to ethnobotany and analyze its role in traditional medicine.	1, 2	1, 4	R, U, An	F, C	L
CO2	Classify ethnobotanical practices and apply documentation methods for field research.	1, 6	1, 2	U, Ap, An	C, P	L,P/T
CO3	Examine the principles of pharmacognosy and evaluate the applications of medicinal plants in ethnic communities.	2, 3	1, 5	U, An, E	C, P	L/T
CO4	Analyze the role of ethnobotany in conservation and assess the significance of sacred groves and folklore.	2, 5	2, 6	An, E	C, P	L
CO5	Differentiate pharmacognostic plant drugs and construct reports on their medicinal applications.	3, 7	3, 5, 6	An, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-

CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	MIUK4SECBOT 250.1
Course Title	**MEDICINAL PLANT MERCHANDISING**
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
	3	2 hours	-	2 hours	4

Pre-requisites	Interest in medicinal plants and commercialization
Course Summary	This course equips you with the foundational knowledge of medicinal plants, its processing and requirements for commercialization; essential for understanding business opportunities using medicinal plants.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Get Acquainted with Medicinal Plants**	7
	1	Study and identification of the major medicinal plants in Kerala with special reference to their Botanical description morphology of the useful part and medicinal properties. 1. *Akshoka* (Walnut) 2. *Amaravalli* (Akasavalli) 3. *Amra (Ambazham) 4. Bimbi (Kova) 5. Damanaka (Nilampala) 6. Himsra (Kakkathondi) 7. Musali (Musalli) 8. Neeli (Neelayamari) 9. Sarja (Kuntirikkappayin)*	

		10. Vrikshamla (Punampuli)	
	2	Activity: Field visit/documentation of medicinal plants	
II	**Medicinal Plant Cultivation and Processing**		**10**
	3	Harvesting and collection**:** Factors affecting phytochemical composition.	
	4	Drying and storage**:** Sun, shade, oven drying; humidity control.	
	5	Extraction and purification**:** Overview of maceration, percolation, Soxhlet extraction, steam distillation, chromatography, and filtration.	
III	**Present scope of herbal drug industry**		**8**
	6	Current scenario of herbal medicine in India and global trends.	
	7	Preservatives, shelf-life, and quality control.	
	8	Case studies**:** Insights from successful entrepreneurs in herbal industries.	
IV	**Plant Excipients**		**5**
	9	Natural excipients**:** Role of colorants, sweeteners, binders, diluents, viscosity builders, and stabilizers.	
	10	Basic formulation techniques to enhance bioavailability and patient compliance.	
V	**Merchandising**		**15**
	11	Post-harvest management of high-demand medicinal plants.	
	12	Regulatory frameworks (GACP, GMP, labeling requirements, licensing).	
	13	Sustainability and conservation strategies in medicinal plant exploitation.	
	14	Research and innovation in medicinal plant-based therapies.	
	15	Activity: Review of national/state agencies (CIMAP, NMPB, SMPBs) supporting herbal businesses.	

Practicals (30 hrs)

1. Identify medicinal plants and match the botanical names of plants with their common names and medicinal uses.
2. Analyse and research medicinal plants in the market and prepare presentations
3. Practice cultivation and propagation of medicinal plants
4. Develop Value-Added Product
5. Investigate traditional uses of medicinal plants, folklore, and indigenous knowledge systems, emphasizing the importance of ethical sourcing and cultural sensitivity in merchandising practices.

References

1. Hao, D. C., Gu, X. J., & Xiao, P. G. (2015). *Medicinal plants: Chemistry, biology and omics*. Woodhead Publishing.
2. Tarentino, K. (2001). Medicinal plants of the world, Volume 2: Chemical constituents, traditional and modern medicinal uses. *Clinical Chemistry, 47*(8), 1504-1505. Humana Press.
3. The Ayurvedic Pharmacopoeia of India. (n.d.). Govt. of India Publication.
4. Lohar, D. R. (2008). *Protocol for testing Ayurvedic, Siddha, and Unani medicines*. Government of India.
5. Willard, H. H., Merritt, L. L., Settle, F., & Dean, J. A. (1988). *Instrumental methods of analysis*. CBS Publishers & Distributors.
6. Beckett, A. H., & Stenlake, J. B. (1988). *Practical pharmaceutical chemistry – Part II*. Athlone Press.
7. Ravishankar, S. (2022). *Pharmaceutical analysis*. Rx Publications.
8. Kasture, A. V. (2008). *Pharmaceutical analysis*. Nirali Prakashan.
9. Watson, D. G. (2020). *Pharmaceutical analysis*. Elsevier.
10. Cannors, K. A. (1982). *Textbook of pharmaceutical analysis*. Wiley.
11. Chatton, L. G. (1986). *Pharmaceutical chemistry* (Vols. I & II). Marcel Dekker.
12. Beckett, A. H., & Stenlake, J. B. (1988). *Practical pharmaceutical chemistry – Part II*. Athlone Press.
13. Jenkins, G. L., Knevel, A. M., & DiGangi, F. E. (1967). *Quantitative pharmaceutical chemistry*. McGraw-Hill.
14. World Health Organization (WHO). (n.d.). *Quality control methods for herbal materials*.

15. Harborne, J. B. (1998). *Phytochemical methods: A guide to modern techniques of plant analysis*. Chapman and Hall Ltd.
16. Kokate, C. K., & Gokhale, S. B. (2008). *Practical pharmacognosy*. Vallabh Prakashan.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify and describe the major medicinal plants of Kerala, focusing on their morphology and medicinal properties.	1, 4	R, U, Ap
CO-2	Explain the cultivation, processing, and extraction techniques of medicinal plants and analyze their impact on product quality.	1, 2	U, An
CO -3	Evaluate the current scope of the herbal drug industry and assess commercialization challenges and regulatory frameworks.	1, 5	An, E
CO-4	Differentiate plant-based excipients and apply their roles in drug formulation and product development.	2, 6	An, Ap
CO-5	Analyze the importance of sustainability and conservation in medicinal plant commerce and propose strategies for ethical and innovative practices.	3, 5, 6	An, C

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

Name of the Course: MEDICINAL PLANT MERCHANDISING

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Identify and describe the major medicinal plants of Kerala, focusing on their morphology and medicinal	1, 2	1, 4	R, U, Ap	F, C	L

	properties.					
CO2	Explain the cultivation, processing, and extraction techniques of medicinal plants and analyze their impact on product quality.	1, 6	1, 2	U, An	C, P	L/T
CO3	Evaluate the current scope of the herbal drug industry and assess commercialization challenges and regulatory frameworks.	2, 3	1, 5	An, E	C, P	L
CO4	Differentiate plant-based excipients and apply their roles in drug formulation and product development.	2, 5	2, 6	An, Ap	C, P	L,P
CO5	Analyze the importance of sustainability and conservation in medicinal plant commerce and propose strategies for ethical and innovative practices.	3, 7	3, 5, 6	An, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓			✓
CO5	✓	✓	✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK4SECBOT 251.1**				
Course Title	**FOOD PROCESSING**				
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
	3	2 hours	-	2 hours	4
Pre-requisites	Awareness of the potential of seasonal fruits				
Course Summary	A course in food processing gives an understanding about various aspects of food production, preservation and safety.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fruits and Vegetable**	**6**
	1	Seasonal fruits of Kerala – Jackfruit, papaya, pineapple, custard apple, guava, cucumber.	
	2	Post-harvest handling: Harvesting, transportation, storage, and processing (peeling, sizing, blanching, canning).	
	3	Food industry regulations: Good Manufacturing Practices (GMP), Standard Operating Procedures (SOPs), Good Laboratory Practices (GLP).	
	4	Sanitation and hygiene: HACCP, sanitation laws, allergen	

		control, waste disposal, and sanitization methods.	
II	**Food Microbiology**		**7**
	5	Microorganisms in food: Classification, sources, intrinsic and extrinsic factors affecting microbial growth.	
	6	Food spoilage: Types, microbial spoilage, and preventive measures.	
	7	Foodborne illnesses: Bacterial, non-bacterial (protozoa, fungi, viruses, algae), indicators of food and water safety.	
III	**Value Added Food Products**		**10**
	8	Preparation of fruit-based products: Jams, jellies, preserves, juices, nectars, sauces, syrups.	
	9	Specialty products: Dried fruits, fruit leather, fruit vinegar, chutneys, salsas, ice creams, fruit-infused beverages.	
IV	**Food Processing Equipment and Storage**		**7**
	10	Evaporation, filtration, sedimentation, and mixing: Principles and applications in food processing.	
	11	Solar and refrigeration technology: Heaters, driers, cookers, distillers, cold storage, humidifiers, dehumidifiers.	
V	**Food Preservation and Shelf Life**		**15**
	12	Food spoilage and shelf life: Types of foods (perishable, semi-perishable, shelf-stable), causes of spoilage.	
	13	Freezing & refrigeration: Types of freezing (slow, quick), thawing, and effects on food.	
	14	Thermal processing: Sterilization, commercial sterilization, pasteurization, and blanching.	
	15	Moisture control: Drying and dehydration – Effects on food quality and stability.	

Practicals (30 hrs)

1.Isolation and identification of specific microorganisms of normal and spoiled.

a. Fruits b. Vegetables

2.Preparaation and preservation of seasonal fruits and vegetables

Preservation of foods by sugar-Jam, Jelly, Marmalade, Cordial, Squash, Fruit bars, Fruit Preserves-Tuity Fruity (Papaya), Ginger Murabha (Ginger).

3. Preservation of foods by salt and acid-Vathal, Vadagam, Tomato ketchup and Squash, Pickles-Lemon, Mango, Mixed vegetable, Garlic.

4. Preservation by fermentation- Wine, Vinegar

References

1. Fellows, P. J. (2022). *Food processing technology: principles and practice*. Woodhead publishing.
2. Simpson, B. K., Nollet, L. M., Toldrá, F., Benjakul, S., Paliyath, G., & Hui, Y. H. (Eds.). (2012). *Food biochemistry and food processing*. John Wiley & Sons.
3. Brennan, J. G., & Grandison, A. S. (Eds.). (2012). *Food processing handbook*. Weinheim, Germany: Wiley-Vch.
4. Stumbo, C. R. (2013). *Thermobacteriology in food processing*. Elsevier.
5. Van Boekel, M., Fogliano, V., Pellegrini, N., Stanton, C., Scholz, G., Lalljie, S.,& Eisenbrand, G. (2010). A review on the beneficial aspects of food processing. *Molecular nutrition & food research*, *54*(9), 1215-1247.
6. Lelieveld, H. L., Holah, J., & Napper, D. (Eds.). (2014). *Hygiene in food processing: principles and practice*. Elsevier.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the post-harvest handling, processing, and sanitation practices in the food industry.	R, U, Ap	1, 4
CO-2	Analyze microbial activity in food, foodborne diseases, and spoilage prevention techniques.	An, E	1, 2
CO -3	Apply food processing techniques to develop value-added fruit-based products.	Ap, C	1, 5
CO-4	Explain the role of processing equipment and refrigeration systems in food preservation.	U, Ap, E	2, 6
CO-5	Evaluate different food preservation methods and analyze their impact on shelf life and food quality.	An, E	3, 5, 6

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

Name of the Course: FOOD PROCESSING

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Describe the post-harvest handling, processing, and sanitation practices in the food industry.	1, 2	1, 4	R, U, Ap	F, C	L
CO2	Analyze microbial activity in food, foodborne diseases, and spoilage prevention techniques.	1, 6	1, 2	An, E	C, P	L
CO3	Apply food processing techniques to develop value-added fruit-based products.	2, 3	1, 5	Ap, C	C, P	L,P/T
CO4	Explain the role of processing equipment and refrigeration systems in food preservation.	2, 5	2, 6	U, Ap, E	C, P	L,P
CO5	Evaluate different food preservation methods and analyze their impact on shelf life and food quality.	3, 7	3, 5, 6	An, E	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK4SECBOT 252.1**				
Course Title	**AQUAPONICS AND HYDROPONICS**				
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
	3	2 hours	-	2 hours	4
Pre-requisites	Student must interest and awareness about this topic				
Course Summary	By the end of the course, students will acquire the knowledge about Aquaponics and hydroponics and able to maintain a sustainable cultivation and to find out a self-employment.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction and Over view**	**6**
	1	Definition and principles of Aquaponics.	
	2	History and application of aquaponics.	
	3	Nutrient and pH maintenance, Working of aquaponics.	
	4	Merits and demerits of aquaponics.	
II		**Aquaponic Systems and maintenance**	**7**
	5	Components of aquaponics: - Fish tank, Filter, Mechanical and biofilters, Sump tank, Aerators	

	6	Types of aquaponic units: - media based grow bed, Deep water culture (DWC) bed- (Floating raft system), Nutrient film techniques- Channel or gutter style system	
	7	Types of and fishes in aquaponics, Fish health management, maintenance of water quality	
	8	Setting up and maintenance of aquaponics	
III	**Hydroponics**		**7**
	9	Introduction, Definition and principles of Hydroponics.	
	10	History and application of hydroponics.	
	11	Hydroponic production – Basic principles, Historical Perspectives	
	12	Advantages/Disadvantages.	
IV	**Hydroponic System and environmental factors**		**10**
	13	Types of Hydroponics Systems. Hydroponic systems - NFT, DWC, gravel/sand/ebb-and flood, slab culture	
	14	Growing Substrates Plant Nutrition, Nutrient Solution and System Monitoring: EC(Electrical Conductivity), pH	
	15	Aerial Environmental Factors and Plant Growth: Light, Temperature, CO_2, RH, Cooling Systems.	
	16	Hydroponics Systems in leafy greens, herbs, and microgreens Hydroponics for Fruit and Flowering Crops. Tomatoes, Cucumbers, Peppers and strawberries: Larger crops that require more space and nutrient management.	
V	**Controlled Environment Agriculture (CEA) and Advanced Topics**		**15**
	17	Introduction to CEA: Integration of advanced technologies in controlled environments Vertical farming: Design and scalability for urban farming-Case studies: Real-world applications of CEA and vertical farming	
	18	Organic principles in hydroponics and aquaponics	
	19	Evaluating New Crops for Hydroponics and Aquaponics	
	20	Future of Aquaponics and Hydroponics Potential for these systems in addressing global food security challenges	

Practicals (30 hrs)

1. Identification to aquarium accessories like aerator, bubblers, feeding cup, food dispenser, filters-bottom, column and surface.
2. Checking and Adjusting pH of aquaponic culture
3. Identification of aquaponics animals (Tilapia, catfish, common carp) selecting crop, their management and care.
4. Field visit

References

1. Tyson, R. V., Treadwell, D. D., & Simonne, E. H. (2011). Opportunities and challenges to sustainability in aquaponic systems. *HortTechnology, 21*(1), 6-13.
2. Sustainable Agriculture Research and Education (SARE). (2012). Increasing economic and environmental sustainability of aquaculture production systems through aquatic plant culture.
3. Rakocy, J. (2006). Aquaponics—Integration of hydroponics with aquaculture. *ATTRA-National Sustainable Agriculture Information Service*.
4. Crossley, P. L. (2004). Sub-irrigation in wetland agriculture. *Agriculture and Human Values, 21*(2), 191-205.
5. Boutwell, J. (2007, December 16). Aztecs' aquaponics revamped. *Napa Valley Register*.
6. Bishop, M., Bourke, S., Connolly, K., & Trebic, T. (2009). Baird's Village aquaponics project: AGRI 519/CIVE 519 sustainable development plans. McGill University.
7. Lennard, W. A. (2017). *Commercial aquaponic systems: Integrating recirculating aquaculture and hydroponics for sustainable food production*. CreateSpace Independent Publishing.
8. Somerville, C., Cohen, M., Pantanella, E., Stankus, A., & Lovatelli, A. (2014). Small-scale aquaponic food production: Integrated fish and plant farming. *FAO Fisheries and Aquaculture Technical Paper No. 589*. Food and Agriculture Organization of the United Nations.
9. Resh, H. M. (2013). *Hydroponic food production: A definitive guidebook for the advanced home gardener and the commercial hydroponic grower* (7th ed.). CRC Press.
10. Nelson, R. (2017). *Aquaponic food production: Raising fish and plants for food and profit*. New Society Publishers.

11. Jones, J. B. (2005). *Hydroponics: A practical guide for the soilless grower* (2nd ed.). CRC Press.
12. Rakocy, J. E., Masser, M. P., & Losordo, T. M. (2006). *Recirculating aquaculture tank production systems: Aquaponics—Integrating fish and plant culture*. Southern Regional Aquaculture Center (SRAC) Publication No. 454.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the principles, history, and working mechanisms of aquaponics and analyze its advantages and limitations.	R, U, An	1, 4
CO-2	Describe the components, types, and maintenance of aquaponic systems and apply management practices for fish health and water quality.	U, Ap, An	1, 2
CO -3	Compare hydroponic and aquaponic techniques and evaluate their applications in sustainable agriculture.	An, E	1, 5
CO-4	Analyze hydroponic system design, nutrient management, and environmental control factors for optimal plant growth.	An, Ap, E	2, 6
CO-5	Assess the productivity of hydroponic and aquaponic farming systems and develop strategies for controlled environment agriculture.	An, C	3, 5, 6

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

Name of the Course: AQUAPONICS AND HYDROPONICS

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the principles, history, and working mechanisms of aquaponics and analyze its advantages and limitations.	1, 2	1, 4	R, U, An	F, C	L

CO2	Describe the components, types, and maintenance of aquaponic systems and apply management practices for fish health and water quality.	1, 6	1, 2	U, Ap, An	C, P	L
CO3	Compare hydroponic and aquaponic techniques and evaluate their applications in sustainable agriculture.	2, 3	1, 5	An, E	C, P	L/T
CO4	Analyze hydroponic system design, nutrient management, and environmental control factors for optimal plant growth.	2, 5	2, 6	An, Ap, E	C, P	L,P
CO5	Assess the productivity of hydroponic and aquaponic farming systems and develop strategies for controlled environment agriculture.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓	✓	✓
CO5	✓	✓	✓	✓

SEMESTER V

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK5DSCBOT 300.1**
Course Title	**TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY**
Type of Course	**DSC**
Semester	**V**
Academic Level	**300 – 399**

<table>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3 hours</td><td>-</td><td>2 hours</td><td>5</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Students should complete the course Angiosperm morphology and Reproductive Botany</td></tr>
<tr><td>Course Summary</td><td colspan="5">Course is designed to provide students with a deep understanding of plant classification, identification, and structural features. The course covers the principles and methods of plant taxonomy, including the use of morphological and anatomical characteristics for plant classification. Students learn about economically important plants and their uses.</td></tr>
</table>

Detailed Syllabus:

<table>
<tr><th>Module</th><th>Unit</th><th>Content</th><th>Hrs</th></tr>
<tr><td rowspan="2"></td><td colspan="2">Nomenclature and Classification</td><td>10</td></tr>
<tr><td>1</td><td>Definition, scope and significance of Taxonomy, History of plant taxonomy. Plant Identification, documentation (keys and flora), Concepts of Taxonomic hierarchy -</td><td></td></tr>
</table>

I		Species/Genus/Family, species concept and intraspecific categories - subspecies, varieties and forms. Basic rules of Binomial Nomenclature and International Code of Nomenclature for algae, fungi and plants (ICN or ICNafp). Preservation – preparation of preservative – FAA. Importance of herbarium, Herbarium techniques and Botanical gardens.	
	2	Systems of classification: 1. Artificial -Carolus Linnaeus (Brief account only) 2. Natural -Bentham & Hooker- Detailed account 3. Phylogenetic –Engler & Prantl (Brief account only) 4. APG system- Brief account only	
	3	Activity- Create fictitious plant names that comply with standard nomenclature regulations; in order to encourage students to apply their understanding of plant nomenclature while fostering creativity and imagination.	
II		**Plant Families in Polypetalae**	**8**
	4	A study of the following families with emphasis on the morphological peculiarities and Economic importance of its members (based on Bentham & Hooker's system) *Annonaceae , Malvaceae, Rutaceae, Anacardiaceae, Combretaceae, Leguminosae*	
III		**Plant Families in Gamopetalae**	**7**
	5	A study of the following families with emphasis on the morphological peculiarities and Economic importance of its members (based on Bentham & Hooker's system) *Apiaceae, Rubiaceae , Sapotaceae, Asteraceae, Apocynaceae , Solanaceae, Lamiaceae*	
IV		**Plant Families in Monochlamydeae and Monocotyledonae**	**5**
	6	A study of the following families with emphasis on the morphological peculiarities and Economic importance of its	

		members (based on Bentham & Hooker's system) Monochlamydeae - Amaranthaceae*, Euphorbiaceae*.	
	7	Monocotyledonae- *Orchidaceae, Liliaceae and Poaceae*	
V		**Economic Botany**	**15**
	8	Study of the major crop in Kerala with special reference to their Methods of cultivation, Botanical description, morphology of the useful part and economic importance - Coconut and Paddy.	
	9	A brief account on the utility of the following plants, specifying the Binomial, family and morphology of the useful parts.**Cereals**– (Wheat & Maize), Millets- (Ragi & Fox tail millet), **Pulses** – (Black gram, Green gram, Bengal gram), **Sugar yielding plants** – (Sugar Cane), **Spices**- (pepper, cloves, cardamom), **Beverages** – (Coffee, Tea), **Fibre yielding plants**- (Cotton), **Dye Yielding plants** – (Henna and *Bixa Orellana*), **Resins**- (Asafoetida), **Tuber crops** – (Tapioca, Potato), **Oil yielding plants**- (Sesame, ground nut), **Latex yielding plants**- (Rubber), **Medicinal plants** – (*Sida, Zingiber officinalis, Aloe vera* and *Vinca rosea*), **Insecticide**-(Neem)	
	10	Activity –Collect and submit any five plant materials used in our day today life (Which are not mentioned in the syllabus)	

Practicals (30 hrs)

1. Students must be able to identify the angiosperm members included in the syllabus up to the level of families. Draw labelled diagram of the habit, floral parts, L S of flower, T S of ovary, floral diagram, and floral formula and describe the salient features of the member in technical terms. (Minimum two plants from each dicot family and one from monocot family).
2. Identify the economic products obtained from the plants mentioned under Economic Botany
3. Students must submit practical records, Herbarium sheets (20 Nos: representing one sheet from each family) and Field book at the time of practical examination.

4. Field visits are to be conducted to familiarize the local flora. Field trips are to be conducted for three days either as continuous or one daytrips.

References

1. Davis and Heywood (2011). *Principles of Angiosperm Taxonomy*. Oliver and Royd, London.
2. Lawrence. G.H.M. (1951). *Taxonomy of Vascular Plants*. Macmillan, NewYork.
3. Mukash Biswas (2014). *Taxonomy of Angiosperms*, Thomson publishers, ND
4. Naik, V.N. (1984). *Taxonomy of Angiosperms*. Tata McGraw Hill, NewYork.
5. Pandey & Misra (2014). *Taxonomy of Angiosperms*, Ane Books, India
6. Pandey B P (2001) *Taxonomy of Angiosperms*. S Chand and Co
7. Sharma O P (2009). *Plant Taxonomy*. Mc Graw – Hill Publishing Company Ltd, NewDelhi.
8. Singh V and Jain D K (2009). *Taxonomy of Angiosperms*, Rastogi Publication
9. Sinha R K (2010) *Practical Taxonomy of Angiosperms*. IK International Publishing Pvt Ltd.
10. Sivarajan, V.V (1991). *Introduction to the principle of plant taxonomy*, Oxford and IBH Publishing Company
11. Verma B K (2011). *Introduction to Taxonomy of Angiosperms*. PHI Learning Pvt Ltd. 12. Kochhar, S L (2012). *Economic Botany in Tropics*. MacMillan & Co. New Delhi, India.
13. Panday, BP (2000). *Economic Botany*. S Chand Publishing Company. New Delhi. India
14. Verma V, (2009) *Text Book of Economic Botany*; Ane Books Pvt. Ltd.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the principles of plant nomenclature and classification and analyze the significance of herbarium techniques and botanical gardens.	R, U, An	1, 4
CO-2	Describe the key diagnostic features of Polypetalae, Gamopetalae, Monochlamydeae, and Monocotyledonae families and evaluate their economic importance.	U, An, E	1, 2

CO -3	Analyze the phylogenetic relationships among plant families and assess their classification based on various taxonomic systems.	An, E	1, 5
CO-4	Examine the major economic crops of Kerala and apply botanical knowledge in understanding their cultivation and utilization.	U, Ap, E	2, 6
CO-5	Assess the importance of economically valuable plants and develop awareness of their sustainable use and conservation.	An, C	3, 5, 6

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

Name of the Course: TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the principles of plant nomenclature and classification and analyze the significance of herbarium techniques and botanical gardens.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe the key diagnostic features of Polypetalae, Gamopetalae, Monochlamydeae, and Monocotyledonae families and evaluate their economic importance.	1, 6	1, 2	U, An, E	C, P	L
CO3	Analyze the phylogenetic relationships among plant families and assess their classification based on various taxonomic systems.	2, 3	1, 5	An, E	C, P	L
CO4	Examine the major economic crops of Kerala and apply botanical knowledge in understanding their cultivation and utilization.	2, 5	2, 6	U, Ap, E	C, P	L,P/T
CO5	Assess the importance of	3,	3, 5,	An, C	C, M	L,P/T

	economically valuable plants and develop awareness of their sustainable use and conservation.	7	6			

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓	✓	✓
CO5	✓	✓	✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK5DSCBOT 301.1**				
Course Title	**ENVIRONMENTAL SCIENCE**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	The course helps in understanding core concepts such as ecosystems, biodiversity, pollution, climate change, and resource management.				
Course Summary	Inculcate environmental awareness among students for the protection of nature				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Natural resources and its conservation**	**8**
	1	Natural Resources - Renewable and Non-renewable Land and Air, Soil, Water, Energy, Minerals, Food and agriculture, Forests, Plants & animals; Wild life resources. Degradation of natural resources - Land degradation, degradation of water resources, Loss of flora and fauna; Causes – population explosion, over exploitation, deforestation, agriculture mismanagement, desertification, overgrazing, soil erosion, mining, urbanization and	

		industrialization- change in land use, depletion of water resources.	
	2	Conservation of natural resources and sustainable life styles. Land and soil- Afforestation, regeneration of waste land Energy - Promoting use of renewable resources-solar, tidal and wind; biodiesel, biofuels. Forests- Reforestation, Community forestry programs	
II		**Ecosystems**	**10**
	3	Ecosystems - Concept, definition, structure and function; components- biotic and abiotic, energy flow.	
	4	Food chains -Food web, ecological Pyramids, biogeochemical cycles - Carbon and Phosphorous cycle	
	5	Ecological succession: Definition, primary and secondary succession, climax concept, hydrosere and xerosere.	
	6	Plant adaptations- Morphological, anatomical, physiological adaptations of Hydrophytes, Xerophytes, Halophytes, Epiphytes, Parasites	
	7	Introduction- types, characteristic features, structure and functions of the following ecosystems. Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems- Ponds, Streams, Rivers, Oceans, Estuaries (brief account only)	
	8	Millennium Ecosystem Assessment (MA), Cultural services: recreational opportunities, spiritual and aesthetic values, and cultural heritage associated with ecosystems.	
III		**Environment and social issues**	**8**
	9	Climate changes and rise in sea level, global warming, acid rains, Ozone layer depletion, nuclear accidents and holocaust	
	10	Resettlement and rehabilitation of people – Problems and concerns	
	11	Water conservation, Rain water harvesting, Watershed management, ground water dams	

	12	Sustainable development; Key aspects, sustainable agriculture, sustainable forestry	
IV		**Environmental legislations**	**4**
	13	Environment protection Act (1986); Air [prevention and control of pollution] Act (1981; Amended 1987); Water prevention and control of pollution Act (1974; Amended 1988); Wildlife Protection Act (1972); Forest conservation Act (1980) (Scope and relevance only)	
	14	Environmental Organisations –UNEP, IPCC, WWF, Central Pollution Control Board	
V		**Environmental pollution**	**15**
	15	Definition, causes, effects and control measures of – Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution.	
	16	Solid Waste Management- waste minimization, Recycling and Reuse, Consuming environment friendly products. E-waste management.	

Practicals (30 hrs)

1. Visit a local polluted site and report major pollutants.
2. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes,
3. Halophytes, Epiphytes and Parasites.
4. Observe and study different ecosystems mentioned in the syllabus.

References

1. Ahluwalia, V. K., & Malhotra, S. (2009). *Environmental science*. Ane Books Pvt. Ltd.
2. Ambasht, R. S. (2008). *Textbook of plant ecology*. Students and Friends & Co.
3. Kumar, A. (2009). *Pollution and biodiversity: Biosocial aspects*. Daya Publishing House.
4. Asthana, D. K., & Asthana, M. (2006). *A textbook of environmental studies*. S. Chand & Company Ltd.
5. Chandoc, S., Weaver, C., & Clements, F. (1949). *Plant ecology*. McGraw Hill Publications.

6. Chapman, J. L. (2006). *Ecology: Principles and application*. Cambridge University Press India Pvt. Ltd.
7. Cutter, S. L. (1999). *Environmental risks and hazards*. Prentice Hall.
8. Bryant, E. (2005). *Natural hazards*. Cambridge University Press.
9. Bharucha, E. (2013). *Textbook of environmental studies for undergraduate courses*. Universities Press, University Grants Commission.
10. Hill, M. J., Mason, I., & Kilburn, C. (2002). *Natural hazards and environmental change*. Oxford University Press.
11. Kumaresan, B. (2009). *Plant ecology & phytogeography*. Rastogi Publications.
12. Misra, S., & Pandey, S. N. (2009). *Essential environmental studies*. Ane Books Pvt. Ltd.
13. Odum, E. P. (2018). *Fundamentals of ecology* (5th ed.). Saunders.
14. Periasamy, K. (1965). *Elements of plant ecology*. M.K. Publications.
15. Sharma, P. D. (1981). *Elements of ecology*. Rastogi's Company Ltd..

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the types, causes, and degradation of natural resources and analyze conservation strategies for sustainable management.	R, U, An	1, 4
CO-2	Describe the structure and function of ecosystems and evaluate ecological interactions, adaptations, and biogeochemical cycles.	U, An, E	1, 2
CO -3	Analyze global environmental issues and assess sustainable development strategies for environmental conservation.	An, E	1, 5
CO-4	Examine environmental laws and policies and apply their significance in pollution control and biodiversity protection.	U, Ap, E	2, 6
CO-5	Assess the causes and effects of environmental pollution and develop strategies for waste management and sustainability.	An, C	3, 5, 6

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

Name of the Course: ENVIRONMENTAL SCIENCE

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the types, causes, and degradation of natural resources and analyze conservation strategies for sustainable management.	1, 2	1, 4	R, U, An	F, C	L/T
CO2	Describe the structure and function of ecosystems and evaluate ecological interactions, adaptations, and biogeochemical cycles.	1, 6	1, 2	U, An, E	C, P	L
CO3	Analyze global environmental issues and assess sustainable development strategies for environmental conservation.	2, 3	1, 5	An, E	C, P	L/T
CO4	Examine environmental laws and policies and apply their significance in pollution control and biodiversity protection.	2, 5	2, 6	U, Ap, E	C, P	L,P
CO5	Assess the causes and effects of environmental pollution and develop strategies for waste management and sustainability.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-

CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓	✓	✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK5DSCBOT 302.1**				
Course Title	**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
	4	3 hours	-	2 hours	5
Pre-requisites	Students should complete the course Cell and Evolutionary Biology				
Course Summary	Gives an overview of genetics, including the history of the field, and the basic principles of inheritance and inheritance of various traits. The course imparts the role of chromosomes in inheritance, including linkage, crossing over, and sex determination and sex chromosomal anomalies. Population genetics focuses on the study of genetic variation within and between populations. Epigenetics includes basic concepts and explain the main epigenetic mechanisms and environmental influences on epigenetic modification				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Mendelian Genetics**	**5**
	1	Mendel and his experiments- Experimental plant, characters selected, Principles, reason for the success.	
	2	Monohybrid Experiments- law of segregation	

	3	Dihybrid Experiments- Law of Independent assortment, back cross and Testcross, Reciprocal cross	
II	**Interaction of Genes and Variation from Mendelian ratios**		**10**
	4	Allelic interaction- Incomplete dominance –Flower color in *Mirabilis;* Co-dominance-AB blood group, MN blood Group.	
	5	Non allelic Interaction of genes-Collaborative Gene-Comb pattern in poultry, 9:3:3:1; Epistasis – Recessive epistasis-Coat color in mice. 9:3:4; Dominant epistasis- Fruit colour in summer squash, 12:3:1; Complementary genes-Flower color in *Lathyrus* 9:7; Duplicate gene with cumulative effect- Fruit shape in summer squash. 9:6:1; Duplicate dominant genes – Fruit shape in *Capsella bursa-pastoris*-15:1; Inhibitory gene-Leaf color in Paddy, 13:3. Pleiotropism- Phenylketonuria; Penetrance and Expressivity	
III	**Patterns of Inheritance**		**10**
	6	Multiple alleles-General account. ABO blood group in man. Rh factor, Self-sterility in *Nicotiana*	
	7	Quantitative characters- General characters of quantitative inheritance, polygenic inheritance; Skin color in man, Ear size in Maize.	
	8	Extra nuclear inheritance General account, maternal influence. Plastid inheritance in *Mirabilis*. Shell coiling in snails, kappa particle in *Paramecium*.	
IV	**Chromosomal Basis of inheritance**		**15**
	9	Linkage - Linkage and its importance, linkage and independent assortment. Complete and incomplete linkage.	
	10	Crossing over – a general account, two-point, three-point cross. Determination of gene sequence. Interference and coincidence. Mapping of chromosomes.	
	11	Sex determination- Sex chromosomes, chromosomal basis of sex determination XX- XY, XX-XO mechanism. Sex determination in higher plants (*Silene lactifolia* (syn: *Melandrium album*))	

	12	Sex chromosomal abnormalities in man- Klinefelter's syndrome, Turner's syndrome. Sex linked inheritance- X- linked inheritance -White Eye colour in *Drosophila*, Hemophilia in man. Y- Linked Inheritance-Hypertrichosis of the ear.	
V		**Population Genetics and Epigenetics**	**5**
	13	Hardy Weinberg law, Factors affecting equilibrium - Mutation, Migration, selection and Genetic drift.	
	14	Epigenetics- Basic Concepts -an overview of basic genetics concepts like DNA, genes, and heredity, epigenetic mechanisms- DNA methylation, histone modifications, and non-coding RNAs. Environmental Influence: Highlight how environmental factors can influence epigenetic modifications.	
	15	Activity -Discuss studies that demonstrate how diet, stress, toxins, and lifestyle choices can impact gene expression through epigenetic changes	

Practicals (30 hrs)

Students should work out problems from the following crosses

1. Monohybrid cross (Dominance and incomplete dominance), Dihybrid cross (Dominance and incomplete dominance)
2. Gene interactions (All types of gene interactions mentioned in the syllabus)
    a. Recessive epistasis 9: 3: 4.
    b. Dominant epistasis 12: 3:1
    c. Complementary genes 9:7
    d. Duplicate genes with cumulative effect 9: 6:1
    e. Inhibitory genes 13:3
    f. Duplicate dominant gene 15: 1
    g. Collaborative gene 9:3:3:1
4. Linkage and crossing over
    a. Two-point and three-point crosses
    b. Construction of genetic map.

References

1. Gardner, E. J., Simmons, M. J., & Snustad, D. (1991). *Principles of genetics* (8th ed.). John Wiley & Sons.
2. Gardner, E. J., & Snustad, D. P. (1984). *Principles of genetics*. John Wiley & Sons.
3. Gupta, P. K. (2018). *Genetics* (5th ed.). Rastogi Publications.
4. Ringo, J. (2004). *Fundamental genetics*. Cambridge University Press India Pvt. Ltd.
5. Sinnott, E. W., Dunn, L. L., & Dobzhansky, T. (1997). *Principles of genetics*. Tata McGraw-Hill.
6. Rastogi, V. B. (2008). *Fundamentals of molecular biology*. Ane Books Pvt. Ltd.
7. Verma, P. S., & Agarwal, V. K. (2003). *Genetics*. S. Chand & Co. Ltd.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain Mendelian principles of inheritance and analyze their applications in classical genetics.	R, U, An	1, 4
CO-2	Describe gene interactions and variations from Mendelian ratios and evaluate their effects on inheritance.	U, An, E	1, 2
CO -3	Analyze patterns of inheritance, including multiple alleles, quantitative traits, and extra-nuclear inheritance, and assess their genetic significance.	An, E	1, 5
CO-4	Examine the chromosomal basis of inheritance and apply concepts of linkage, crossing over, and sex determination in genetic mapping.	U, Ap, E	2, 6
CO-5	Assess population genetics and epigenetic mechanisms and develop insights into their role in evolution and gene expression.	An, C	3, 5, 6

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

Name of the Course: GENETICS

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain Mendelian principles of inheritance and analyze their applications in classical genetics.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe gene interactions and variations from Mendelian ratios and evaluate their effects on inheritance.	1, 6	1, 2	U, An, E	C, P	L/T
CO3	Analyze patterns of inheritance, including multiple alleles, quantitative traits, and extra-nuclear inheritance, and assess their genetic significance.	2, 3	1, 5	An, E	C, P	L
CO4	Examine the chromosomal basis of inheritance and apply concepts of linkage, crossing over, and sex determination in genetic mapping.	2, 5	2, 6	U, Ap, E	C, P	L,P
CO5	Assess population genetics and epigenetic mechanisms and develop insights into their role in evolution and gene expression.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	BOTANY				
Course Code	MIUK5DSCBOT 303.1				
Course Title	ARCHEGONIATES AND PALAEOBOTANY				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge on plant classification – plant diversity				
Course Summary	To familiarize students with the characteristic features and evolutionary significance of . To impart knowledge about fossil formation and its significance. To give a basic outlook towards the ecological and economic significance of Archegoniates.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Archegoniates**	**10**
	1.	Characteristics of Archegoniates, Evolutionary significance of Archegoniates, Classification of Archegoniates, Major groups: Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms	
	2	Bryophytes- General characters and classification by Proskauer (1957), Study of habit, thallus organization, vegetative and sexual reproduction and alternation of	

		generation of the following types: *Riccia, Polytrichum* (Developmental details are not required)	
	3	Economic Importance of Bryophytes.	
II		**Pteridophytes**	**8**
	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: *Selaginella* and *Pteris* (Developmental details not required)	
	6	Economic importance of Pteridophytes	
III		**Gymnosperms**	**10**
	7	Introduction –General characters and classification by Sporne, (1965).	
	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	
IV		**Gnetum and its affinities with angiosperms**	**2**
	10	Affinities of *Gnetum* with angiosperms	
V		**Palaeobotany, Fossilization and Plant Fossils**	**15**
	11	Definition and scope of Palaeobotany, Importance of Palaeobotany in understanding plant evolution.	
	12	Geological time scale, Plant evolution and diversification over geological time.	
	13	Fossilization processes, Types of plant fossils	
	14	Extinct Plant Forms- Rhyniophytes, Lycophytes, Cycadophytes: Extinct plants and their contribution to modern biodiversity.	
	15	Major evolutionary transitions in plant history: from Bryophytes to Angiosperms. Co-evolution of plants with pollinators and other organisms	
	16	Significance of Palaeobotany and Role of Palaeobotany in	

		reconstructing the history of life on Earth.	

Practical (30 hrs)

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 leaflet, coralloid root (morphology), Male and female cones (morphology).
6. *Pinus*- spur shoot, T.S. of needle, male and female cone (morphology).
7. *Gnetum*- T.S of stem and leaf, male and female cone (morphology)
8. Observing the fossilized specimens and permanent slides of fossil plant parts.

References

1. Pandey, B. P. (2010). *College botany (Vol. II).* Chand Publications.
2. Parihar, N. S. (2015). *An introduction to Embryophyta: Pteridophytes.* Surjeet Publications.
3. Rashid, A. (2012). *An introduction to bryophytes.* Vikas Publishing House.
4. Chopra, R. N., & Kumra, P. K. (2005). *Biology of bryophytes.* New Age International Publishers.
5. Cutler, J. M., & Chamberlain, C. J. (1958). *Morphology of gymnosperms.* Central Book Depot.
6. Gupta, V. K., & Varshneya, U. D. (1967). *An introduction to gymnosperms.* Kedarnath.
7. Pandey, B. P. (1972). *College botany (Vol. I).* Chand Publications.
8. Sambamurthy, A. V. (2005). *A textbook of bryophytes, pteridophytes, gymnosperms, and palaeobotany.* IK International Pvt. Ltd.
9. Sharma, A. K., & Rajeswari Sharma. (2010). *Palaeobotany and gymnosperms.*
10. Sharma, O. P. (2016). *Gymnosperms.* Pragathi Prakashan.
11. Smith, G. M. (1955). *Cryptogamic botany (Vol. II).* McGraw-Hill.
12. Sporne, K. R. (1966). *Morphology of pteridophytes.* Hutchinson University

Library.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyze the evolutionary significance, classification, and life cycle patterns of archegoniates, with emphasis on bryophyte structure, reproduction, and economic importance.	U, An	1, 4
CO-2	Examine the morphology, anatomy, reproduction, and life cycles of representative pteridophytes and evaluate their evolutionary position and economic importance.	An,E	1, 2
CO -3	Analyze structural and reproductive features of major gymnosperms and interpret their life cycle patterns and economic significance.	U, An	2, 5
CO-4	Compare the morphological and reproductive affinities of Gnetum with angiosperms and assess its evolutionary significance.	An,E	3, 6
CO-5	Evaluate fossilization processes, geological time scale, and major evolutionary transitions to interpret plant evolution and reconstruct the history of plant life on Earth.	An, E, C	3, 5, 6

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

Name of the Course: ARCHEGONIATES AND PALAEOBOTANY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO-1	Analyze the evolutionary significance, classification, and life cycle patterns of archegoniates, with emphasis on bryophyte structure, reproduction, and economic	1,2 ,3	1,2,6	U, An	F, C	L/T

	importance.					
CO-2	Examine the morphology, anatomy, reproduction, and life cycles of representative pteridophytes and evaluate their evolutionary position and economic importance.	1,2,3,6	1,2,4,6	An, E	C, P	L/P
CO -3	Analyze structural and reproductive features of major gymnosperms and interpret their life cycle patterns and economic significance.	1,2,3	1,2,6	U, An	C, P	L/P
CO-4	Compare the morphological and reproductive affinities of Gnetum with angiosperms and assess its evolutionary significance.	2,3,6	1,2,5,6	An, E	C, M	L
CO-5	Evaluate fossilization processes, geological time scale, and major evolutionary transitions to interpret plant evolution and reconstruct the history of plant life on Earth.	2,3,5,6	1,2,4,5,6,7	An, E, C	C, M	L

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

Mapping of COs with PSOs and POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	2	-	-	-	-	3	2	-	-	-	2	-
CO2	3	3	2	-	-	1	-	3	3	-	1	-	2	-
CO3	3	2	2	-	-	-	-	3	2		-	-	3	-
CO4	2	3	2	-	-	1	-	2	3	-	-	1	2	
CO5	2	3	3	-	2	3	-	2	3	-	1	3	3	1

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓		✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK5DSCBOT 304.1**				
Course Title	**ANGIOSPERM TAXONOMY AND MODERN TRENDS IN 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
	4	3 hours	-	2 hours	5
Pre-requisites	Students require knowledge on plant diversity, and angiosperm morphology and anatomy				
Course Summary	This course explores the field of plant systematics, focusing on the classification, identification, and nomenclature of angiosperms (flowering plants). It covers traditional and modern methods of plant classification, ranging from morphological and anatomical approaches to modern molecular techniques. The course aims to provide students with a comprehensive understanding of the classification of plants and introduce them to the latest advancements in molecular plant systematics.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Taxonomy *vs* Systematics**	**2**
	1	Definition and Scope of taxonomy and systematics	
	2	Main focus of plant taxonomy- classification, nomenclature	

		and identification Main focus of plant systematics- Analyzing the phylogenetic relationships, Studying the origin, diversification, and adaptation of plant groups over time.	
II	**Angiosperm taxonomy**		**8**
	3	Historical development of the systems of angiosperm classification: 1. Artificial- sexual system of Linnaeus 2. Natural - Bentham and Hooker (**detailed account**) 3. Phylogenetic- Engler and Prantl (Brief account only)	
	4	Basic rules of Binomial Nomenclature and International Code of Nomenclature of plants (ICN). Outline- Rule of priority and its limitations, Author citation -typification (Holotype, Isotype, Syntype, Paratype, and Lectotype), Effective and valid publication, Nomina rejicienda, Nomina conservenda.	
	5	Taxonomic aids- Herbarium, techniques, preparation, International (Kew, K), National (Central National Herbarium, CAL), BSI Coimbatore, JNTBGRI, Virtual herbarium (concept and example only)- Botanical gardens and its role- important Botanic gardens: RBG, Kew; Acharya Jagadeesh Chandrabose Indian Botanic Garden-Calcutta, JNTBGRI, Thiruvananthapuram- Botanical Survey of India- Structure and organization. Taxonomic Literature: Floras, Monographs, Revisions and Journals- Taxonomic keys:	
III	**Taxonomic study of Angiosperm families**		**12**
	6	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*	
IV		**Modern trends in plant taxonomy**	**8**
	7	Principles of numerical taxonomy- steps involved, phenograms and cluster analysis	
	8	Phylogenetic Systematics (Cladistics)-Basics of cladistics and its importance, Cladograms and their interpretation, Monophyly, paraphyly and polyphyly, Molecular systematics and its role in cladistics	
	9	Angiosperm phylogeny and APG classification- Introduction to APG classification. Differences between traditional (Cronquist) and modern (APG) classification	
	10	Orders and families recognized in APG IV	
V		**Molecular taxonomy and DNA Barcoding**	**15**
	11	Role of molecular markers in plant taxonomy	
	12	DNA barcoding and its applications	
	13	Common molecular techniques- RAPD, RFLP, AFLP, SSR, SNP, ITS, cpDNA, mtDNA, rbcL, matK	
	14	Digital herbarium- Indian Virtual Herbarium, Kew Herbarium Catalogue, Auroville Virtual Herbarium, Virtual herbarium of Kerala Forest Research Institute. Virtual taxonomy databases, Global Taxonomy Initiative (GTI) (https://www.cbd.int/gti/tools)	
	15	Role of AI and machine learning in plant identification.	

Practicals (30 hrs)

1. Study of plant families mentioned in the syllabus
    - using morphological features,
    - Flower dissection and identification of floral parts,
    - construction of floral diagram and floral formula
    - Identification of families based on floral morphology
2. Plant collection and Herbarium preparation of plants belonging to families mentioned in the syllabus
3. Using software (e.g., MEGA) to generate phylogenetic trees from molecular data.
4. Molecular Systematics Techniques
    - DNA extraction, PCR amplification, and gel electrophoresis.
    - Using molecular markers for classification (e.g., RAPD, ISSR).
    - Sequence data analysis and phylogenetic tree generation.

References

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.
5. Hutchinson, J. (1959). *The Families of Flowering plants*. Oxford.
6. Judith, E.W. (2002). *Describing Plant Species*.
7. Kitching, I.J. et al. (1998). *Cladistics – the theory and practice of Parsimony Analysis*. Oxford University Press.
8. Michael G. Simpson. (2019) *Plant systematics*
9. Mukash Biswas (2014). *Taxonomy of Angiosperms*, Thomson publishers, ND
10. Naik, V.N. (1984). *Taxonomy of Angiosperms*. Tata McGraw Hill, NewYork.
11. Pandey & Misra (2014). *Taxonomy of Angiosperms*, , Ane Books, India
12. Pandey, B. P. (2001) *Taxonomy of Angiosperms*. S Chand and Co

13. Sinha, R. K. (2010). *Practical Taxonomy of Angiosperms*. IK International Publishing Pvt Ltd.
14. Sivarajan, V.V (1991). *Introduction to the principle of plant taxonomy*, Oxford and IBH Publishing Company
15. Subrahmanyam, N. S. (2006). Modern Plant Taxonomy. Vikas publishing House 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 concept of classification and different systems of classification and differentiates plant taxonomy and systematics	U, An	1, 4
CO-2	Understand taxonomic hierarchy and various new branches in taxonomy	U, An	1, 2
CO -3	Conduct plant identification and classification through both morphological and molecular methods.	Ap, An	2, 5
CO-4	Use molecular data to resolve taxonomic and phylogenetic questions.	Ap, E	3, 6
CO-5	Apply systematics in the conservation and study of plant biodiversity.	An, C	3, 5, 6

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

Name of the Course: ANGIOSPERM TAXONOMY AND MODERN TRENDS IN 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	Understand the concept of classification and different systems of classification and differentiates plant taxonomy and systematics	1, 2	1, 4	U, An	F, C	L/T

CO-2	Understand taxonomic hierarchy and various new branches in taxonomy	2, 3	1, 2	U, An	C, P	L
CO -3	Conduct plant identification and classification through both morphological and molecular methods.	3, 5	2, 5	Ap, An	C, P	L/P
CO-4	Use molecular data to resolve taxonomic and phylogenetic questions.	3, 6	3, 6	Ap, E	C, M	L/P
CO-5	Apply systematics in the conservation and study of plant biodiversity.	3, 7	3, 5, 6	An, C	C, M	L/P

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK5DSEBOT 300.1**
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
	4	3 hours	-	2 hours	5

Pre-requisites	Should have a knowledge about plant cell and cell division.
Course Summary	The field of plant biotechnology involves the manipulation of plant cells, tissues, and organs for agricultural, medicinal, and industrial applications. It includes techniques such as callus culture, cell suspension culture, organogenesis, and somatic embryogenesis. Students will learn principles and methods of genetic engineering, recombinant DNA technology, and transformation techniques. They will also gain practical skills in plant tissue culture and biotechnological techniques, with hands-on experience in laboratory work to explore the molecular biology of plants.

Detailed Syllabus:

Module	Unit	Content	Hrs
		Plant Tissue Culture	**6**
	1	Introduction – History- major achievements-Biotechnology in India.	

I	2	Plant Tissue culture – Totipotency- definition and importance – dedifferentiation, redifferentiation and cytodifferentiation.	
	3	Equipments and other requirements in tissue culture laboratory – instruments, tools, glass wares	
	4	Sterilization- Explants, equipments and medium	
	5	Culture media-MS Medium, composition and preparation	
	6	Inoculation – Subculture, Callus and suspension culture, meristem culture	
	7	Soma clonal variation, Somatic embryogenesis, Embryo culture and embryo rescue. and organogenesis.	
	8	Production of haploids – pollen culture, anther culture – protoplast culture –somatic hybrids – cybrids - for production of haploid Plant hardening transfer to soil, green house technology.	
	9	Economic exploitation of plant tissue culture.	
II	**Recombinant DNA technology**		**6**
	10	General account of cloning vehicles – plasmid, bacteriophages, cosmids and phagemids. Cutting and joining of DNA molecules – restriction endonucleases, ligases – Gene library.	
	11.	Brief account of gene transfer techniques – Direct DNA uptake by protoplast vector method Agrobacterium mediated, physical method- electroporation- shot gun method – microinjection.	
III	**Methods in Biotechnology.**		**9**
	12	Isolation and purification of DNA from plant cells.	
	13	Agarose gel electrophoresis	
	14	PCR, RFLP, DNA sequencing-Sanger's method, Next-generation sequencing (NGS), Southern blotting, ELISA.	
	15	Forensics - DNA finger printing.	
IV	**Application of genetic transformation**		**9**
	16	Medicine – edible vaccines from plants, gene therapy	

	17	Agriculture – nif genes, genetically modified crops – Golden rice, Flavr-savr tomato, Bt crops - herbicide resistance, fungal resistance,	
	18	Environment- Bioremediation- use of genetically engineered bacteria-Super bug	
	19	Production technology of plantibodies and monoclonal antibodies by hybridoma technology. Transgenic plants as bioreactors.	
	20	Biosafety and ethical issues, Intellectual Property Rights (IPR)	
V	**Industrial applications**		**15**
	21	Horticulture and Floriculture Industry,	
	22	Production of alcohol	
	23.	Production of vitamins	
	24.	Single cell protein	

Practicals (30 hrs)

1. Preparation of MS medium.
2. Process of *in vitro* sterilization and inoculation methods by using different explants (leaf, nodal bud and seeds of tobacco, Datura, Brassica)
3. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis
4. Extraction and separation of plant DNA by agarose gel electrophoresis.
5. Extraction and separation of Plant protein by SDS-PAGE**.**
6. Visit to biotechnology lab and document.

Reference

1. Bhojwani, S. S., & Dantu, P. K. (2013). *Plant tissue culture: An introductory text*. Springer.
2. Bhojwani, S. S., & Bhatnagar, S. P. (2011). *The embryology of angiosperms* (5th ed.). Vikas Publication House Pvt. Ltd.

3. Bhojwani, S. S., & Razdan, M. K. (1996). *Plant tissue culture: Theory and practice*. Elsevier Science.
4. Chawla, H. S. (2002). *Introduction to plant biotechnology*. Oxford and IBH Publishing Co. Pvt. Ltd.
5. Glick, B. R., & Pasternak, J. J. (2003). *Molecular biotechnology: Principles and applications of recombinant DNA*. ASM Press.
6. Halford, N., & Halford, N. G. (2007). *Plant biotechnology: Current and future applications of genetically modified crops*. John Wiley & Sons.
7. Ignacimuthu, S. (2004). *Plant biotechnology*. Oxford and IBH Publishing House.
8. Kumar, U. (2008). *Plant biotechnology and biodiversity conservation*. Agrobios.
9. Snustad, D. P., & Simmons, M. J. (2010). *Principles of genetics* (5th ed.). John Wiley & Sons.
10. Stewart, C. N., Jr. (2008). *Plant biotechnology & genetics: Principles, techniques, and applications*. John Wiley & Sons Inc.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the principles and techniques of plant tissue culture and analyze its role in biotechnology and economic applications.	R, U, An	1, 4
CO-2	Describe the fundamentals of recombinant DNA technology and evaluate various gene transfer techniques used in plant genetic engineering.	U, An, E	1, 2
CO -3	Analyze key molecular biology techniques, including DNA isolation, sequencing, and PCR, and assess their applications in genetic research and forensic science.	An, E	1, 5
CO-4	Examine the applications of genetic transformation in medicine, agriculture, and the environment and apply biotechnology in bioremediation and	U, Ap, E	2, 6

	transgenic plant production.		
CO-5	Assess industrial applications of biotechnology in horticulture, floriculture, alcohol, vitamins, and single-cell protein production and develop strategies for their commercialization.	An, C	3, 5, 6

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

Name of the Course: PLANT BIOTECHNOLOGY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the principles and techniques of plant tissue culture and analyze its role in biotechnology and economic applications.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe the fundamentals of recombinant DNA technology and evaluate various gene transfer techniques used in plant genetic engineering.	1, 6	1, 2,7	U, An, E	C, P	L
CO3	Analyze key molecular biology techniques, including DNA isolation, sequencing, and PCR, and assess their applications in genetic research and forensic science.	2, 3	1, 5,7	An, E	C, P	L
CO4	Examine the applications of genetic transformation in medicine, agriculture, and the environment and apply biotechnology in bioremediation and transgenic plant production.	2, 5	2, 6	U, Ap, E	C, P	L,P

CO5	Assess industrial applications of biotechnology in horticulture, floriculture, alcohol, vitamins, and single-cell protein production and develop strategies for their commercialization.	3, 7	3, 5, 6	An, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	1
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	1
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓	✓	✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK5DSEBOT 301.1**				
Course Title	**FORESTRY AND PHYTOGEOGRAPHY**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Awareness about forestry and phytogeography				
Course Summary	Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundementals of forestry**	**5**
	1	Basic concepts: Definitions (Forestry, Silviculture, Pollarding, Coppice, Seed orchards, Shelter belts, Logging, Succession).	
	2	Forest classification: Reserved, Protected, and Unclassed forests.	
	3	Reserved forest, Protected forest, Unclassed forest, Log,Logging, Pod, Raft, Scrub, Succession.	
II		**Silviculture**	**5**

	4	Scope & management of forest crops.	
	5	Silviculture systems: General, Mangrove, Cold desert, and Tree Silviculture.	
	6	Forest soils & conservation: Soil chemistry, fertility, watershed management.	
III		**Forest**	**13**
	7	Types & functions of forests.	
	8	Agroforestry: Concepts, objectives, classification, tree-crop interactions, benefits, limitations, urban forestry.	
	9	Social forestry: Objectives, necessity, implementation at local/national levels.	
	10	Forest protection: Threats (fires, pests, diseases, invasive species), management methods (biological, chemical, integrated).	
	11	Wildlife management: Food chains, prey-predator dynamics, Man and Biosphere (MAB) program.	
	12	Activity: PowerPoint presentation on forest types.	
IV		**Phytogeography**	**7**
	13	Concepts & species distribution: Continental drift, continuous & discontinuous patterns.	
	14	Vegetation of India: Forests (Tropical, Temperate, Alpine, Mangroves, Grasslands).	
	15	Phytogeographical regions of India: Western & Eastern Himalayas, Desert, Western Ghats, Deccan Peninsula, Gangetic Plain, North East India, Coasts & Islands.	
	16	Activity: Site study of regional vegetation.	
V		**Forest policies**	**15**
	17	Indian forest policies: Key features.	
	18	Forest laws & acts: Indian Forest Act (1927), Forest Conservation Act (1980), Wildlife Protection Act, Tribal Bill (2007), Biodiversity Bill (2002), National Agroforestry	

		Policy (2014).	
	19	Global policies & agreements: ITTO, GATT, Rio Summit, Kyoto Protocol—impact on timber export.	

Practicals (30 hrs)

1. Phytogeographical regions of India- Photos/Diagram
2. Field visit to a relevant phytogeographical region and submit a report.
3. Identification of Forest trees.
4. Identification of major agro-forestry trees and plants used in silviculture (Kerala context)

References

1. Baumer, M. (1989). *Agroforestry for watershed management.* ICRAF.
2. Datta, S. K. (1986). *Soil conservation and land management.* International Book Distributors.
3. Dhruva Narayana, V. V. (1993). *Soil and water conservation research in India.* ICAR.
4. Hamilton, I. S. (1987). *Forest and watershed development and conservation in Asia and the Pacific.* International Book Distributors.
5. Hamilton, I. S. (1988). *Tropical forest watersheds: Hydrologic and soil response to major uses of conservation.* International Book Distributors.
6. Hewlett, J. D., & Nutter, W. L. (1969). *An outline of forest hydrology.* University of Georgia Press.
7. Moorthy, V. V. N. (1990). *Land and water management.* Kalyani Press.
8. Morgan, R. P. C. (1984). *Soil conservation.* Nataraj Publishing.
9. Murty, J. V. S. (1995). *Watershed management in India.* Wiley Eastern.
10. Oswal, M. C. (1999). *Watershed management (For dryland agriculture).* Associated Publishing.
11. Rajora, R. (1998). *Integrated watershed management.* Ravat Publications.
12. Rama Rao. (1980). *Soil conservation.* Standard Book Depot.
13. Satterlund, D. R. (1972). *Wildland watershed management.* The Ronald Press.
14. .Edwards, D.G.W and Naithani, S.C. 1999. Seed and nursery Technology for Forest Trees. New Agri. International Publishers, New Delhi.

15. Gurumurthy, K., Mcena, D and Bhandari, H.C.S 1989.Vegetative Propagation, IFGTB, Coimbatore
16. Hartmann, H.T.,Kester, D.E, Davies, F.T and Geneva, R.L 1997. Plant Propagation Principles and Practices, Prentice hall of India, Pvt. Ltd, New Delhi
17. Duryea ML. and Landis TD. (eds). 1984. Forest tree nursery manual: Production of bare root seedlings. Martinus Nijhoff/Dr W. Junk publishers, 385p.
18. Sagwal, S.S. 1994. Trees on marginal lands. Scientific Publishing Company, Jodhpur.
19. Surendran, C., Parthiban, K.T., Vanangamudi, K and Balaji, S. 2000. Vegetative propagation of trees- Principles and Practices, Tamil Nadu Agricultural University, Coimbatore.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain fundamental forestry concepts, afforestation, and reforestation strategies and analyze their role in sustainable forest management.	R, U, An	1, 4
CO-2	Describe silviculture systems, soil conservation methods, and forest protection strategies and evaluate their impact on ecosystem stability.	U, An, E	1, 2
CO -3	Analyze the ecological significance of agroforestry, social forestry, and urban forestry and assess their contributions to biodiversity conservation and climate resilience.	An, E	1, 5
CO-4	Examine phytogeographical regions of India and apply phytogeographical principles to understand plant distribution and conservation.	U, Ap, E	2, 6
CO-5	Assess national and international forest policies and laws and develop insights into their role in sustainable forestry and biodiversity protection.	An, C	3, 5, 6

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

Name of the Course: FORESTRY AND PHYTOGEOGRAPHY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain fundamental forestry concepts, afforestation, and reforestation strategies and analyze their role in sustainable forest management.	1, 2	1, 4	R, U, An	F, C	L
CO2	Describe silviculture systems, soil conservation methods, and forest protection strategies and evaluate their impact on ecosystem stability.	1, 6	1, 2	U, An, E	C, P	L
CO3	Analyze the ecological significance of agroforestry, social forestry, and urban forestry and assess their contributions to biodiversity conservation and climate resilience.	2, 3	1, 5	An, E	C, P	L
CO4	Examine phytogeographical regions of India and apply phytogeographical principles to understand plant distribution and conservation.	2, 5	2, 6	U, Ap, E	C, P	L,P/T
CO5	Assess national and international forest policies and laws and develop insights into their role in sustainable forestry and biodiversity protection.	3, 7	3, 5, 6	An, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-

CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓	✓	✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK5DSEBOT 302.1**
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
	4	3 hours	-	2 hours	5

Pre-requisites	Basicunderstanding in principles of Horticulture.
Course Summary	Provides a comprehensive understanding of essential horticultural principles and plant propagation methods. Understand and learn to apply concepts in garden designing, nursery management and sustainable horticultural practices.

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of Horticulture and Propagation Techniques**	**5**
	1	Fundamentals of Horticulture: Definition, scope, importance in modern society, divisions of horticulture.	
	2	Soil, Fertility, and Irrigation Management: Soil composition and types, preparation of potting mixtures; Irrigation methods: surface, sprinkler, and drip systems.	
	3	Vegetative Propagation Methods: Cutting; Layering (Air layering, Ground layering - Tip, Trench, Compound);	

		Budding (T-budding); Grafting (Approach grafting, Bridge grafting, Whip and tongue grafting).	
II	**Nutrient Management and Garden Design**		10
	4	Manures and Fertilizers: Types, application methods, timing and frequency, soil amendments, pH management, Integrated Nutrient Management (INM).	
	5	Components of Garden: Design principles, plant selection, site preparation, planting techniques, maintenance, hard and soft landscaping elements, specialty gardens (herbal, butterfly, rooftop gardens).	
III	**Nursery Management**		**10**
	6	Introduction to Nursery Management: Definition, significance, role in horticulture, types of nurseries, essential infrastructure (greenhouses, shade structures, propagation areas).	
	7	Nursery Stock Selection and Management: Criteria for selecting ornamentals, fruit trees, shrubs; Procurement, maintenance of mother plants; Inventory management; Pest and disease control using biopesticides.	
IV	**Entrepreneurship in Nursery Management**		**5**
	8	Business Planning and Development: Budgeting, financial management, record-keeping, legal and regulatory requirements for nursery operations.	
	9	Marketing and Sales Strategies**:** Market analysis, branding, packaging, product presentation, advertising, promotions, use of social media.	
V	**Advanced Horticulture Practices and Sustainable Management**		**15**
	10	Advances in Horticulture: Precision Nursery Management (Remote sensing, sensor networks, drones); Controlled Environment Agriculture (CEA) (Aquaponics, Hydroponics); Vertical Nursery Production (Multi-level shelving, stacked container systems).	
	11	Sustainable Horticulture Practices**:** Organic farming, crop	

		rotation, sequential cropping, polyculture, agroforestry, soilless cultivation.	

Practicals (30 hrs)

1. Preparation of potting mixtures, demonstration of budding, layering and grafting techniques
2. Hands-on training in garden layout design, fertilizer application, and nursery bed preparation.
3. Identification of healthy nursery stock, pest management techniques, and greenhouse management
4. Development of a small-scale nursery business plan, marketing strategy presentation
5. Demonstration of hydroponic and aquaponic techniques; visit to an organic farm or nursery.

References

1. Acquaah, G. (2012). *Horticulture: Principles and Practices* (4th ed.). Pearson.
2. Adams, C. R., & Early, M. P. (2011). *Principles of Horticulture* (5th ed.). Routledge.
3. Brown, T. A. (2020). *Genetic Engineering in Horticulture*. Oxford University Press.
4. Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2010). *Plant Propagation: Principles and Practices* (8th ed.). Pearson.
5. Janick, J. (2011). *Horticultural Science* (3rd ed.). W. H. Freeman.
6. Kumar, N. (2019). *Introduction to Horticulture*. Oxford & IBH Publishing.
7. Rice, G. (2017). *The Garden Book: Planning, Designing, and Planting Gardens*. DK Publishing.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamentals of horticulture, soil management, and vegetative propagation	U, Ap	1, 4

	techniques.		
CO-2	Demonstrate knowledge of garden design, nutrient management, and fertilizer application in horticultural practices.	Ap, An	1, 2
CO -3	Analyze nursery management practices, including stock selection, pest control, and inventory management.	An, E	2, 5
CO-4	Apply entrepreneurial skills in nursery management, business planning, and marketing strategies.	Ap, C	3, 6
CO-5	Evaluate advanced horticultural practices such as precision nursery management, hydroponics, aquaponics, and sustainable horticulture techniques.	E, C	3, 5, 6

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)
CO1	Understand the fundamentals of horticulture, soil management, and vegetative propagation techniques.	1, 2	1, 4	U, Ap	F, C	L
CO2	Demonstrate knowledge of garden design, nutrient management, and fertilizer application in horticultural practices.	2, 3	1, 2	Ap, An	C, P	L,P
CO3	Analyze nursery management practices, including stock selection, pest control, and inventory management.	3, 5	2, 5	An, E	C, P	L,P/T
CO4	Apply entrepreneurial skills in nursery management, business planning, and	3, 6	3, 6	Ap, C	C, M	L,P/T

	marketing strategies.					
CO5	Evaluate advanced horticultural practices such as precision nursery management, hydroponics, aquaponics, and sustainable horticulture techniques.	3, 7	3, 5, 6	E, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓	✓	✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">BOTANY</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK5SECBOT 300.1</td></tr>
<tr><td>Course Title</td><td colspan="5">MUSHROOM CULTIVATION</td></tr>
<tr><td>Type of Course</td><td colspan="5">SEC</td></tr>
<tr><td>Semester</td><td colspan="5">V</td></tr>
<tr><td>Academic Level</td><td colspan="5">300-399</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>3</td><td>2 hours</td><td>-</td><td>2 hours</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">The course helps understand sterile techniques, nutrient requirements, and environmental conditions needed for successful mushroom cultivation.</td></tr>
<tr><td>Course Summary</td><td colspan="5">Enable the students to identify edible and poisonous mushrooms
After completion of course students should be able to prepare bed for mushroom cultivation and storage. Help the students to learn a means of self-employment and income generation by cultivating mushrooms.</td></tr>
</table>

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Mushrooms**	**10**
	1	History and introduction: Edible mushrooms and Poisonous mushrooms. Systematic position, morphology, distribution-Vegetative characters	
		Common edible mushrooms	**5**

II	2	Button mushroom (*Agaricus bisporus*), Milky mushroom (*Calocybe indica*), Oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom (*Volvariella volvcea*).	
	3	Activity: Collection of different types of mushrooms	
III		**Principles of mushroom cultivation**	**10**
	4	Cultivation: Paddy straw mushroom – substrate, spawn making. Methods – bed method, polythene bag method, field cultivation. Oyster mushroom cultivation –Substrate, spawning, pre-treatment of substrate. Maintenance of mushroom.	
	5	Diseases, pests and nematodes, weed moulds and their management strategies.	
	6	Processing - Blanching, steeping, sun drying, canning, pickling, freeze drying, Storage – short term and long term storage.	
	7	Storage – short term and long-term storage.	
IV		**Health benefits of mushroom**	**5**
	8	Nutritional and medicinal values of mushrooms. Therapeutic aspects- Antiviral, antibacterial effect, antifungal effect, anti-tumour effect.	
V		**Mushroom Marketing**	**15**
	9	Common Indian mushrooms. Production level, economic return, foreign exchange from Mushroom cultivating countries and international trade	

Practicals (30 hrs)

1.Sterilization and sanitation of mushroom house, instruments and substrates

2. Preparation of mother culture, media preparation, inoculation, incubation and spawn production

3. Cultivation of oyster mushroom using paddy straw/agricultural wastes

4. Visit to a mushroom cultivating laboratory

References

1. Pandey, B. P. (1996). *A textbook of fungi*. Chand and Company.
2. Kalc, P. (2016). *Edible mushrooms: Chemical composition and nutritional value*. Elsevier Book Aid International.
3. Marimuthu, T., et al. (1991). *Oster mushroom*. Department of Plant Pathology, Tamil Nadu Agricultural University.
4. Bhal, N. (2000). *Handbook on mushrooms* (2nd ed., Vol. I & II). Oxford and IBH Publishing Co. Pvt. Ltd.
5. Pandey, R. K., & Ghosh, S. K. (1996). *A handbook on mushroom cultivation*. Emkey Publications.
6. Pathak, V. N., & Yadav, N. (1998). *Mushroom production and processing technology*. Agrobios.
7. Kapoor, S. C., & Tewari, P. (1988). *Mushroom cultivation*. Mittal Publications.
8. Tripathi, D. P. (2005). *Mushroom cultivation*. Oxford & IBH Publishing Co. Pvt. Ltd.
9. Pathak, V. N., Yadav, N., & Gaur, M. (2000). *Mushroom production and processing technology*. Vedams Ebooks Pvt. Ltd.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the history, classification, and morphology of edible and poisonous mushrooms and analyze their significance in the fungal kingdom.	1, 4	R, U, An
CO-2	Identify and describe common edible mushrooms and apply knowledge in their collection and documentation.	1, 2	U, Ap
CO -3	Analyze the principles of mushroom cultivation, including substrate preparation, spawn making, and disease management, and evaluate processing and storage techniques.	1, 5	An, E
CO-4	Examine the nutritional and medicinal benefits of mushrooms and assess their therapeutic	2, 6	U, E

	applications in healthcare.		
CO-5	Assess the economic potential of mushroom cultivation and develop strategies for mushroom marketing and trade.	3, 5, 6	An, C

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)
CO1	Explain the history, classification, and morphology of edible and poisonous mushrooms and analyze their significance in the fungal kingdom.	1, 2	1, 4	R, U, An	F, C	L
CO2	Identify and describe common edible mushrooms and apply knowledge in their collection and documentation.	1, 6	1, 2	U, Ap	C, P	L,P/T
CO3	Analyze the principles of mushroom cultivation, including substrate preparation, spawn making, and disease management, and evaluate processing and storage techniques.	2, 3	1, 5	An, E	C, P	L,P
CO4	Examine the nutritional and medicinal benefits of mushrooms and assess their therapeutic applications in healthcare.	2, 5	2, 6	U, E	C, P	L
CO5	Assess the economic potential of mushroom cultivation and develop strategies for mushroom marketing and trade.	3, 7	3, 5, 6	An, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	3	-	-	-	-	2	-	3	2	-	-	-	-	-
CO3	-	3	2	-	-	-	-	3	-	-	-	2	-	-
CO4	-	3	-	-	2	-	-	-	3	-	-	-	2	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓	✓	✓
CO5	✓	✓		✓

SEMESTER VI

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK6DSCBOT 350.1**				
Course Title	**HORTICULTURE AND PLANT BREEDING**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic interest in horticulture				
Course Summary	Understanding the importance of horticulture. Learn the methods of plant reproduction and propagation. Demonstrate proficiency in the techniques and practices used in the cultivation, propagation, management of horticultural crops, irrigation, pest control, and crop maintenance. Exploring various career paths in horticulture, including roles in research, extension and industry.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Horticulture**	**7**
	1	Introduction, scope and significance; branches of horticulture.	
	2	Principles of garden making and components of garden- trees	

		, shrubs, shrubberies, climbers and creepers, flower bed , borders, ornamental hedges and edges. Lawns and landscaping	
	3	Potting mixture and potting medi. Irrigation methods– Surface, sprinkle, drip and gravity irrigation.	
	4	Manures and Fertilizers- farm yard manure, compost, vermin compost, biofertilizers, chemical fertilizers. Time and application of manures and fertilizer , foliar sprays. Growth regulators in horticulture: Rooting hormones, Growth promoters, Flower induction, Parthenocarpy.	
	5	Flower Arrangement- Containers and requirements for flower arrangements Free style, Shallow and Mass arrangement, Japanese –Ikebana, Bouquet and garland making. Dry flower arrangement Bonsai–Principle, creating the bonsai. Cultivation and post-harvest management of vegetables and ornamental plants.	
II		**Plant Propagation**	**9**
	6.	Cuttings- root, stem, leaf Layering – Air layering, Ground layering (Tip, Trench and Compound) Budding – T-Budding, Grafting – Approach grafting, Bridge grafting, whip and tongue grafting. Activity: Should be trained in - Cutting/ layering/ grafting/budding.	
III		**Plant Breeding**	**9**
	7	History of plant breeding. Concept of centres of origin, their importance with reference to Vavilov's work. Important national and international plant breeding Institutes. Contribution of M.S. Swaminathan.	
	8	Plant introduction. Agencies of plant introduction in India, Procedure of introduction - Acclimatization -Achievements.	

IV	**Breeding Techniques**		**5**
	9	Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods.	
	10	Hybridization: Procedure of hybridisation, inter generic, inter specific, inter varietal hybridisation with examples. Composite and synthetic varieties.	
	11	Heterosis and inbreeding depression- genetic basis; male sterility	
	12	Mutation breeding – method – achievements in India	
V	**Seed Technology**		**15**
	13	Seed Priming and seed Pelletting; Commercial seed Trade; Genetically Modified Seeds; Seed Industry; Seed Certification. Quarantine measures. Plant breeder's rights Act. National Biodiversity Policy. Modern tools for plant breeding: Genetic Engineering and products of genetically modified crops (brief study only).	

Practicals (30 hrs)

1. Students must be trained to do Cutting/ layering/ grafting/budding.
2. Preparation of nursery bed
3. Preparation of potting mixture – Potting, repotting.
4. Field work in cutting, grafting, budding, layering
5. Familiarizing gardening tools and implements
6. Visit to a horticulture station
7. Techniques of emasculation and hybridization of any bisexual flower.
8. Estimation of pollen sterility and fertility percentage
9. Visit to plant breeding station. Submit a report

References

1. Adriance, G. W., & Brison, F. R. (1955). *Propagation of horticultural plants* (2nd ed.). McGraw-Hill.
2. Acquaah, G. (2005). *Horticulture: Principles and practices* (3rd ed.). Pearson Education.
3. Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2011). *Hartmann & Kester's plant propagation: Principles and practices* (8th ed.). Prentice Hall.
4. Kolay, A. K. (2000). *Basic concepts of soil science* (2nd ed.). New Age International Publishers.
5. Sinha, N. (1996). *Gardening in India*. Abhinav Publications.
6. Allard, R. W. (1960). *Principles of plant breeding*. John Wiley & Sons.
7. Chaudhari, H. K. (1984). *Elementary principles of plant breeding*. Oxford & IBH Publishing Co.
8. Singh, B. D. (2005). *Plant breeding: Principles and methods* (7th ed.). Kalyani Publishers.
9. Swaminathan, M. S., Gupta, P. K., & Sinha, U. (1983). *Cytogenetics of crop plants*.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the scope, principles, and techniques of horticulture, including garden design, irrigation methods, and plant nutrition.	R, U, Ap	1, 4
CO-2	Demonstrate various plant propagation techniques such as cutting, layering, grafting, and budding and apply them in practical horticultural practices.	Ap, An	1, 2
CO -3	Explain the fundamental concepts of plant breeding, centers of origin, and the contributions of key scientists, and evaluate their impact on modern agriculture.	U, E	2, 5
CO-4	Analyze different breeding techniques such as selection, hybridization, heterosis, and mutation breeding and assess their applications in crop	An, E	3, 6

	improvement.		
CO-5	Evaluate seed technology methods, including seed certification, quarantine, and genetic engineering, and apply knowledge to sustainable seed production and biodiversity conservation.	E, Ap	3, 5, 6

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

Name of the Course: HORTICULTURE AND PLANT BREEDING

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the scope, principles, and techniques of horticulture, including garden design, irrigation methods, and plant nutrition.	1, 2	1, 4	R, U, Ap	F, C	L,P/T
CO2	Demonstrate various plant propagation techniques such as cutting, layering, grafting, and budding and apply them in practical horticultural practices.	2, 3	1, 2	Ap, An	C, P	L,P/T
CO3	Explain the fundamental concepts of plant breeding, centers of origin, and the contributions of key scientists, and evaluate their impact on modern agriculture.	2, 5	2, 5	U, E	C, P	L
CO4	Analyze different breeding techniques such as selection, hybridization, heterosis, and mutation breeding and assess their applications in crop improvement.	3, 6	3, 6	An, E	C, M	L,P
CO5	Evaluate seed technology methods, including seed certification, quarantine, and genetic engineering, and apply knowledge to sustainable	3, 7	3, 5, 6	E, Ap	C, M	L,P

	seed production and biodiversity conservation.					

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓	✓	✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK6 DSCBOT 351.1**				
Course Title	**PLANT PHYSIOLOGY AND PHYTOCHEMISTRY**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	A solid understanding of basic biology and chemistry**.**				
Course Summary	Students understand plant life processes.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Plant -Water Relations**	**10**
	1	Water relations of plants: Importance of water to plant life	
	2	Absorption of water- organs of absorption, root and root hair. Physical aspects of absorption- imbibition, diffusion and osmosis. Plant cell as an osmotic system; water potential and osmotic potential. Plasmolysis and its significance, practical applications. Mechanism of water absorption – active and passive absorption, root pressure. Pathway of water across root cells.	
	3	Ascent of sap- vital and physical theories.	
	4	Loss of water from plants: transpiration-cuticular, lenticular	

		and stomatal mechanism, Theories – starch sugar hypothesis, potassium - ion theory. Transpiration, Significance, Guttation, anti-transpirants, factors affecting transpiration.	
	5	Mineral nutrition- Gross chemical analysis of the plant body, ash analysis, criteria for essentiality of elements. Macro and micro elements, role of essential elements and their deficiency symptoms. Culture methods - sand culture, hydroponics and aeroponics. Mechanism of mineral absorption (a) passive absorption- ion exchange and Donnan's equilibrium (b) active absorption- carrier concept, Lundegardh hypothesis.	
II		**Photosynthesis**	**8**
	6	Introduction, significance and general equation; Photosynthetic apparatus, structure and function of chloroplast, quantasomes - solar spectrum and its importance - Fluorescence and phosphorescence; Red drop, Emerson effect.	
	7	Two pigment systems, raw material for photosynthesis, Mechanism of Photosynthesis- Light reaction - cyclic and non - cyclic photophosphorylation, Hill Reaction.	
	8	Dark reaction: Calvin cycle; Comparative study of C3, C4 and CAM plants, Photorespiration.	
	9	Factors affecting photosynthesis - Law of limiting factor.	
III		**Respiration**	**8**
	10	Introduction, definition and significance and general equation, Respiratory substrate	
	11	Types of respiration- aerobic and anaerobic.	
	12	Aerobic respiration - glycolysis, Krebs's cycle, terminal oxidation.	
	13	Anaerobic respiration – fermentation: alcoholic and lactic acid fermentation.	
	14	Energy relation of respiration - R Q and its significance,	

		Factors affecting respiration	
	15	Nitrogen metabolism: Biological nitrogen fixation – symbiotic and asymbiotic. Nitrogen fixation by blue green algae - rotation of crops. Nif genes- Leg haemoglobin. Nitrate and ammonia assimilation.	
IV		**Plant Growth and Response**	4
	16	Growth: Phases of growth- vegetative and reproductive growth, growth curves-J and S shaped	
	17	Plant growth regulators - Auxins, Gibberellins, Cytokinin, Ethylene, Abscisic acid, synthetic plant hormones - practical applications.	
	18	Senescence and abscission, Photoperiodism	
	19	Vernalization - phytochrome and its significance. Physiology of bud and seed dormancy, germination.	
	20	Plant movements: Tropic and nastic movements. Circadian rhythm and biological clock.	
	21	Stress physiology: water stress, salt stress.	
V		**Phytochemistry**	**15**
	22	Introduction- Phytochemicals, Primary and secondary metabolites, sources, classification, and Function (General account only).	
	23	Phytochemicals: Alkaloids, terpenoids, phenolics, flavonoids, and tannins. Role of phytochemicals in the plant defense mechanism.	
	24	Functions of phytochemicals in the living organism - antioxidants, antimicrobial agents, wound healing, antihypertension, stimulation of the immune system, anti-inflammatory functions (brief study only)	
	25	Brief study of basic metabolic pathways and formation of different secondary metabolites through these pathways- Shikimic acid pathway, and Amino acid pathway.	
	26	BioSource - 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,	

Practicals (30hrs)

1. 1. Water potential of onion peel / *Rhoeo* peel by plasmolytic method.
2. Imbibition of water by different types of seeds.
3. Effect of temperature on permeability.
4. Papaya petiole osmoscope.
5. Determination of stomatal index.
6. Determination of water absorption and transpiration ratio.
7. Measurement of rate of transpiration using Ganong's potometer or Farmer's potometer.
8. Evolution of oxygen during photosynthesis.
9. Light screen experiment
10. Measurement of photosynthesis by Wilmott'sbubbler.
11. Evolution of CO2 during respiration.
12. Ganong's respirometer and measurement of R.Q
13. Alcoholic fermentation using Kuhn's fermentation vessel
14. Geotropism using clinostat (Excluded from practical exam)
15. Measurement of growth using Arc auxanometer. (Excluded from practical exam)
16. Subject any one of the given plants to Soxhlet extraction/ hydrodistillation/Cold extraction -*Curcuma longa* rhizome powder, *Piper nigrum* fruits powder, *Syzygium aromaticum, Cinnamomum malabatram* (or any plant of interest).
17. 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.

References

1. Devlin, R. M., & Witham, F. H. (1986). *Plant physiology* (4th ed.). C B S Publishers.
2. Inam, A., Sahay, S., & Akhtar, A. (2016). *Experiments in plant physiology, biochemistry, and ecology*. Jaya Publishing House.
3. Kochhar, P. L., & Krishnamoorthy, H. N. (1964). *Plant physiology*. Atmaram & Sons.

4. Kumar, & Purohit. (1996). *Plant physiology: Fundamentals and applications*. Agrobotanical Publications.
5. Malik, C. P., & Srivastava, A. K. (2005). *Textbook of plant physiology*. Kalyani Publishers.
6. Noggle, G. R., & Fritz, G. J. (1983). *Introductory plant physiology* (2nd ed.). Prentice Hall of India.
7. Pandey, S. N., & Sinha, B. K. (1996). *Plant physiology* (3rd ed.). Vikas Publishing House.
8. Purohit, S. S. (2003). *Plant physiology*. Student Edition.
9. Salisbury, F. B., & Ross, C. W. (2005). *Plant physiology* (4th ed.). Wadsworth Publishing Company.
10. Sinha, R. K. (2004). *Modern plant physiology*. Narosa Publishing House.
11. Verma, V. (2016). *Plant physiology* (2nd ed.). Athena Academic.
12. Hopkins, W. G. (2008). *Introduction to plant physiology* (4th ed.). John Wiley & Sons.
13. Nelson, D. L., & Cox, M. M. (2020). *Lehninger principles of biochemistry* (8th ed.).
14. Stryer, L. (2019). *Biochemistry* (8th ed.).
15. Rodwell, V. W., Bender, D., & others. (2020). *Harper's illustrated biochemistry*.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental principles of plant-water relations, including absorption, transpiration, and mineral nutrition.	U, R	1, 3
CO-2	Analyze the biochemical pathways of photosynthesis and respiration, comparing C3, C4, and CAM plants and evaluating energy production mechanisms.	An, Ap	2, 4
CO -3	Apply knowledge of plant growth regulators, stress physiology, and responses to environmental stimuli for understanding plant adaptations.	Ap, C	3, 5
CO-4	Evaluate the role of phytochemicals in plant	E, Ap	4, 6

	defense, metabolism, and their therapeutic and commercial applications.		
CO-5	Develop an integrative understanding of secondary metabolite biosynthesis pathways and their biotechnological significance.	Ap, C	3, 6

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

Name of the Course: PLANT PHYSIOLOGY AND PHYTOCHEMISTRY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO-1	Understand the fundamental principles of plant-water relations, including absorption, transpiration, and mineral nutrition.	1, 2	1, 3	U, R	F, C	L/T
CO-2	Analyze the biochemical pathways of photosynthesis and respiration, comparing C3, C4, and CAM plants and evaluating energy production mechanisms.	2, 3	2, 4	An, Ap	C, P	L,P
CO -3	Apply knowledge of plant growth regulators, stress physiology, and responses to environmental stimuli for understanding plant adaptations.	3, 4	3, 5	Ap, C	C, P	L,P
CO-4	Evaluate the role of phytochemicals in plant defense, metabolism, and their therapeutic and commercial applications.	4, 5	4, 6	E, Ap	P, M	L,P
CO-5	Develop an integrative understanding of secondary metabolite biosynthesis pathways	5, 6	3, 6	Ap, C	M, P	L,P

	and their biotechnological significance.					

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓	✓	✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	BOTANY				
Course Code	MIUK6DSCBOT 352.1				
Course Title	MOLECULAR BIOLOGY AND BIOINFORMATICS				
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
	4	3 hours	-	2 hours	5
Pre-requisites	A good understanding of basics in genetics and cell biology are vitally important.				
Course Summary	The student will be able to understand the structural organisation of cells and the functions of the organelles. The student will be able to differentiate between plant and animal cells and to analyse different stages of mitosis and meiosis. The student can analyse the structure and function of both DNA and RNA. Students will learn fundamental concepts, tools, and techniques used in bioinformatics research, with a focus on genome analysis, sequence alignment, structural biology, and data mining.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Structure and Organization of Nucleus and Nuclear Material**	**6**
	1	Nucleic acids: Carriers of genetic information, Experimental evidence- Griffith's experiment on bacterial transformation, Avery's experiment, Hershey- Chase experiment.	

	2	Types of genetic material, denaturation and renaturation, cot curves, Organization of DNA and structure of RNA- Prokaryotes, Viruses, Eukaryotes	
II		**Genetic Materials**	**6**
	3	Molecular Structure of DNA, Watson and Crick double helical model, Salient features of double helix, biological significance of double helical model of DNA, Chargaff's rule	
	4	Forms of DNA- A, B and Z DNA, Satellite and repetitive DNA, chloroplast DNA, Mitochondrial DNA. Structure, Properties and functions of RNA- mRNA, tRNA, rRNA, SnRNA and microRNA	
III		**Central Dogma of Molecular Biology**	**9**
	5	General principles –semi discontinuous replication, semi conservative model- Meselson and Stahl experiment, leading strand, lagging strand synthesis, Okazaki fragments, replication fork and origin of replication, unidirectional and bidirectional replication, replisome.	
	6	Role of enzymes- Topoisomerase, DNA polymerases, Primases, Helicase, Ligase, DNA repairing mechanism – photoreactivation, Replication of DNA in eukaryotes (brief account only)	
	7	Transcription in prokaryotes and eukaryotes, RNA modifications- introns, exons, removal of introns, spliceosome Ribozymes, exon shuffling; RNA editing and mRNA transport. Translation (Prokaryotes and eukaryotes).	
	8	Genetic code, Wobble hypothesis, Operon concept, Lac- operon, Gene silencing, transcriptional gene regulation in eukaryotes (brief account)- promoters, enhancers, RNA interference	
IV		**Bioinformatics**	**9**
	9	Introduction: Definition, Origin of concept of Bioinformatics; Brief history, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Importance of	

		bioinformatics; Wet lab and Web lab.	
	10	Basics of 'omes' and 'omics'-Genomics, Proteomics & Comparative genomics	
	11	Introduction, Biological sequence databases, NCBI, Tools and databases of NCBI, sequence submission to NCBI. Classification format of Biological Databases: Nucleic acid databases (EMBL, Gen Bank, DDBJ); Protein sequence databases. (PIR, SWISS PROT, UNIPROT); Protein structure databank- (PDB), Model organism databases and Biodiversity data bases (brief account only); Biological database retrieval systems-SRS, ENTREZ.	
	12	Gene sequence, Homology searches- Genetic map and physical map; Sequence analysis and alignment- introduction and concept of alignment. Pair wise sequence alignment, multiple sequence alignment (MSA), Sequence Alignment Tools: BLAST- number of hits and hit extension, CLUSTAL X - Scoring Matrices- PAM and BLOSUM.	
V	**Bioinformatics tools and its applications**		**15**
	13	Bioinformatics in relation to Biomolecular structure; Molecular visualization tool- Rasmol	
	14	Phylogenetic analysis: Phylogenetic tree- components; Molecular phylogeny- advantages; Methods of Phylogeny- Distance matrix, Parsimony. Software for Phylogenetic tree construction- PHYLIP and PHYLOBLAST.	
	15	Applications of Bioinformatics: Structural Bioinformatics in Drug design and drug discovery, Microbial genome applications, Gene therapy, Personalized medicine, Evolution, antibiotic resistant, preventive health care, bioinformatics tool and Crop improvement.	

Practicals (30 hrs)

1. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et.al., Griffith's, Hershey & Chase's experiments

2. Nucleic acid and protein databases- FASTA files
3. Sequence retrieval from databases- SRS, ENTREZ
4. Sequence alignment- BLAST, CLUSTAL X
5. Sequence homology and Gene annotation- physical map and genetic map
6. Construction of phylogenetic tree- PHYLIP, PHYLOBLAST.

References

1. Baxevanis, A. D., & Ouellette, B. F. F. (2001). *Bioinformatics: A practical guide to the analysis of genes and proteins* (2nd ed.). John Wiley & Sons, Inc.
2. Ghosh, Z., & Bibekanand, M. (2008). *Bioinformatics: Principles and applications*. Oxford University Press.
3. Mount, D. (2004). *Bioinformatics: Sequence and genome analysis* (2nd ed.). Cold Spring Harbor Press.
4. Durbin, R. (2007). *Biological sequence analysis*. Cambridge University Press India Pvt. Ltd.
5. Pevsner, J. (2009). *Bioinformatics and functional genomics* (2nd ed.). Wiley-Blackwell.
6. Xiong, J. (2007). *Essential bioinformatics*. Cambridge University Press India Pvt. Ltd.
7. Higgs, D. (2005). *Bioinformatics and molecular evolution*. Ane Books India Pvt. Ltd.
8. Campbell, A. M., & Heyer, L. J. (2006). *Discovering genomics, proteomics, and bioinformatics* (2nd ed.). Benjamin Cummings.
9. Xiong, J. (2006). *Essential bioinformatics*. Cambridge University Press.
10. Zvelebil, M. J. (2007). *Understanding bioinformatics*. Garland Science.
11. Ye, S. Q. (2019). *Bioinformatics: A practical approach*. CRC Press.
12. Tramontano, A. (2018). *Introduction to bioinformatics*. CRC Press.
13. Mani, K., & Vijayaraj, N. (2002). *Bioinformatics for beginners*. Kalaikathir Achchagam.
14. De Robertis, E. D. P., & Robertis, E. M. P. (1991). *Cell and molecular biology*. Scientific American Books.
15. Iwasa, J., & Marshall, W. (2016). *Karp's cell and molecular biology: Concepts and experiments* (8th ed.). John Wiley & Sons, Inc.
16. Twymann, R. M. (1998). *Advanced molecular biology*. Viva Books..

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the structure and organization of genetic material, including DNA, RNA, and their roles in genetic information storage and transmission.	U, An	1, 4
CO-2	Explain the molecular structure of DNA, different forms of DNA, and the functional significance of RNA types in various biological processes.	U, Ap	1, 2
CO -3	Analyze the mechanisms of DNA replication, transcription, and translation, including enzyme functions, gene regulation, and post-transcriptional modifications.	An, E	2, 5
CO-4	Apply bioinformatics tools for gene sequence analysis, homology searches, and phylogenetic studies to understand genome structure and evolutionary relationships.	Ap, E	3, 6
CO-5	Evaluate the applications of bioinformatics in structural biology, drug discovery, gene therapy, and microbial genomics for advancements in biotechnology and medicine.	E, C	3, 5, 6

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

Name of the Course: MOLECULAR BIOLOGY AND BIOINFORMATICS

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the structure and organization of genetic material, including DNA, RNA, and their roles in genetic information storage and transmission.	1, 2	1, 4	U, An	F, C	L,P

CO2	Explain the molecular structure of DNA, different forms of DNA, and the functional significance of RNA types in various biological processes.	2, 3	1, 2	U, Ap	C, P	L
CO3	Analyze the mechanisms of DNA replication, transcription, and translation, including enzyme functions, gene regulation, and post-transcriptional modifications.	3, 5	2, 5	An, E	C, P	L
CO4	Apply bioinformatics tools for gene sequence analysis, homology searches, and phylogenetic studies to understand genome structure and evolutionary relationships.	3, 6	3, 6	Ap, E	C, M	L,P
CO5	Evaluate the applications of bioinformatics in structural biology, drug discovery, gene therapy, and microbial genomics for advancements in biotechnology and medicine.	3, 7	3, 5, 6	E, C	C, M	L,P/T

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓		✓	✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK6DSCBOT 353.1**				
Course Title	**PLANT FUNCTION AND DEVELOPMENT**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge of plant morphology, anatomy, cell biology				
Course Summary	Create awareness about physiological and biochemical aspects of growth & metabolism				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Plant water relations**	**7**
	1	Water relations of plants: Importance of water to plant life. Absorption of water- organs of absorption, root and root hair. Physical aspects of absorption- imbibition, diffusion and osmosis. Plant cell as an osmotic system; water potential and osmotic potential. Plasmolysis and its significance, practical applications.	

	2	Mechanism of water absorption – active and passive absorption, root pressure. Pathway of water across root cells. Ascent of sap- vital and physical theories.	
	3	Loss of water from plants: transpiration-cuticular, lenticular and stomatal mechanism Theories – starch sugar hypothesis, potassium - ion theory. Significance of transpiration - guttation, anti-transpirants, factors affecting transpiration.	
II		**Mineral nutrition in plants**	**5**
	4	Mineral nutrition: Gross chemical analysis of the plant body, ash analysis, criteria for essentiality of elements, macro and micro elements, role of essential elements and their deficiency symptoms. Culture methods - sand culture, hydroponics and aeroponics. Mechanism of mineral absorption (a) passive absorption- ion exchange and Donnan equilibrium (b) active absorption- carrier concept, Lundegardh hypothesis.	
III		**Carbon assimilation in plants**	**10**
	5	Photosynthesis: Introduction, significance and general equation; Photosynthetic apparatus, structure and function of chloroplast, raw material for photosynthesis;	
	6	Quantasomes - solar spectrum and its importance - Fluorescence and phosphorescence; Red drop, Emerson effect; Two pigment systems	
	7	Mechanism of photosynthesis- Light reaction - cyclic and non cyclic photophosphorylation; Hill reaction - Dark reaction: Calvin cycle; Comparative study of C3, C4 and CAM plants; Photorespiration. Factors affecting photosynthesis - Law of limiting factor.	
	8	Bacterial photosynthesis and chemosynthesis (Brief account only)	
	9	Translocation of solutes: Path way of movement, phloem transport, mechanism of transport - Munch hypothesis,	

		protoplasmic streaming theory – activated diffusion hypothesis, electro osmotic theory.	
IV	**Cellular respiration and Carbon oxidation**		**8**
	10	Respiration: Introduction, definition and significance and general equation. Respiratory substrate, types of respiration- aerobic and anaerobic. RQ and its significance	
	11	Aerobic respiration - glycolysis, Krebs's cycle, terminal oxidation. Alternative pathway- Pentose Phosphate Pathway.	
	12	Anaerobic respiration–fermentation: alcoholic and lactic acid fermentation. Energy relation of Respiration. Factors affecting respiration.	
V	**Plant growth, flowering and movement**		**15**
	13	Growth: Phases of growth - vegetative and reproductive growth - growth curve- plant growth regulators - Auxins, Gibberellins, Cytokinins, Ethylene, Abscissic acid - synthetic plant hormones - practical applications. Senescence and ab-scission, Photoperiodism	
	14	Plant movements: Tropic and nastic movements. Circadian rhythm and biological clock.	
	15	Vernalization - phytochrome and its significance. Physiology of bud and seed dormancy, germination.	
	16	Nitrogen metabolism: Source of nitrogen - Biological nitrogen fixation –symbiotic and asymbiotic. Nitrogen fixation by blue green algae - rotation of crops. Nif genes - Leghaemoglobin.	
	17	Stress physiology: water stress, salt stress.	

Practical (30 hrs)

1 Demonstration of the following experiments to understand plant metabolic processes

- Water potential of onion peel / Rhoeo peel by plasmolytic method.
- Imbibition of water by different types of seeds.
- Effect of temperature on permeability.
- Papaya petiole osmoscope.
- Determination of stomatal index.

- Determination of water absorption and transpiration ratio.
- Measurement of rate of transpiration using Ganong's potometer or Farmer's potometer.
- Evolution of oxygen during photosynthesis.
- Light screen experiment
- Measurement of photosynthesis by Wilmott'sbubbler.
- .Evolution of CO2 during respiration.
- Ganong's respirometer and measurement of R.Q
- .Alcoholic fermentation using Kuhn's fermentation vessel
- Geotropism using clinostat
- Measurement of growth using Arc auxanometer.

2. Separation of chlorophyll pigments by chromatographic technique
3. Hill activity by DCPIP/ ferricyanide reduction.
4. Physiological identification of CAM in plant species. Differentiation of CAM and non-CAM plants by titration.

References

1. Evlin, R. M., & Witham, F. H. (1986). *Plant physiology* (4th ed.). C.B.S. Publishers.
2. Dey, P. M., & Harborne, J. B. (2016). *Plant biochemistry*. Academic Press.
3. Inam, A., Sahay, S., & Akhtar, A. (2016). *Experiments in plant physiology, biochemistry, and ecology*. Jaya Publishing House.
4. Jain, J. L., Jain, S., & Jain, N. (2016). *Fundamentals of biochemistry*. S. Chand & Co.
5. Jain, J. L. (2005). *Fundamentals of biochemistry* (6th ed.). S. Chand & Company.
6. Wilson, K., & Walker, J. (2008). *Principles and techniques of biochemistry and molecular biology* (6th ed.). Cambridge University Press.
7. Kochhar, P. L., & Krishnamoorthy, H. N. (1964). *Plant physiology*. Atmaram & Sons.
8. Kumar, H., & Purohit, S. (1996). *Plant physiology: Fundamentals and applications*. Agrobotanical Publications.
9. Lehninger, A. L. (2012). *Principles of biochemistry* (6th ed.). W. H. Freeman & Co.
10. Malik, C. P., & Srivastava, A. K. (2005). *Textbook of plant physiology*. Kalyani Publishers.
11. Nagini, S. (2009). *Instant biochemistry*. Ane Books Pvt. Ltd.

12. Noggle, G. R., & Fritz, G. J. (1983). *Introductory plant physiology* (2nd ed.). Prentice Hall of India.
13. Pandey, S. N., & Sinha, B. K. (1996). *Plant physiology* (3rd ed.). Vikas Publishing House.
14. Plummer, D. T. (2006). *An introduction to plant biochemistry* (3rd ed.). Tata McGraw Hill.
15. Purohit, S. S. (2003). *Plant physiology* (Student edition). Jodhpur.
16. Venn, R. F. (2004). *Principles and practice of bioanalysis*. Taylor & Francis.
17. Salisbury, F. B., & Ross, C. W. (2005). *Plant physiology* (4th ed.). Wadsworth Publishing Company.
18. Satyanarayana, U. (2008). *Essentials of biochemistry*.
19. Sinha, R. K. (2004). *Modern plant physiology*. Narosa Publishing House.
20. Sundara Rajan, S. (2006). *College botany* (Vol. IV). Himalaya Publishing House.
21. Verma, V. (2016). *Plant physiology* (2nd ed.). Athena Academic.
22. Hopkins, W. G. (2008). *Introduction to plant physiology* (4th ed.). John Wiley & Sons.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand physiology of absorption, and transpiration and students will develop the ability to design, conduct, and analyze experiments in physiology, using modern laboratory techniques and instrumentation.	U, An	1, 4
CO-2	Learns about mineral absorption in plants and compares with water absorption mechanisms	U, Ap	1, 2
CO -3	Understands the process of photosynthesis in plants and compares with the autotropism in bacteria	An, E	2, 5
CO-4	Analyze and interpret carbon breakdown in plants, including the identification of key intermediates, enzymes, and regulatory mechanisms involved in	Ap, E	3, 6

	metabolic reactions		
CO-5	Analyze the role of phytohormones in plant growth, flowering, movement and stress tolerance in plants	E, C	3, 5, 6

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

Name of the Course: PLANT FUNCTION AND DEVELOPMENT

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand plant-water relations, including water absorption, transpiration mechanisms, and ascent of sap, and analyze their physiological significance.	1, 2	1, 4	U, An	F, C	L
CO2	Explain the role of essential minerals in plant growth, nutrient uptake mechanisms, and different culture methods used in mineral nutrition studies.	2, 3	1, 2	U, Ap	C, P	L
CO3	Analyze carbon assimilation through photosynthesis, translocation of solutes, and photorespiration, comparing different pathways such as C3, C4, and CAM.	3, 5	2, 5	An, E	C, P	L,P
CO4	Apply knowledge of cellular respiration, including glycolysis, Krebs cycle, fermentation, and their energy relationships, in understanding plant metabolism.	3, 6	3, 6	Ap, E	C, M	L,P
CO5	Evaluate plant growth and development, including plant hormones, photoperiodism, nitrogen	3, 7	3, 5, 6	E, C	C, M	L,P/T

	metabolism, plant movements, and stress physiology, and apply this knowledge to real-world agricultural and ecological challenges.					

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓	✓	✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK6DSEBOT 350.1**				
Course Title	**FORENSIC BOTANY**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic understanding of plant anatomy , palynology and morphology				
Course Summary	Course is designed to familiarize students to professional practice in the field.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction**	**4**
	1	Definition, Introduction, Different divisions and units of Forensic Science Laboratory, Legends and their contributions in the field of forensic science.	
	2	The Bharatiya Nyaya Sanhita (2023)	
	3	Case studies and other works from the forensic literature	
II		**Plants as Evidence**	**6**
	4	Pollen calendar, Pollen for Geolocation and Time of Death	

		Estimation, Analysis of diatoms, Forensic mycology - spores, fruiting bodies, botanical decomposition, site conditions	
	5	Green villans – plants as instruments of crime. Poisonous plants.	
	6	Considerations while Plant Evidence Collection and Preservation and digitalizing evidence	
	7	**Activity**-1. Prepare micrographs of pollen from local flora 2. Document previous case histories on notorious plant involvements in criminal cases.	
III		**Molecular Techniques**	**15**
	8	DNA Extraction procedure from various samples- (plant, Blood, Saliva, Seminal fluid, Bone, tissues and inert items.)	
	9	Polymerase Chain Reaction (PCR), Next-Generation Sequencing (NGS), Real-Time PCR (qPCR), Short Tandem Repeat (STR) Analysis, Single Nucleotide Polymorphism (SNP) Analysis,	
IV		**Advanced Molecular Techniques in Genetic and Epigenetic Analysis**	**5**
	10	Mitochondrial DNA (mtDNA) Sequencing, Y-Chromosome Analysis: DNA Methylation Analysis, RNA Analysis, High-Resolution Melting Analysis (HRM)	
V		**Agencies**	**15**
	11	National and International Agencies- Central Bureau of Investigation (CBI), National Crime Records Bureau (NCRB), Central Forensic Science Laboratory (CFSL), International Criminal Police Organization (INTERPOL), International Society for Forensic Genetics (ISFG), United Nations Office on Drugs and Crime (UNODC)	

Practicals (30 hrs)

1. Acetolysis - Pollen and spore examination.
2. Staining of fungal hyphae using aniline blue.
3. Preparation of slides photographing diatoms

References

1. Adler F. (5th Edition) (2004), Criminology, McGraw-Hill
2. Ashraf Mozayani, Carla Noziglia. The Forensic Laboratory Handbook Procedures and Practice, 2nd edition, Humana Press 2010
3. Barak G. (1998), Integrative Criminology, Ashgate Pub Ltd.
4. Barnett P.D. (2001), Ethics in Forensic Science: Professional Standards for the Practice of Criminalistics, CRC press .
5. Bridges (1942), Practical Finger Printing, Funk and Washalls Co. New York.
6. Cooke G. (1980), The role of Forensic Psychologist, Thomas Publication.
7. Gaensselen R., Harris H. and Lee H. (2007), Introduction to Forensic Science and Criminalistics, McGraw-Hill Education.
8. Haward R.C.L. (1981), Forensic Psychology, Batsford Academic and Educational.
9. Hess A.K. and Weiner I.B. (2nd Edition) (1999), Handbook of Forensic Psychology, Wiley, John & Sons, Incorporated
10. James S.H and Nordby J.J. (2003), Forensic Science: An introduction to scientific and investigative techniques, CRC Press, USA.
11. Johnson E.H. (4th Edition) (1978), Crime, Correction and Society, Dorsey Press.
12. Kirk P.L. (1953), Criminal Investigation: physical evidence and the police laboratory, Interscience Publisher Inc. New York.
13. Mehta M. K. (1980), Identification of Thumb Impression & Cross Examination of Finger Prints, N. M. Tripathi (P) Ltd. Bombay.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental concepts of forensic science, including historical contributions, divisions, and legal frameworks.	U, An	1, 4
CO-2	Analyze the role of plants as forensic evidence, including pollen analysis, forensic mycology, plant toxins, and their significance in crime investigations.	An, E	1, 2
CO -3	Apply molecular techniques, such as DNA extraction and PCR-based methods, to identify and analyze forensic samples from plant and human sources.	Ap, E	2, 5
CO-4	Evaluate advanced genetic and epigenetic forensic techniques, including mtDNA sequencing, Y-chromosome analysis, and DNA methylation profiling.	E, C	3, 6
CO-5	Understand the role of national and international forensic agencies in crime investigation and genetic data management.	U, Ap	3, 5, 6

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

Name of the Course: FORENSIC BOTANY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the fundamental concepts of forensic science, including historical contributions, divisions, and legal frameworks.	1, 2	1, 4	U, An	F, C	L
CO2	Analyze the role of plants as forensic evidence, including pollen analysis,	2, 3	1, 2	An, E	C, P	L

	forensic mycology, plant toxins, and their significance in crime investigations.					
CO3	Apply molecular techniques, such as DNA extraction and PCR-based methods, to identify and analyze forensic samples from plant and human sources.	3, 5	2, 5	Ap, E	C, P	L,P
CO4	Evaluate advanced genetic and epigenetic forensic techniques, including mtDNA sequencing, Y-chromosome analysis, and DNA methylation profiling.	3, 6	3, 6	E, C	C, M	L,P/T
CO5	Understand the role of national and international forensic agencies in crime investigation and genetic data management.	3, 7	3, 5, 6	U, Ap	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK6DSEBOT 351.1**				
Course Title	**RESEARCH METHODOLOGY AND BIOSTATISTICS**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic Knowledge in Mathematics				
Course Summary	Equip students with essential tools and skills needed to conduct rigorous and ethical research in the life sciences, preparing them for careers in academia, industry, healthcare or public health.				

Detailed Syllabus

Module	Unit	Content	Hrs
I		**Research Methodology**	**5**
	1	Introduction; Need for research; Stages of Research – Definition of problem, execution of the problem, interpretation of results	
	2	Characteristics of Research, Types of research- Qualitative & quantitative.	
	3	Experimental design, components of experimental designs- Randomized blocks, completely randomized designs	

	4	Activity- a) Design a hypothesis and its alternative hypothesis b) Design an RBD experiment and solve it. (Example- A pharmaceutical company wants to compare the effectiveness of four different drug formulations in treating a particular medical condition. However, patient responses may vary due to factors such as age and gender. Design an RBD experiment to control for these potential sources of variability and accurately assess the efficacy of the drug formulations.	
II		**Preparation of a project report**	**5**
	5	Data analysis and consolidation of photographs, illustrations, tables and graphs	
	6	Title, introduction, review of literature, materials and methods, results, discussions, summary, references, acknowledgements; Bibliography – Method of citing and arrangement of references – Reference management software – Mendeley, EndNote	
	7	Activity – Explore Google scholar platform and compile latest reference source on any selected topic of student's choice and present it in APA and MLA format.	
III		**Basics of Biostatistics**	**9**
	8	Biostatistics - definition –an outline of statistical methods – Statistical terms and symbols, basic principles; Variables – types, measurements; significance, limitations and uses of statistics.	
	9	Distribution of data in Biology -Nature and types - Typical examples, Data collection- primary and secondary; methods for collection of data; Data presentation- tables, diagrams (bar & pie diagrams) and Graphs (Histogram, frequency polygon, frequency curve & Ogives).	
	10	Samples and sampling methods- random sampling and non-random sampling.	

	11	Activity – Make a questionnaire for data collection using google forms	
IV		**Descriptive statistics**	**11**
	12	Statistical treatment of data: frequency distribution; Measures of central tendencies (mean, median, mode- merits and demerits), Measures of dispersion (range, mean deviation, variance, standard deviation, standard error, skewness and kurtosis, quartile deviation –merits and demerits); coefficient of variation.	
	13	Correlation - types and methods of correlation-Pearson's correlation, regression analysis-types, simple regression equation, fitting prediction, Differences and similarities of correlation and regression analysis.	
V		**Inferential statistics**	**15**
	14	Hypothesis – testing hypothesis - student' s t' test (paired and unpaired), chi square test, F-test (ANOVA-one-way ANOVA and two-way ANOVA), probability test.	
	15	Application of biostatistics-Public health, Quantitative genetics, Expression data, other studies; Scope of biostatistics.	

Practicals (30 hrs)

1. Tabulation and presentation of data- Diagrams and Graphs**.**
2. Calculation of Frequency distribution, measures of central tendancy and
3. measures of dispersion, coefficient of variation.
4. Calculation of correlation coefficient- Pearson's and regression analysis.
5. Statistical inference - hypothesis – student 't' test - chi square test, F-test
6. (ANOVA-one-way ANOVA and two-way ANOVA), probability test.
7. Uses of software in biostatistics- Excel, Instat, SPSS, sigmaplot and R
8. software.

References

1. Gurumani N. (2006) Research Methodology For Biological Sciences, MJP Publ.

2. Kothari C R & Garg C (2014) Research methodology methods and techniques, New Age international publishers
3. Rastogi, Veer Bala.; Fundamentals of Biostatistics; 2nd edition, New Delhi : Ane Books India 2008.
4. Bailey T.J. (1995) Statistical Methods in Biology (3rd Edition) – Cambridge University Press India Pvt Ltd.
5. Elizabeth Allman (2004). Mathematical Methods in Biology, Cambridge University Press India Pvt. Ltd
6. Mann, S. P. (2016). Introductory Statistics, 9th edition. Hoboken, NJ, Jone Wiley and Sons Inc.
7. Khan and Khanum (1994). Fundamentals of Biostatistics, Saras Publications
8. Marcello Pagano and Kimberlee Gauvreau (2018) Principles of Biostatistics 2nd Edition CRC Press, Chapman & Hall
9. Khan, I.A., Khanum, A. (2004). Fundamentals of Biostatistics, 5th edition. Hyderabad: Ukaaz publications
10. Zar, J.H. (2014). Biostatistical Analysis, 5th edition. London, London: Pearson Publication.
11. Saha I and Paul B (2016) Essentials of Bio-statistics 2ndEdition Academic Publishers
12. Stephen W. Looney (2009). Biostatistical Methods, Humana Press, Springer International Edn.
13. Veer Bala Rastogi (2008). Fundamentals of Biostatistics, Ane Books Pvt. Ltd
14. Pandey, M. (2015). Biostatistics Basic and Advanced. New Delhi, Delhi: M V Learning.
15. Sundar Rao, P.S.S., Richards, (1996). An introduction to Biostatistics, 3rd edition. Vellore, Tamil Nadu: J. Christian Medical College.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental concepts of research methodology, types of research, experimental design, and hypothesis formulation.	U, Ap	1, 4
CO-2	Demonstrate proficiency in writing a scientific project report, including literature review, data consolidation, referencing, and citation using reference management software.	Ap, E	1, 2
CO -3	Analyze the principles of biostatistics, including data types, data collection, presentation methods, and sampling techniques.	An, Ap	2, 5
CO-4	Apply descriptive statistical methods, such as frequency distribution, central tendencies, dispersion, and correlation analysis, to interpret biological data.	Ap, An	3, 6
CO-5	Evaluate inferential statistical techniques, including hypothesis testing, ANOVA, chi-square, and probability tests, and apply them to real-world biological and public health studies.	E, C	3, 5, 6

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

Name of the Course: RESEARCH METHODOLOGY AND BIOSTATISTICS

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the fundamental concepts of research methodology, types of research, experimental design, and hypothesis formulation.	1, 2	1, 4	U, Ap	F, C	L

CO2	Demonstrate proficiency in writing a scientific project report, including literature review, data consolidation, referencing, and citation using reference management software.	2, 3	1, 2	Ap, E	C, P	L
CO3	Analyze the principles of biostatistics, including data types, data collection, presentation methods, and sampling techniques.	3, 5	2, 5	An, Ap	C, P	L,P/T
CO4	Apply descriptive statistical methods, such as frequency distribution, central tendencies, dispersion, and correlation analysis, to interpret biological data.	3, 6	3, 6	Ap, An	C, M	L,P
CO5	Evaluate inferential statistical techniques, including hypothesis testing, ANOVA, chi-square, and probability tests, and apply them to real-world biological and public health studies.	3, 7	3, 5, 6	E, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓		✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK6DSEBOT 352.1**
Course Title	**INTRODUCTION TO PLANT GENETICS AND GENOMICS**
Type of Course	**DSE**
Semester	**VI**
Academic Level	**300-399**

<table>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3 hours</td><td>-</td><td>2 hours</td><td>5</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">A foundational understanding of biological principles, such as cell biology, genetics, and basic physiology.</td></tr>
<tr><td>Course Summary</td><td colspan="5">Course offers a comprehensive knowledge heredity and inheritance. The students gain the knowledge of history of genetics and its advancements. The students get the fundamental concepts of plant genome structure, function, and applications.</td></tr>
</table>

Detailed Syllabus:

<table>
<tr><th>Module</th><th>Unit</th><th>Content</th><th>Hrs</th></tr>
<tr><td rowspan="2">I</td><td colspan="2">Introduction to Genetics</td><td>7</td></tr>
<tr><td>1</td><td>Heredity and Variation, 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.</td><td></td></tr>
</table>

II	**Modified Mendelian ratios**		**12**
	2	Incomplete Dominance- Flower colour in *Mirabilis jalapa*; codominance- MN blood group in man; Gene interactions (nonallelic interactions)- Complementary gene action- flower colour in *Lathyrus odoratus*; Epistasis- dominant (fruit colour in *Cucurbita pepo*) and recessive (coat colour in mice); Duplicate gene action- seed shape in *Capsella bursa pastoris*; Duplicate gene with cumulative effect- fruit shape in *Cucurbita pepo***,** Collaboratory gene action- comb patterns in domestic fowls; Inhibitory gene action- leaf colour in *Oryza sativa.*	
	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	**Chromosomal Basis of inheritance**		**5**
	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.	
IV	**Sex determination and inheritance patterns**		**6**
	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- Plastid inheritance in *Mirabilis jalapa*, inheritance of kappa particles in Paramecium. Maternal effect- Shell coiling in Snail	
V	**Plant Genomics**		**15**

	9	What is genomics? Importance of plant genomics in agriculture, biotechnology, and evolution, Plant Genome Structure - Nuclear, mitochondrial, and plastid genomes, genome size variation across plants	
	10	Functional Genomics in Plants- Introduction to functional genomics (transcriptomics, proteomics, metabolomics) Tools for functional genomics: Gene knockouts, RNA interference (RNAi), CRISPR/Cas9. Structural genomics (brief account).	
	11	Comparative Genomics in Plants - Key plant genome projects (Arabidopsis, rice, maize, and other crop species), Comparative genome analysis: Conserved genes and evolutionary relationships, Plant genome evolution and the concept of synteny. Application of genomics in crop improvement (polyploidy).	
	12	Epigenetics in Plant Genomics - DNA methylation, histone modification, and their role in gene regulation, Epigenetic changes and their inheritance in plants, Impact of epigenetics on plant development and responses to environmental stress	

Practicals (30 hrs)

1. Work out the problems related with monohybrid and dihybrid crosses and Test crosses.
2. Work out the problems related with different allelic and non-allelic interactions.
3. Work out the problems related with two point and three-point test crosses. Construction of genetic map.

References

1. Aggarwal, S. K. (2009). *Foundation course in biology* (2nd ed.). AneBooks Pvt. Ltd.
2. Pierce, B. A. (2012). *Genetics: A conceptual approach* (4th ed.). W. H. Freeman and Company.
3. Cohn, N. S. (1964). *Elements of cytology*. Brace and World Inc.

4. Darnell, J., Lodish, H., & Baltimore, D. (1991). *Cell and molecular biology*. Lea and Fibiger.
5. De Robertis, E. D. P., & Robertis, E. M. P. (1991). *Cell and molecular biology*. Scientific American Books.
6. Dobzhansky, B. (1961). *Genetics and the origin of species*. Columbia University Press.
7. Durbin, R. (2007). *Biological sequence analysis*. Cambridge University Press.
8. Gardner, E. J., & Snustad, D. P. (1984). *Principles of genetics*. John Wiley.
9. Karp, G. (1985). *Cell biology*. McGraw-Hill.
10. Gupta, P. K. (2010). *Genetics*. Rastogi Publications.
11. Janet, I., & Wallace, M. (2017). *Karp's cell and molecular biology*. John Wiley & Sons, Inc.
12. Ringo, J. (2004). *Fundamental genetics*. Cambridge University Press India Pvt. Ltd.
13. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2012). *Concepts of genetics*. Pearson Education, Inc.
14. Lewin, B. (1994). *Genes*. Oxford University Press.
15. Naha, S., Philipose, P. M., Hazare, N., & Sridhar, S. (2014). *Cell biology, genetics and microbial biotechnology*. Dominant Publishers and Distributors Pvt. Ltd.
16. Nicholl, T. (2007). *An introduction to genetic engineering*. Cambridge University Press India Pvt. Ltd.
17. Roy, S. C., & De, K. K. (1997). *Cell biology*. New Central Books.
18. Sharma, A. K., & Sharma, A. (1980). *Chromosome technique: Theory and practice*. Aditya Books.
19. Snustad, P. D., & Simmons, M. J. (2012). *Principles of genetics* (6th ed.). John Wiley & Sons, Inc.
20. Strickberger, M. W. (2008). *Genetics* (3rd ed.). Pearson Education India.
21. Swanson, C. P. (1957). *Cytology and genetics*. Englewood Cliffs.
22. Taylor, R. (2008). *Biological sciences*. Cambridge University Press India Pvt. Ltd.
23. Rastogi, V. B. (2008). *Fundamentals of molecular biology*. Ane Books Pvt. Ltd.
24. Verma, P. S., & Agarwal, V. K. (2004). *Cell biology, genetics, molecular biology, evolution & ecology*. S Chand & Co.
25. Smith-Keary, P. (1991). *Molecular genetics*. Macmillan Pub. Co. Ltd.
26. Glick, B. R., & Pasternak, J. J. (2010). *Molecular biotechnology*.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand Mendelian genetics, inheritance patterns, and the fundamental principles governing heredity and variation.	U, An	1, 4
CO-2	Analyze modified Mendelian ratios, gene interactions, and quantitative inheritance patterns in plants and animals.	An, Ap	1, 2
CO -3	Explain the chromosomal basis of inheritance, sex determination, and extranuclear inheritance, including gene mapping techniques.	U, E	2, 5
CO-4	Apply knowledge of plant genomics, genome structure, and functional genomics techniques such as RNA interference and CRISPR/Cas9.	Ap, E	3, 6
CO-5	Evaluate the role of epigenetics in plant development and adaptation, including its impact on gene regulation and environmental responses.	E, C	3, 5, 6

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

Name of the Course: **INTRODUCTION TO PLANT GENETICS AND GENOMICS**

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand Mendelian genetics, inheritance patterns, and the fundamental principles governing heredity and variation.	1, 2	1, 4	U, An	F, C	L
CO2	Analyze modified Mendelian ratios, gene interactions, and quantitative inheritance patterns in plants and animals.	2, 3	1, 2	An, Ap	C, P	L
CO3	Explain the chromosomal basis of	3,	2, 5	U, E	C, P	L,P

	inheritance, sex determination, and extranuclear inheritance, including gene mapping techniques.	5				
CO4	Apply knowledge of plant genomics, genome structure, and functional genomics techniques such as RNA interference and CRISPR/Cas9.	3, 6	3, 6	Ap, E	C, M	L,P/T
CO5	Evaluate the role of epigenetics in plant development and adaptation, including its impact on gene regulation and environmental responses.	3, 7	3, 5, 6	E, C	C, M	L/P

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓		✓	✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK6SECBOT 350.1**				
Course Title	**PLANT FIBRE TECHNOLOGY**				
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	2 hours	-	2 hours	4
Pre-requisites	Basic knowledge in Histology.				
Course Summary	By the end of the course, students will be able know about different types of fibers and dyes. And dyeing process.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Plant Fibers and Their Applications**	**5**
	1	Types and Classification of Plant Fibers – Based on origin: Seed fibers (Cotton, Kapok), Bast fibers (Jute, Flax, Hemp, Ramie), Leaf fibers (Sisal, Abaca, Pineapple), and Grass fibers (Bamboo, Banana).	
	2	Essential and Desirable Properties of Plant Fibers – Strength, flexibility, durability, biodegradability.	
	3	Applications of Plant Fibers – Textiles, ropes, carpets, eco-	

		packaging, industrial composites.	
	4	Comparing Natural and Synthetic Fibers – Environmental and functional perspectives.	
	5	Activity: Collection and classification of different plant fibers.	
II		**Fiber Extraction and Processing Techniques**	**10**
	6	Fiber Extraction Methods – Retting (Jute, Flax), Ginning (Cotton), Decortication (Coir, Banana).	
	7	Processing and Spinning of Natural Fibers – Carding, combing, roving, and yarn formation.	
	8	Bleaching and Dyeing of Plant Fibers – Traditional and modern eco-friendly methods.	
	9	Weaving and Non-Woven Textiles – Basic loom structures, knitted fabrics, felted fibers.	
	10	Activity: Demonstration of fiber separation and simple weaving techniques.	
III		**Paper-Making Technology and Plant-Based Pulping**	**7**
	11	History and Significance of Paper-Making – Early papermaking techniques, industrial advancements.	
	12	Raw Materials for Paper Production – Wood pulp, Bamboo, Bagasse, Cotton linters, Jute, Kenaf, and Agro-waste fibers.	
	13	Pulping Techniques – Mechanical, Chemical (Kraft & Sulfite processes), Semi-chemical, and Recycled pulp.	
	14	Paper Manufacturing Process – Beating, refining, sheet formation, pressing, drying, and finishing.	
	15	Activity**:** Hands-on experience in handmade paper production.	
IV		**Textile testing**	**8**
	16	Dyeing and Printing of Plant Fibers – Block printing, Batik, Tie-dye, and Screen Printing Technology.	
	17	Finishing Treatments for Natural Textiles – Mercerization (Cotton), Flame retardancy, Water repellency.	
	18	Testing of Fiber Quality – Strength, elongation, color fastness, absorption capacity.	

	19	Functional and Smart Textile Applications – UV-resistant fabrics, antimicrobial textiles, Fire-retardant textiles.	
	20	Activity: Textile dyeing and screen-printing demonstration.	
V	**Sustainable Fiber Production & Environmental Considerations**		**15**
	21	Waste Management in Fiber and Paper Industries – Recycling, upcycling, alternative raw materials.	
	22	Impact of Textile and Paper Industries on Environment – Chemical pollution, water consumption, carbon footprint.	
	23	Eco-Friendly Innovations in Fiber Technology – Biodegradable textiles, plant-based leather alternatives, nanocellulose.	
	24	Regulatory Standards and Sustainability Practices – Fair Trade, Organic Certification, Green chemistry.	

Practicals (30 hrs)

1. Collection and classification of plant fibers
2. Fiber extraction techniques
3. Processing and spinning of natural fibers
4. Dyeing and printing techniques
5. Handmade paper production
6. Quality testing of plant fibers
7. Weaving and non-woven fabric preparation
8. Recycling and upcycling of fiber waste
9. Visit to a fiber processing or paper recycling facility

Refrences

1. Baker, C. A., & Meacham, A. G. (Eds.). (2009). *Textile fibers: Developments and innovations in natural fibers.* Woodhead Publishing.
2. Bown, D. (2001). *The herbaceous plant: A guide to the identification and uses of over 200 common plant fibers.* University of California Press.
3. Dahman, Y., & Sain, M. (2010). *Natural fibers: Advances in engineering materials.* Springer Science & Business Media.

4. Goonetilleke, S. (2015). *Plant fibers: Advances in sustainable biocomposites and their applications.* CRC Press.
5. Kaufman, M., & Garber, D. (2010). *Textile dyeing and printing: Techniques, advances, and innovations.* Elsevier.
6. Khan, A., & Pradhan, A. (2015). *Paper and pulp production from natural fibers: Methods and applications.* Wiley-Blackwell.
7. Kumar, V., & Suthar, M. (2018). *Handbook of plant-based biofuels: Advances in production and applications.* CRC Press.
8. Mishra, M., & Singh, R. P. (Eds.). (2017). *Handbook of textile fibers: Volume 1: Natural fibers.* CRC Press.
9. Sengupta, R., & Sengupta, S. (2012). *Plant fibers for industry and research.* Springer Science & Business Media.
10. Sharma, N., & Sethi, S. (2009). *Natural fibers in the textile and paper industries: Technologies and applications.* Woodhead Publishing.
11. Smith, S., & Miller, P. (2018). *The global textile industry and environmental issues: An overview of plant-based fibers.* Springer.
12. Taylor, J. R., & Greenfield, M. (2015). *Environmental impacts and sustainability in fiber production.* Cambridge University Press.
13. Wang, Z., & Zhang, H. (2017). *Sustainable and eco-friendly fibers in textile and paper industries.* Elsevier.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Classify plant fibers based on their origin and evaluate their essential properties and applications.	U, An	1, 2
CO-2	Demonstrate fiber extraction and processing techniques and analyze their efficiency.	Ap, An	3, 4
CO -3	Explain the principles of paper-making technology and evaluate eco-friendly pulping and paper production methods.	U, E	5, 6
CO-4	Apply knowledge of textile dyeing, finishing, and	Ap, E	4, 7

	fiber testing to assess fiber quality and functionality.		
CO-5	Examine sustainable fiber production practices and environmental impacts, proposing innovative solutions.	An, C	6, 7

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

Name of the Course: **PLANT FIBRE TECHNOLOGY**

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Classify plant fibers based on their origin and evaluate their essential properties and applications.	1, 2, 3	1, 2	U, An	F, C	L
CO2	Demonstrate fiber extraction and processing techniques and analyze their efficiency.	1, 2, 6	3, 4	Ap, An	P	P
CO3	Explain the principles of paper-making technology and evaluate eco-friendly pulping and paper production methods.	1, 3, 5	5, 6	U, E	C, P	L/P
CO4	Apply knowledge of textile dyeing, finishing, and fiber testing to assess fiber quality and functionality.	2, 4, 6	4, 7	Ap, E	P	P
CO5	Examine sustainable fiber production practices and environmental impacts, proposing innovative solutions.	3, 5, 7	6, 7	An, C	M	L

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	2	-	-	-	-	3	2	-	-	-	-	-
CO2	3	3	-	-	-	3	-	-	-	3	3	-	-	-
CO3	3	-	3	-	2	-	-	-	-	-	-	3	3	-
CO4	-	3	-	3	-	2	-	-	-	-	3	-	-	3
CO5	-	-	3	-	3	-	3	-	-	-	-	-	3	3

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓	✓	✓
CO5	✓	✓		✓

SEMESTER VII

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK7DSCBOT 400.1**				
Course Title	**CARBON METABOLISM IN PLANTS**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of plant physiology				
Course Summary	The course incorporates the fate of carbon- both the foundational and advanced pathways that carbon undergoes in plant metabolism, providing a comprehensive understanding of metabolic pathways in plants				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Overview of carbon flow**	**5**
	1	Introduction to carbon cycling, assimilation, storage, and oxidation in plants.	
	2	Introduction to Metabolic Pathways: ATP production, NADPH generation, and the interplay between anabolic (building) and catabolic (breaking down) pathways.	
II		**Carbon assimilation**	**11**

	3	Light-dependent Reactions: Capture of light energy to produce ATP and NADPH, photolysis of water, and oxygen release.	
	4	Calvin Cycle (C3 Pathway)**:** Enzymatic steps including carbon fixation (RuBisCO activity)**,** reduction phase**,** regeneration of RuBP, and synthesis of 3-carbon sugars (G3P).	
	5	C4 and CAM Pathways: Specialized carbon fixation pathways for adaptation to high light intensity and low water availability.	
III		**Pathways of carbon storage and transport**	**7**
	6	Starch Biosynthesis: Synthesis of starch in chloroplasts and amyloplasts, involving enzymes like ADP-glucose pyrophosphorylase**,** starch synthase**,** and branching enzymes**.**	
	7	Sucrose Biosynthesis and Transport: Conversion of G3P to sucrose in the cytoplasm, involving sucrose phosphate synthase and sucrose phosphatase**.** Transport through the phloem to various plant parts.	
	8	Carbohydrate Partitioning: Mechanisms for directing carbon to either storage (starch) or transport (sucrose) and partitioning between growth and storage functions.	
IV		**Carbon oxidation respiration and energy release**	**7**
	9	Glycolysis**:** Conversion of glucose to pyruvate in the cytoplasm, producing ATP and NADH.	
	10	Tricarboxylic Acid Cycle (Krebs Cycle): Oxidation of pyruvate-derived acetyl-CoA in mitochondria, producing NADH, $FADH_2$, and CO_2 with regulatory control at steps like citrate synthase, isocitrate dehydrogenase, and α-ketoglutarate dehydrogenase.	
	11	Electron Transport Chain and Oxidative Phosphorylation: Oxidation of NADH and $FADH_2$ to generate ATP in the mitochondria. Release of CO_2 as a byproduct.	

	12	Photorespiration: Alternative carbon oxidation pathway that occurs when RuBisCO fixes oxygen instead of carbon dioxide, particularly in C3 plants.	
V	**Secondary metabolism and carbon**		**15**
	13	Shikimate Pathway**:** Synthesis of aromatic amino acids and phenolics, which serve as precursors for lignin, flavonoids, and other phenolic compounds.	
	14	Mevalonate and MEP (Methylerythritol Phosphate) Pathways**:** Pathways for terpenoid biosynthesis. Terpenoids are important for plant defense, aroma, and pigments.	
	15	Alkaloid Biosynthesis: Conversion of amino acids into nitrogen-containing secondary metabolites like nicotine and morphine, which function in defense.	
	16	Phenylpropanoid Pathway: Production of lignin, flavonoids, and tannins from phenylalanine, playing roles in structural integrity and UV protection.	

Practicals (30 hrs)

1. Chlorophyll Extraction and Pigment Analysis Using Thin-Layer Chromatography (TLC)
2. Enzyme Assay for RuBisCO Activity in the Calvin Cycle
3. Quantification of Starch and Sucrose Content in Plant Tissues
4. Glycolysis Pathway Enzyme Assay: Phosphofructokinase Activity
5. Measurement of Respiration Rate in Plant Tissues Using a Respirometer
6. Extraction and Quantification of Secondary Metabolites (e.g., Phenolics or Terpenoids)

References

1. Taiz, L., & Zeiger, E. (2010). *Plant Physiology* (5th ed.). Sinauer Associates.
2. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry and Molecular Biology of Plants* (2nd ed.). Wiley Blackwell.
3. Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2005). *Biology of Plants* (7th ed.). W. H. Freeman.

4. Heldt, H. W., & Piechulla, B. (2010). *Plant Biochemistry* (4th ed.). Academic Press.
5. Moore, T. C. (1989). *Biochemistry and Physiology of Plant Hormones*. Springer.
6. Salisbury, F. B., & Ross, C. W. (1992). *Plant Physiology* (4th ed.). Wadsworth Publishing.
7. Campbell, N. A., & Reece, J. B. (2005). *Biology* (7th ed.). Benjamin Cummings.
8. Foyer, C. H., & Noctor, G. (2005). *Redox Metabolism and Signal Transduction in Plants*. Academic Press.
9. Dey, P. M., & Harborne, J. B. (1997). *Plant Biochemistry*. Academic Press.
10. Moore, T. C. (1994). *Plant Biochemistry*. Academic Press.
11. Karp, G. (2013). *Cell and Molecular Biology: Concepts and Experiments* (7th ed.). Wiley.
12. Huber, S. C., & Huber, J. L. (2008). *Regulation of Photosynthesis: The Role of Carbohydrates*. Springer.
13. Sinha, A. K., & Saluja, A. (2015). *Principles of Plant Physiology*. New Age International.
14. Bidlack, J. E., & Jansky, S. H. (2010). *Stern's Introductory Plant Biology* (12th ed.). McGraw-Hill.
15. Kozlowski, T. T., & Pallardy, S. G. (2002). *Principles of Tree-Ring Analysis*. Springer.
16. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge University Press.
17. Benning, C., & Oppenheimer, D. (2010). *Lipids in Plant Metabolism*. Wiley-Blackwell.
18. Vanderhaeghen, R., & Geelen, D. (2009). *Plant Cell Culture: Essential Techniques*. Wiley.
19. Kranjc, M., & Škerget, M. (2015). *Plant Physiology and Biochemistry*. Springer.
20. Jha, S., & Nityanand (2007). *Plant Physiology and Biochemistry*. New India Publishing Agency.
21. Weng, J. K., & Chapple, C. (2010). *The Role of Secondary Metabolites in Plant Stress Responses*. Wiley.
22. Van der Kooij, T. A., & Zang, L. (2010). *Plant Metabolism and Secondary Metabolites*. Springer.

23. Campbell, N. A., & Reece, J. B. (2012). *Biology* (9th ed.). Pearson Benjamin Cummings.
24. Houghton, R. A., & Goodall, R. (2014). *Plant Physiology and Biochemistry: The Essentials*. Wiley-Blackwell.
25. Lin, S. S. (2010). *Plant Hormones: Physiology, Biochemistry and Molecular Biology*. CRC Press.
26. Assmann, S. M., & Glandorf, D. L. (2004). *Plant Physiology: A Contemporary Approach*. Wiley.
27. Hoad, G. R., & Hurd, J. D. (1999). *Plant Physiology: A Mechanistic Approach*. CRC Press.
28. McCarty, D. R., & Tsai, J. (2009). *Genetic Engineering of Plant Metabolism*. Wiley.
29. Ghosh, P. K., & Bandyopadhyay, A. (2010). *Biochemistry and Physiology of Plant Growth Regulators*. Springer.
30. Sinha, A. K., & Saluja, A. (2008). *Plant Physiology and Biochemistry*. New Age International.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the fundamental processes of carbon cycling, assimilation, storage, and oxidation in plants.	U, Ap	1, 4
CO-2	Analyze the light-dependent and light-independent reactions in photosynthesis, including specialized carbon fixation pathways.	An, E	1, 2
CO-3	Evaluate pathways involved in carbon storage, partitioning, and sucrose/starch biosynthesis in plants.	E, C	2, 5
CO- 4	Interpret the metabolic pathways of carbon oxidation and energy release, including glycolysis, TCA cycle, and oxidative phosphorylation.	Ap, An	3, 6

CO-5	Assess the role of carbon in secondary metabolism, including the biosynthesis of terpenoids, alkaloids, and phenylpropanoids.	E, C	3, 5, 6

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

Name of the Course: CARBON METABOLISM IN PLANTS

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the fundamental processes of carbon cycling, assimilation, storage, and oxidation in plants.	1, 2	1, 4	U, Ap	F, C	L/T
CO2	Analyze the light-dependent and light-independent reactions in photosynthesis, including specialized carbon fixation pathways.	2, 3	1, 2	An, E	C, P	L,P
CO3	Evaluate pathways involved in carbon storage, partitioning, and sucrose/starch biosynthesis in plants.	3, 5	2, 5	E, C	C, P	L,P
CO4	Interpret the metabolic pathways of carbon oxidation and energy release, including glycolysis, TCA cycle, and oxidative phosphorylation.	3, 6	3, 6	Ap, An	C, M	L,P
CO5	Assess the role of carbon in secondary metabolism, including the biosynthesis of terpenoids, alkaloids, and phenylpropanoids.	3, 7	3, 5, 6	E, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK7DSCBOT 401.1**				
Course Title	**ADVANCED PLANT GENOMICS AND PROTEOMICS**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in genetics, molecular biology, and biotechnology.				
Course Summary	Genomics and proteomics are central to current advances in understanding plant biology at the molecular level. This course would allow students to engage deeply with tools like next-generation sequencing, CRISPR, and mass spectrometry, which are transformative in plant research.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to plant genomics**	**8**
	1	Overview of plant genomics, Historical perspective and significance, Importance of genomics in plant science, Applications in agriculture, horticulture, and environmental science.	
	2	Genomic technologies and methodologies, Next-generation sequencing (NGS), whole-genome sequencing, and RNA-	

		seq	
	3	Genome sequencing techniques- Sanger sequencing, NGS platforms, and their applications,	
	4	Comparative genomics, Tools and databases for comparative studies among plant species, understanding evolutionary relationships.	
II		**Plant genome structure and function**	**8**
	5	Organization of plant genomes, Chromosomal structure, gene density, and organization in different plant species	
	6	Gene structure and function, Functional elements of genes, regulatory sequences, and gene families	
	7	Non-coding RNAs and their roles, Types of non-coding RNAs, including microRNAs and long non-coding RNAs, Role RNA in gene regulation	
	8	Epigenetics in plants, Mechanisms of epigenetic regulation, including DNA methylation and histone modification, Genomic databases and bioinformatics tools, Introduction to tools like NCBI, Ensembl Plants, and their uses in genomic research	
III		**Genomics for plant breeding**	**7**
	9	Marker-assisted selection (MAS), Understanding molecular markers and their application in plant breeding, Genomic selection.	
	10	Predictive breeding strategies based on genomic information, Genotype-phenotype associations, Exploring the relationship between genetic variation and phenotypic traits.	
	11	Applications of genomics in crop improvement, Case studies of successful genomic interventions in crops (e.g., drought resistance, disease resistance), Introduction to gene editing technologies	
	12	Overview of CRISPR/Cas9, TALENs, and ZFNs, with applications in targeted trait improvement.	

IV		**Introduction to proteomics in plants**	**7**
	13	Basics of plant proteomics, Definition and significance in understanding plant biology,	
	14	Techniques in proteomic analysis, Overview of methods such as 2D gel electrophoresis, mass spectrometry, and liquid chromatography	
	15	Post-translational modifications, Types of modifications and their functional implications in plants,.	
	16	Protein-protein interactions, Techniques to study interactions, including co-immunoprecipitation and yeast two-hybrid screening,	
	17	Proteomic data analysis and interpretation, Tools and software for analyzing proteomic datasets	
V		**Integrating genomics and proteomics**	**15**
		Systems biology approaches, understanding plant systems through integrative analysis of genomic and proteomic data, Functional genomics and proteomics, Linking gene function to protein function and metabolic pathways, Transcriptomics and proteomics integration, Analyzing the relationship between mRNA expression levels and protein abundance, Case studies of genomics and proteomics in plant research, Successful applications in stress response, development, and metabolic engineering, Future directions in plant genomics and proteomics, emerging technologies, including synthetic biology and multi-omics approaches, and their potential impact on agriculture.	

Practicals (30 hrs)

1. Use bioinformatics tools to analyze genomic sequences, including BLAST, multiple sequence alignment, and phylogenetic analysis.

2. Perform genome annotation on a sequenced plant genome using available online databases and software tools.
3. Analyze publicly available RNA-seq data to assess gene expression profiles in response to environmental changes.
4. CRISPR design project, Design a CRISPR/Cas9 gene editing experiment using computational tools to predict off-target effects and validate guide RNA sequences.
5. Use software (e.g., PyMOL, Chimera) to predict and model the three-dimensional structures of plant proteins based on their amino acid sequences.
6. Pathway analysis, Use online tools to analyze metabolic pathways in plants and predict the effects of gene modifications on these pathways.
7. Data visualization, Create visual representations of genomic or proteomic data using tools like R or Python for better interpretation of results.

References

1. Baxevanis, A. D., & Ouellette, B. F. F. (2001). *Bioinformatics: A practical guide to the analysis of genes and proteins* (2nd ed.). John Wiley & Sons, Inc.
2. Ghosh, Z., & Bibekanand, M. (2008). *Bioinformatics: Principles and applications*. Oxford University Press.
3. Mount, D. (2004). *Bioinformatics: Sequence and genome analysis* (2nd ed.). Cold Spring Harbor Press.
4. Durbin, R. (2007). *Biological sequence analysis*. Cambridge University Press India Pvt. Ltd.
5. Pevsner, J. (2009). *Bioinformatics and functional genomics* (2nd ed.). Wiley-Blackwell.
6. Xiong, J. (2007). *Essential bioinformatics*. Cambridge University Press India Pvt. Ltd.
7. Higgs, P. G. (2005). *Bioinformatics and molecular evolution*. Ane Books India Pvt. Ltd.
8. Campbell, A. M., & Heyer, L. J. (2006). *Discovering genomics, proteomics, and bioinformatics* (2nd ed.). Benjamin Cummings.
9. Xiong, J. (2006). *Essential bioinformatics*. Cambridge University Press.
10. Zvelebil, M. J. (2007). *Understanding bioinformatics*. Garland Science.
11. Ye, S. Q. (2019). *Bioinformatics: A practical approach*. CRC Press.
12. Tramontano, A. (2018). *Introduction to bioinformatics*. CRC Press.

13. Mani, K., & Vijayaraj, N. (2002). *Bioinformatics for beginners*. Kalaikathir Achchagam.
14. De Robertis, E. D. P., & Robertis, E. M. P. (1991). *Cell and molecular biology*. Scientific American Books.
15. Gupta, S. C., et al. (Eds.). *Plant genomics: Methods and applications*.
16. Valente, C. R. R., & dos Santos, M. A. H. G. (Eds.). *Plant genomics: A new approach to agriculture*.
17. Edwards, K. J., & van Loon, J. A. M. H. A. (Eds.). *The plant genome: A genomics perspective*.
18. Kumar, M. R. S. (Ed.). *Plant proteomics: Methods and protocols*.
19. dos Santos, M. A. H. G. (Ed.). *Plant proteomics: Techniques and applications*.

Course Outcomes

No.	**Upon completion of the course the graduate will be able to**	**Cognitive Level**	**PSO addressed**
CO-1	Understand plant genomics, sequencing techniques, and comparative genomics for evolutionary analysis.	U, Ap	1, 3
CO -2	Analyze plant genome structure, gene function, and epigenetic regulation, integrating bioinformatics tools for genomic research.	An, E	2, 4
CO-3	Apply genomic approaches, including marker-assisted selection and gene-editing technologies, for crop improvement and breeding strategies.	Ap, C	2, 5
CO-4	Evaluate proteomic techniques for analyzing plant proteins, post-translational modifications, and protein-protein interactions.	E, C	3, 6
CO-5	Integrate genomics and proteomics using systems biology, functional genomics, and transcriptomics for advanced plant research.	E, C	3, 5, 6

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

Name of the Course: ADVANCED PLANT GENOMICS AND PROTEOMICS

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial(T)/ Practical (P)
CO1	Understand plant genomics, sequencing techniques, and comparative genomics for evolutionary analysis.	1, 2	1, 3	U, Ap	F, C	L/T
CO2	Analyze plant genome structure, gene function, and epigenetic regulation, integrating bioinformatics tools for genomic research.	2, 3	2, 4	An, E	C, P	L,P
CO3	Apply genomic approaches, including marker-assisted selection and gene-editing technologies, for crop improvement and breeding strategies.	3, 5	2, 5	Ap, C	C, P	L,P
CO4	Evaluate proteomic techniques for analyzing plant proteins, post-translational modifications, and protein-protein interactions.	3, 6	3, 6	E, C	C, M	L,P
CO5	Integrate genomics and proteomics using systems biology, functional genomics, and transcriptomics for advanced plant research.	3, 7	3, 5, 6	E, C	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-

CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**
Course Code	**MIUK7DSCBOT 402.1**
Course Title	**DEVELOPMENTAL BOTANY**
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
	4	3 hours	-	2 hours	5

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**	**5**
	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**	**9**
	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**	**9**
	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**	**7**
	8	Hormonal control of growth**:** mode of action of auxin, gibberellin,cytokinin & ethylene, abscisic acid, bassinosteroids, salicylic acidand 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: (30 hrs)

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

References

1. Dickison, W. C. (2000). *Integrative plant anatomy*. Harcourt Academic Press.

2. Esau, K. (1990). *Plant anatomy* (2nd ed.). Wiley Eastern Pvt. Ltd.
3. Evert, R. F. (2006). *Esau's plant anatomy: Meristems, cells, and tissues of the plant* (3rd ed.). Wiley.
4. Karp, G. (1985). *Cell biology*. McGraw-Hill.
5. Raghavan, V. (2000). *Developmental biology of flowering plants*. Springer.
6. Riechmann, J. L., & Wellmer, F. (2014). *Methods in molecular biology: Flower development—Methods and protocols* (Vol. 1110). Springer Protocols, Humana Press.
7. Twyman, R. M. (2010). *Instant notes in developmental biology*. BIOS Scientific Publishers.
8. Wolpert, L. (2002). *Principles of development* (2nd ed.). Oxford University Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand plant genomics, sequencing techniques, and comparative genomics for evolutionary analysis.	U, Ap	1, 3
CO -2	Analyze plant genome structure, gene function, and epigenetic regulation, integrating bioinformatics tools for genomic research.	An, E	2, 4
CO-3	Apply genomic approaches, including marker-assisted selection and gene-editing technologies, for crop improvement and breeding strategies.	Ap, C	2, 5
CO-4	Evaluate proteomic techniques for analyzing plant proteins, post-translational modifications, and protein-protein interactions.	E, C	3, 6
CO-5	Integrate genomics and proteomics using systems biology, functional genomics, and transcriptomics for advanced plant research.	E, C	3, 5, 6

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)
CO1	Understand the processes of embryonic and post-embryonic development in plants, including embryo and endosperm formation.	1, 2	1, 3	U, R	F, C	L
CO2	Analyze cell differentiation, morphogenesis, and the role of meristems in plant growth and development.	2, 3	2, 4	An, E	C, P	L,P
CO3	Apply knowledge of seed development, organogenesis, and regulatory mechanisms to explain plant growth and reproductive transitions.	3, 5	2, 5	Ap, E	C, P	L,P
CO4	Evaluate the role of hormones, environmental factors, and genetic mechanisms in regulating plant growth, sex determination, and senescence.	3, 6	3, 6	E, C	C, M	L,P
CO5	Investigate the influence of nuclear-cytoplasmic interactions and tumorigenesis in plant development, focusing on gene regulation and pathogen interactions.	3, 7	3, 5, 6	Ap, An	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓		✓	✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">BOTANY</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK7DSEBOT 400.1</td></tr>
<tr><td>Course Title</td><td colspan="5">AQUATIC BOTANY</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400 – 499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3 hours</td><td>-</td><td>2 hours</td><td>5</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Basic understanding in aquatic environment and ecosystems</td></tr>
<tr><td>Course Summary</td><td colspan="5">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.</td></tr>
</table>

Detailed Syllabus:

<table>
<tr><th>Module</th><th>Unit</th><th>Content</th><th>Hrs</th></tr>
<tr><td rowspan="3">I</td><td colspan="2">Aquatic ecosystems</td><td>8</td></tr>
<tr><td>1</td><td>Aquatic ecosystems: Definition, features, types, and functions of aquatic ecosystems- marine ecosystems (ocean, coastal) and freshwater ecosystems (lotic, lentic, and wetlands).</td><td></td></tr>
<tr><td>2</td><td>Freshwater/Inland ecosystems: Origin, classification, and</td><td></td></tr>
</table>

		distribution of rivers, lakes, and ponds, major river systems of India. Riparian flora.	
II		**Marine ecosystem**	**5**
	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 andclassification- brief idea of Plankton, Nekton, Benthos.	
	7	Marine Phytoplankton- Dinoflagellates, nano-plankton, ultraplankton, 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**	**7**
	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: (30 hrs)

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 afield report

References

1. Jhingran, V. G. (1985). *Fish and fisheries of India*. Hindustan Publication Corp.
2. Nair, B. N., & Thampy, D. M. (1980). *A text book of marine ecology*.
3. Nybakken, J. W. (2001). *Marine biology: An ecological approach* (4th ed.).
4. Perkins, E. J. (1980). *The biology of estuaries and coastal waters*. Academic Press.
5. Barnes, R. S. K. (1999). *Introduction to marine ecology*. Blackwell Science.
6. Edmondson, W. T. (1976). *Freshwater biology* (2nd ed.). John Wiley & Sons Inc.
7. Golterman, H. L., Clyno, R. S., & Ohnstad, M. A. M. (1978). *Methods for physical and chemical analysis of freshwater* (2nd ed.). IBP Handbook No. 8. Blackwell Scientific Publication.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the structure, classification, and functioning of different aquatic ecosystems, including freshwater and marine environments.	U, R	1, 3
CO-2	Analyze the diversity, distribution, and ecological roles of aquatic plant resources, including algae, phytoplankton, seaweeds, and seagrasses.	An, E	2, 4
CO-3	Apply knowledge of plant adaptations, trophic interactions, and ecosystem dynamics to assess the role of aquatic vegetation in ecological balance.	Ap, E	2, 5
CO- 4	Evaluate the major threats to freshwater ecosystems, including pollution, eutrophication, and invasive species, and recommend conservation strategies.	E, C	3, 6
CO-5	Investigate sustainable management practices for aquatic plant resources, including restoration,	Ap, An	3, 5, 6

	biomonitoring, and the role of Ramsar sites in wetland conservation.		

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)
CO1	Understand the structure, classification, and functioning of different aquatic ecosystems, including freshwater and marine environments.	1, 2	1, 3	U, R	F, C	L/T
CO2	Analyze the diversity, distribution, and ecological roles of aquatic plant resources, including algae, phytoplankton, seaweeds, and seagrasses.	2, 3	2, 4	An, E	C, P	L,P
CO3	Apply knowledge of plant adaptations, trophic interactions, and ecosystem dynamics to assess the role of aquatic vegetation in ecological balance.	3, 5	2, 5	Ap, E	C, P	L,P
CO4	Evaluate the major threats to freshwater ecosystems, including pollution, eutrophication, and invasive species, and recommend conservation strategies.	3, 6	3, 6	E, C	C, M	L,P
CO5	Investigate sustainable management practices for aquatic plant resources, including restoration, biomonitoring, and the role of Ramsar sites in wetland conservation.	3, 7	3, 5, 6	Ap, An	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK7DSEBOT 401.1**				
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
	4	3 hours	-	2 hours	5
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.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to plant Tissue culture**	6

	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**	**6**
	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**	**6**
	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 (30 hrs)

1. MS Media Preparation and Sterilization.
2. Surface Sterilization, explant preparation, inoculation, and incubation.
3. Micropropagation, multiplication, rooting hardening of any
4. commercially important plants

a. Ornamental plants (Orchids/ Anthuriums/ any available sps) OR
b. Fruits/ Vegetables (Banana/ Papaya or any other species)

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

References

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, S. M., Kumari, V. B. C., Sumana, K., Sujay, S., Tejaswini, M., Shirahatti, P. S., & Ramu, R. (2021). Sustainable development of plant tissue culture industry: The Indian scenario. *Journal of Applied Biology & Biotechnology, 9*(2), 18-27.
3. Srivastava, D. K., Thakur, A. K., & Kumar, P. (Eds.). (2021). *Agricultural biotechnology: Latest research and trends*. Springer Nature Singapore Pte Ltd.
4. Prasad, S., & Pareek, L. K. (Eds.). (1996). *Impact of plant biotechnology in horticulture*. Agro Botanical Publishers (India).
5. Bajaj, Y. P. S. (Ed.). (1997). *High tech 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. (Eds.). (2010). *Plant tissue culture engineering* (Focus on Biotechnology). Springer.
8. George, E. F., Hall, M. A., & De Klerk, G. J. (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, S. M., & Ishii, K. (Eds.). (2003). *Micropropagation of woody trees and fruits*. Kluwer Academic Publishers.
11. Dirr, M. A., & Heuser, C. W. Jr. (2006). *The reference manual of woody plant propagation: From seed to tissue culture*.
12. Neumann, K. H., Kumar, A., & Imani, J. (2009). *Plant cell and tissue culture – A tool in biotechnology: Basics and application (Principles and practice)*. Springer.
13. Razdan, M. K. (2003). *Plant tissue culture* (2nd ed.). Science Publishers Inc.
14. Trigiano, R. N., & Gray, D. J. (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 fundamentals of plant tissue culture, including somatic embryogenesis, micropropagation, and synthetic seeds.	U, R	1, 3
CO-2	Analyze laboratory design, instrumentation, and sterilization techniques required for successful tissue culture.	An, Ap	2, 4
CO-3	Apply knowledge of media preparation, plant growth regulators, and additives to optimize *in vitro* plant growth.	Ap, E	3, 5
CO- 4	Develop micropropagation protocols for different plants and assess the factors influencing shoot multiplication, rooting, and hardening.	C, E	4, 6
CO-5	Evaluate commercial operations, quality control measures, and cost-benefit analysis in large-scale tissue culture ventures.	E, Ap	3, 6

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)
CO1	Understand the fundamentals of plant tissue culture, including somatic embryogenesis, micropropagation, and synthetic seeds.	1, 2	1, 3	U, R	F, C	L/T
CO2	Analyze laboratory design, instrumentation, and sterilization techniques required for successful tissue culture.	2, 3	2, 4	An, Ap	C, P	L,P
CO3	Apply knowledge of media preparation, plant growth regulators, and additives to optimize *in vitro* plant growth.	3, 4	3, 5	Ap, E	C, P	L,P/T
CO4	Develop micropropagation protocols for different plants and assess the factors influencing shoot multiplication, rooting, and hardening.	3, 5	4, 6	C, E	P, M	L,P
CO5	Evaluate commercial operations, quality control measures, and cost-benefit analysis in large-scale tissue culture ventures.	4, 7	3, 6	E, Ap	C, M	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-

CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓		✓	✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK7DSCBOT 300.1**				
Course Title	**GERMPLASM MANAGEMENT**				
Type of Course	**DSC**				
Semester	**VII**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in environmental science and ecosystem concept.				
Course Summary	The course cover various aspects of germplasm conservation, from practical techniques and global policy to the role of molecular tools and climate adaptation.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction**	5
	1	Definition and Importance of Germplasm- Concept of germplasm in biodiversity and genetic conservation. Types of Germplasm-Wild relatives, landraces, modern varieties, and elite breeding lines. Historical Perspectives on Germplasm	
	2	Role of Germplasm in Crop Improvement- Introduction to gene pools and their utilization in breeding.	
	3	Ethics and Policies in Germplasm Conservation	

		Intellectual property rights, biopiracy, and farmer rights. Significance in food security, genetic diversity, and breeding programs. Conservation- Key milestones and global initiatives (e.g., FAO, CBD).	
II		**Conservation strategies**	8
	4	*In Situ* Conservation-Natural habitats, reserves, and biodiversity hotspots. Field gene banks- preservation of genetic materials under natural conditions -Community participation and agrobiodiversity conservation.	
	5	*Ex Situ* Conservation- Seed banks- orthodox, recalcitrant seeds- differences in handling, guidelines for sending seeds to network of active/ working collections, genetic stability under long term storage condition.	
	6	Role of international seed vaults and gene banks. Cryopreservation Techniques- Basics, application, and challenges. Cryopreservation- procedure for handling seeds of orthodox and recalcitrant-cryoprotectants, desiccation, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities,	
	7	DNA Banks and Genomic Resource Repositories- Role of DNA banks in conservation. Advantages of DNA storage and molecular approaches. *In vitro* storage, maintenance of *in vitro* culture under different conditions, prospects of *in vitro* gene bank. Threats to Germplasm Conservation Climate change, habitat destruction, and invasive species. Policy and regulatory frameworks.	
		Collection and characterisation of germplasm	10
	8	Methods of Germplasm Collection- In situ and ex situ collection methods. Field collections, botanical gardens, seed banks, and herbaria, use of flora.	

III	9	Sampling Techniques- Strategies for sampling in diverse habitats. Sample sizes and population genetics considerations	
	10	Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys.	
	11	Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection	
	12	Documentation and Data Management- Passport data, collecting forms, and database management. Introduction to digital tools for germplasm data.	
	13	Characterization and Evaluation of Germplasm-Morphological, physiological, and molecular characterization. Role of phenotyping and genotyping in germplasm evaluation. Core and Mini-Core Collections Concept, development, and applications in research.	
IV	**Germplasm exchange and utilization**		7
	14	Breeding Programs and Germplasm Utilization: Role of germplasm in breeding for yield, resilience, and quality. Introgression of novel traits. Pre-Breeding and Genetic Enhancement- Pre-breeding approaches and their importance. Strategies for enhancing genetic diversity.	
	15	Germplasm Exchange and International Protocols Access and benefit-sharing (ABS). International treaties, e.g., ITPGRFA, Nagoya Protocol.	
	16	Quarantine and Biosafety Regulations- Standards for the safe movement of germplasm. Phytosanitary measures and genetic contamination risks	
	17	Intellectual Property Rights and Benefit Sharing- Patent laws, plant variety protection, and access rights. Benefit-sharing models and indigenous knowledge protection.	
	Future trends and challenges		15
	18	Role of Biotechnology and Genomics Molecular markers,	

V		gene editing, and genomic selection. Impact of genomics on germplasm conservation and utilization.	
	19	Digital Tools and Databases for Germplasm Management Databases (e.g., GenBank, GRIN) and digital platforms. Digital DNA storage and metadata integration.	
	20	Climate Change and Adaptation Strategies Climate-resilient varieties and germplasm conservation. Conservation techniques for rare and endangered species.	
	21	Urbanization and Loss of Natural Habitats Impact of urban sprawl on conservation efforts. Strategies for promoting urban conservation and community gene banks.	
	22	Future of Germplasm Management- Emerging trends in synthetic biology and bioengineering. Ethical implications and sustainable development goals.	

Practicals (30 hrs)

1. In situ conservation of wild species -case studies at national and international levels-
2. Preparation and handling of materials, packaging, documentation;
3. *in vitro* cultures- embryo, cell/suspension cultures, pollen cultures,
4. study of cryo tank facility and vitrification techniques,
5. visit to NBPGR/NBAGR -study using fruit crops and other horticultural crops.
6. Plant exploration and collection; Identification of wild relatives of crop plants- Example of collection, cataloguing and preservation of specimens
7. Techniques of coarse and fine grid surveys;
8. Sampling techniques of plant materials;
9. Visiting ports, airports to study the quarantine regulations;
10. Techniques for the detection of insects, mites, nematodes, bacteria, weeds, pathogens and viruses on seed and planting materials and salvaging; Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques (controlled greenhouses /growth chambers, etc); Detection of GMOs and GEPs;
11. Study of post-entry quarantine operation, seed treatment and other prophylactic treatments

References

1. Allard, R. W. (1999). *Principles of Plant Breeding* (2nd ed.). Wiley.
2. Brown, A. H. D., Frankel, O. H., Marshall, D. R., & Williams, J. T. (1989). *The Use of Plant Genetic Resources*. Cambridge University Press.
3. Chandel, K. P. S. (1997). *Plant Genetic Resources*. Scientific Publishers.
4. Engels, J. M. M., & Visser, L. (Eds.). (2003). *A Guide to Effective Management of Germplasm Collections*. IPGRI.
5. FAO. (2010). *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. Food and Agriculture Organization of the United Nations.
6. Frankel, O. H., Brown, A. H. D., & Burdon, J. J. (1995). *The Conservation of Plant Biodiversity*. Cambridge University Press.
7. Gepts, P. (2005). *Plant Genetic Resources Conservation and Utilization*. Springer.
8. Hammer, K., Knüpffer, H., & Perrino, P. (Eds.). (2007). *Plant Genetic Resources in Food and Agriculture: The Past Ten Thousand Years*. Springer.
9. Hawkes, J. G., & Witts, R. A. (1992). *The Diversity of Crop Plants*. Harvard University Press.
10. Henry, R. J. (2001). *Plant Genotyping: The DNA Fingerprinting of Plants*. CABI Publishing.
11. Holden, J. H. W., & Williams, J. T. (1984). *Crop Genetic Resources: Conservation and Evaluation*. Allen & Unwin.
12. Hunter, D., & Heywood, V. H. (2011). *Crop Wild Relatives: A Manual of In Situ Conservation*. Earthscan.
13. Maxted, N., Ford-Lloyd, B. V., & Hawkes, J. G. (1997). *Plant Genetic Conservation: The In Situ Approach*. Springer Science & Business Media.
14. Maxted, N., Dulloo, M. E., Ford-Lloyd, B. V., Frese, L., Iriondo, J. M., & Pinheiro de Carvalho, M. A. A. (Eds.). (2012). *Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces*. CABI.
15. Pistrick, K., Hammer, K., & Perrino, P. (1994). *European Wild Relatives of Crop Plants*. Springer.
16. Rao, N. K., Hanson, J., Dulloo, M. E., Ghosh, K., Nowell, D., & Larinde, M. (2006). *Manual of Seed Handling in Genebanks*. Bioversity International.
17. Schlegel, R. H. J. (2009). *Dictionary of Plant Breeding*. CRC Press.
18. Singh, B. D., & Singh, A. K. (2015). *Marker-Assisted Plant Breeding: Principles and Practices*. Springer.

19. Singh, R. J., & Jauhar, P. P. (2005). *Genetic Resources, Chromosome Engineering, and Crop Improvement: Volume 1: Grain Legumes*. CRC Press.
20. van Hintum, T. J. L., Sackville Hamilton, N. R., & Maxted, N. (2003). *Core Collections of Plant Genetic Resources*. Plant Genetic Resources.
21. Ellis RH & Roberts EH & White Head J. 1980. A New More Economic and Accurate Approach to Monitor the Viability of Accessions During Storage in Seed Banks. FAO / IBPGR Pl. Genet. Resources News 41-3-18.
22. Frankel OH & Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press, Cambridge.
23. Simmonds, N.W. 1979. Principles of Crop Improvement Longman. Westwood MN. 1986. Operation Manual for National Clonal Germplasm Repository Processed Report. USDA-ARS and Orgon State Univ. Oregon, USA.
24. Withers LA. 1980. Tissue Culture Storage for Genetic Conservation. IBPGR Tech. Rep. IBPGR, Rome, Italy.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental concepts, importance, and ethical considerations of germplasm conservation.	U, R	1, 3
CO-2	Analyze various in situ and ex situ conservation strategies, including gene banks, cryopreservation, and DNA banks.	An, Ap	2, 4
CO-3	Apply knowledge of germplasm collection, characterization, and evaluation using morphological, physiological, and molecular approaches.	Ap, E	3, 5
CO- 4	Evaluate germplasm exchange protocols, international treaties, and biosafety regulations to facilitate sustainable use in plant breeding.	E, Ap	4, 6
CO-5	Assess future trends, challenges, and	E, C	3, 6

	biotechnological advancements in germplasm conservation, including climate adaptation and urban conservation strategies.		

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

Name of the Course: GERMPLASM MANAGEMENT

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the fundamental concepts, importance, and ethical considerations of germplasm conservation.	1, 2	1, 3	U, R	F, C	L/T
CO2	Analyze various in situ and ex situ conservation strategies, including gene banks, cryopreservation, and DNA banks.	2, 3	2, 4	An, Ap	C, P	L,P
CO3	Apply knowledge of germplasm collection, characterization, and evaluation using morphological, physiological, and molecular approaches.	3, 4	3, 5	Ap, E	C, P	L,P
CO4	Evaluate germplasm exchange protocols, international treaties, and biosafety regulations to facilitate sustainable use in plant breeding.	4, 5	4, 6	E, Ap	P, M	L,P
CO5	Assess future trends, challenges, and biotechnological advancements in germplasm conservation, including climate adaptation and urban conservation strategies.	5, 6	3, 6	E, C	M, P	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓	✓		✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK7DSCBOT 301.1**				
Course Title	**PHYTOREMEDIATION AND ENVIRONMENTAL BIOTECHNOLOGY**				
Type of Course	**DSC**				
Semester	**VII**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in environmental science and biotechnology				
Course Summary	The course focuses on key aspects of plant-based environmental cleanup and biotechnological applications for ecological improvement.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Fundamentals of phytoremediation**	**4**
	1	Overview of environmental contaminants: heavy metals, organic pollutants, radionuclides, and emerging contaminants.	
	2	Basic plant mechanisms: phytoextraction, phytostabilization, phytodegradation, and phytovolatilization.	
	3	Advantages and limitations of phytoremediation in	

		comparison to conventional methods.	
	4	Role of rhizosphere interactions and plant-microbe symbiosis in enhancing remediation.	
II		**Molecular mechanisms in phytoremediation**	**8**
	5	Metal uptake and transport mechanisms: role of transporters, chelators, and sequestration in vacuole.	
	6	Enzymatic and non-enzymatic antioxidant defense systems in plants for contaminant detoxification.	
	7	Molecular responses to stress caused by pollutants: gene expression and regulation in phytoremediation.	
	8	Genetic engineering approaches to enhance phytoremediation capabilities.	
III		**Biotechnological enhancements for phytoremediation**	**8**
	9	Engineering plants for improved tolerance and accumulation of heavy metals.	
	10	Use of transgenic plants expressing specific genes to enhance pollutant uptake or breakdown.	
	11	Microbial bioremediation: introduction of plant-growth-promoting rhizobacteria (PGPR) and mycorrhizal fungi in phytoremediation.	
	12	Application of synthetic biology to design plants with optimized phytoremediation pathways.	
IV		**Environmental biotechnology for phytoremediation**	**10**
	13	Ecological roles of bioremediation in restoring soil health, water bodies, and wetlands.	
	14	Techniques for the bioremediation of oil spills, plastic waste, and pesticides using microbial and plant systems.	
	15	Strategies for re-establishing biodiversity in contaminated sites. Role of biotechnology in creating bioindicators and biosensors for environmental monitoring.	
		Environmental ethics in phytoremediation	**15**

V	16	Case studies of successful phytoremediation projects (e.g., remediation of arsenic-contaminated lands in Bangladesh).	
	17	Evaluation of phytoremediation project design and cost-benefit analysis. International policies, environmental laws, and regulations for deploying phytoremediation. Ethical considerations and public acceptance of genetically modified plants in environmental restoration.	

Practicals (30 hrs)

1. Contaminant Uptake Study
2. Antioxidant Enzyme Activity Assay
3. Plant-Microbe Interaction Experiment
4. Genomic Analysis of Stress-Related Genes
5. Case Study Analysis of Bioremediation Projects
6. Microbial Culture for Bioremediation
7. Design and Proposal of a Phytoremediation Project

References

1. Baker, A. J. M., & Walker, P. L. (2000). *Phytoextraction of Metals: Exploiting Plants to Remediate Contaminated Soils*. John Wiley & Sons.
2. Cunningham, S. D., & Ow, D. W. (1996). *Promises and Prospects of Phytoremediation*. Springer.
3. Diels, L., & van der Lelie, D. (2002). *Advances in Bioremediation and Phytoremediation*. Academic Press.
4. Glick, B. R., & Pasternak, J. J. (2003). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (3rd ed.). ASM Press.
5. Glass, D. J. (1999). *U.S. and International Markets for Phytoremediation, 1999-2000*. D. Glass Associates.
6. Goyal, M. R. (2017). *Phytoremediation: Management of Environmental Contaminants* (Vols. 1–3). Springer.

7. Gupta, S. K., & Singh, A. (2007). *Biotechnology and Environmental Pollution Control*. APH Publishing.
8. Hall, J. L. (2002). *Cellular Mechanisms for Heavy Metal Detoxification and Tolerance*. CRC Press.
9. Hester, R. E., & Harrison, R. M. (2001). *Assessment and Remediation of Contaminated Land*. Royal Society of Chemistry.
10. Huang, J. W., & Cunningham, S. D. (1996). *Lead Phytoextraction: Species Variation in Lead Uptake and Translocation by Hyperaccumulators*. Springer.
11. Iqbal, H. (2019). *Bioremediation of Industrial Waste for Environmental Safety*. Springer.
12. Juwarkar, A., Singh, S. K., & Mudhoo, A. (2011). *Advances in Waste Management: Processes and Technologies for Sustainability*. Apple Academic Press.
13. Khan, S., & Zaidi, A. (2010). *Microbes in Sustainable Agriculture and Biotechnology*. Springer.
14. Mackova, M., Macek, T., & Kucerova, P. (2012). *Phytoremediation: Rhizoremediation*. Springer.
15. McCutcheon, S. C., & Schnoor, J. L. (2003). *Phytoremediation: Transformation and Control of Contaminants*. Wiley-Interscience.
16. Meagher, R. B. (2000). *Phytoremediation of Toxic Metals: Using Plants to Clean Up the Environment*. Springer.
17. Mukhopadhyay, S., & Masto, R. E. (2020). *Contaminants and Clean Technologies*. Springer.
18. Naidu, R., & Gupta, S. K. (2002). *Bioavailability, Toxicity, and Risk Relationships in Ecosystems*. Elsevier.
19. Pilon-Smits, E. (2005). *Phytoremediation*. Annual Review of Plant Biology, 56(1), 15–39.
20. Raskin, I., & Ensley, B. D. (2000). *Phytoremediation of Toxic Metals: Using Plants to Clean Up the Environment*. John Wiley & Sons.
21. Singh, A., Kuhad, R. C., & Ward, O. P. (2009). *Advances in Applied Bioremediation*. Springer.
22. Springer, L. (2010). *Handbook of Soil and Water Remediation*. Nova Science Publishers.

23. Suresh, B., & Ravishankar, G. A. (2004). *Phytoremediation—A Novel and Promising Approach for Environmental Clean-up*. Critical Reviews in Biotechnology, 24(2–3), 97–124.
24. Tsao, D. T. (2003). *Phytoremediation*. Springer Science & Business Media.
25. Varma, A., & Chincholkar, S. B. (2007). *Soil Biology and Agriculture in the Tropics*. Springer.
26. Volesky, B. (2004). *Biosorption of Heavy Metals*. CRC Press.
27. Wong, M. H. (2012). *Environmental Contamination: Health Risks and Ecological Restoration*. Taylor & Francis.

Course Outcomes

No.	**Upon completion of the course the graduate will be able to**	**Cognitive Level**	**PSO addressed**
CO-1	Understand the fundamental principles of phytoremediation, including plant-based mechanisms for pollutant removal and rhizosphere interactions.	U, R	1, 3
CO-2	Analyze molecular mechanisms involved in phytoremediation, such as metal transport, gene regulation, and detoxification pathways.	An, Ap	2, 4
CO-3	Apply biotechnological advancements, including genetic engineering and synthetic biology, to enhance phytoremediation efficiency.	Ap, E	3, 5
CO- 4	Evaluate environmental biotechnology techniques for bioremediation, ecological restoration, and pollution monitoring.	E, Ap	4, 6
CO-5	Assess real-world phytoremediation projects, ethical considerations, and international environmental regulations.	E, C	3, 6

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

Name of the Course: PHYTOREMEDIATION AND ENVIRONMENTAL BIOTECHNOLOGY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the fundamental principles of phytoremediation, including plant-based mechanisms for pollutant removal and rhizosphere interactions.	1, 2	1, 3	U, R	F, C	L
CO2	Analyze molecular mechanisms involved in phytoremediation, such as metal transport, gene regulation, and detoxification pathways.	2, 3	2, 4	An, Ap	C, P	L,P
CO3	Apply biotechnological advancements, including genetic engineering and synthetic biology, to enhance phytoremediation efficiency.	3, 4	3, 5	Ap, E	C, P	L,P
CO4	Evaluate environmental biotechnology techniques for bioremediation, ecological restoration, and pollution monitoring.	4, 5	4, 6	E, Ap	P, M	L,P/T
CO5	Assess real-world phytoremediation projects, ethical considerations, and international environmental regulations.	5, 6	3, 6	E, C	M, P	L/P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓		✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK7DSCBOT 302.1**				
Course Title	**HERBAL TECHNOLOGY AND HERBAL COSMETICS**				
Type of Course	**DSC**				
Semester	**VII**				
Academic Level	**300-399**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in plant Biochemistry				
Course Summary	The course focuses on key aspects of plant-based environmental cleanup and biotechnological applications for ecological improvement.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to herbal technology**	**5**
	1	Traditional herbal practices and their evolution Classification of medicinal plants and their pharmacological applications	
	2	Key bioactive compounds in medicinal plants Ethical and sustainable practices in harvesting and cultivation of medicinal plants.	
II		**Phytochemistry and extraction techniques**	**10**

	3	Types of phytochemicals: alkaloids, flavonoids, terpenoids, glycosides, and polyphenols	
	4	Techniques for the extraction and isolation of bioactive compounds (e.g., solvent extraction, steam distillation, Soxhlet extraction)	
	5	Phytochemical analysis techniques: TLC, HPLC, and GC-MS	
	6	Quality control of extracts: standardization, purity, and stability testing.	
III	**Formulation of herbal cosmetics**		**10**
	7	Types of herbal cosmetics: skincare (creams, lotions), hair care (shampoos, conditioners), and oral care (toothpaste, mouthwash)	
	8	Role of various herbs in cosmetics (e.g., aloe vera for moisturizing, turmeric for anti-inflammation)	
	9	Basics of formulation and stability testing in herbal products Labelling and packaging requirements for herbal cosmetics	
IV	**Quality control**		**5**
	10	National and international guidelines for herbal products (e.g., FDA, WHO, AYUSH)	
	11	Quality assurance practices: GMP (Good Manufacturing Practices) and GACP (Good Agricultural and Collection Practices), Safety, efficacy, and toxicological assessment of herbal products	
	12	Consumer safety and regulatory labelling of herbal products.	
V	**Advances and trends**		**15**
	13	Nanotechnology and its applications in herbal cosmetics Eco-friendly and sustainable ingredients in herbal formulations	
	14	Innovations in herbal product delivery systems (e.g., liposomal and nano-emulsions) Case studies on successful herbal cosmetic brands and products.	

Practicals: (30 hrs)

1. Extraction of Essential Oils from Medicinal Plants
2. Phytochemical Screening of Plant Extracts
3. Preparation of Herbal Creams and Lotions
4. Formulation of Herbal Shampoos and Conditioners
5. Antimicrobial Activity Testing of Herbal Extracts
6. Stability Testing of Herbal Formulations
7. Preparation and Evaluation of Herbal Toothpaste
8. Quality Control Testing of Herbal Products (pH, Viscosity, etc.)
9. Preparation of Herbal Face Masks and Scrubs
10. Thin-Layer Chromatography (TLC) Analysis of Herbal Extracts

References

1. Agrawal, S. S., & Paridhavi, M. (2007). *Herbal Drug Technology*. Universities Press.
2. Ahmad, I., Aqil, F., & Owais, M. (2006). *Modern Phytomedicine: Turning Medicinal Plants into Drugs*. Wiley-VCH.
3. Aneja, K. R. (2007). *Experiments in Microbiology, Plant Pathology and Biotechnology* (4th ed.). New Age International Publishers.
4. Arora, R. (2010). *Medicinal Plant Biotechnology*. CABI.
5. Bisset, N. G. (1994). *Herbal Drugs and Phytopharmaceuticals: A Handbook for Practice on a Scientific Basis*. CRC Press.
6. Blumenthal, M., Busse, W. R., & Goldberg, A. (1998). *The Complete German Commission E Monographs: Therapeutic Guide to Herbal Medicines*. American Botanical Council.
7. Bone, K., & Mills, S. Y. (2013). *Principles and Practice of Phytotherapy: Modern Herbal Medicine* (2nd ed.). Churchill Livingstone.
8. Bruneton, J. (1999). *Pharmacognosy, Phytochemistry, Medicinal Plants* (2nd ed.). Lavoisier Publishing.
9. Capasso, F., & Gaginella, T. S. (1998). *Phytotherapy: A Quick Reference to Herbal Medicine*. Springer.
10. Croteau, R., Kutchan, T. M., & Lewis, N. G. (2000). *Natural Products (Secondary Metabolites)*. Springer.
11. Debnath, M., & Malik, C. P. (2011). *Biotechnology in Medicinal Plants*. Oxford Book Company.

12. Dymock, W., Warden, C. J. H., & Hooper, D. (1890). *Pharmacographia Indica: A History of the Principal Drugs of Vegetable Origin*. Trubner and Co.
13. Elvin-Lewis, M. (2001). *Medical Botany: Plants Affecting Human Health*. Wiley.
14. Evans, W. C. (2009). *Trease and Evans' Pharmacognosy* (16th ed.). Saunders Ltd.
15. Fabricant, D. S., & Farnsworth, N. R. (2001). *The Value of Plants Used in Traditional Medicine for Drug Discovery*. Environmental Health Perspectives.
16. Heinrich, M., Barnes, J., Gibbons, S., & Williamson, E. M. (2012). *Fundamentals of Pharmacognosy and Phytotherapy* (2nd ed.). Churchill Livingstone.
17. Jadhav, R. N. (2012). *Herbal Drug Technology*. Pragati Books Pvt. Ltd.
18. Kapoor, L. D. (1990). *Handbook of Ayurvedic Medicinal Plants: Herbal Reference Library*. CRC Press.
19. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2010). *Pharmacognosy* (49th ed.). Nirali Prakashan.
20. Kothari, S. K. (2018). *Herbs for Health and Healing: An Ayurvedic Approach to Modern Herbal Remedies*. New Age Books.
21. Kumar, N., & Goel, A. (2017). *Herbal Cosmetics Handbook: Formulation, Manufacturing & Quality Control*. Asia Pacific Business Press.
22. Li, S. (2000). *Chinese and Related North American Herbs: Phytopharmacology and Therapeutic Values*. CRC Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the evolution of herbal practices, classification of medicinal plants, and ethical harvesting techniques.	U, R	1, 3
CO-2	Analyze the phytochemical composition of medicinal plants and evaluate extraction techniques for bioactive compounds.	An, Ap	2, 4
CO-3	Apply formulation techniques to develop herbal cosmetics, ensuring stability, efficacy, and safety.	Ap, C	3, 5
CO- 4	Evaluate quality control and regulatory compliance of herbal products, focusing on safety and	E, Ap	4, 6

	standardization.		
CO-5	Assess emerging trends and technological advancements in herbal product development, including nanotechnology applications.	E, C	3, 6

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

Name of the Course: HERBAL TECHNOLOGY AND HERBAL COSMETICS

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the evolution of herbal practices, classification of medicinal plants, and ethical harvesting techniques.	1, 2	1, 3	U, R	F, C	L/T
CO2	Analyze the phytochemical composition of medicinal plants and evaluate extraction techniques for bioactive compounds.	2, 3	2, 4	An, Ap	C, P	L,P
CO3	Apply formulation techniques to develop herbal cosmetics, ensuring stability, efficacy, and safety.	3, 4	3, 5	Ap, C	C, P	L,P
CO4	Evaluate quality control and regulatory compliance of herbal products, focusing on safety and standardization.	4, 5	4, 6	E, Ap	P, M	L,P
CO5	Assess emerging trends and technological advancements in herbal product development, including nanotechnology applications.	5, 6	3, 6	E, C	M, P	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓			✓

SEMESTER VIII

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK8DSCBOT 450.1**				
Course Title	**ADVANCES AND APPLIED ASPECTS OF THALOPHYTES**				
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
	4	3 hours	-	2 hours	5
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**	**8**
	1	Polyphyletic origin of algae and its evolution (with emphasis onendosymbiosis).	
	2	Gene sequencing in algal systematics (18SrRNA).	

	3	Gene sequencing in algal systematics (18SrRNA).	
	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**	**7**
	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 microalgaeupstream and downstream processes.	
	8	Microalgae biotechnology, Seaweed farming, microalgae for aquaculture.	
	9	Bioluminescent forms; Algae in nanotechnology.	
III		**Advancing the frontiers in Mycology & Mycotechnology**	**8**
	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**	**7**
	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.	

	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**	**15**
	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*.	
	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 acount).	

Practicals: (30 hrs)

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.

References

1. Prescott, G. W. (1984). *The algae: A review*. Lubrecht & Cramer Ltd.
2. Round, F. E. (1984). *The ecology of algae*. Cambridge University Press.
3. Fritsch, F. E. (1935, 1948). *Structure and reproduction of algae*. Cambridge University Press.

4. Upreti, D. K., Divakar, P. K., Shukla, V., & Bajpai, R. (2015). *Recent advances in lichenology: Modern methods and approaches in biomonitoring and bioprospection* (Vol. 1). Springer.
5. Dube, H. C. (2013). *An introduction to fungi* (4th ed.). Scientific Publishers, India.
6. Kirk, P., Cannon, P. F., Minter, D. W., & Stalpers, J. A. (2008). *Ainsworth & Bisby's dictionary of fungi* (10th ed.). CAB International.
7. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (2007). *Introductory mycology* (4th ed.). John Wiley & Sons.
8. Sharma, O. P. (2007). *Textbook of fungi*. Tata McGraw Hill Publishing Co. Ltd.
9. Awasthi, D. D. (2000). *Lichenology in Indian subcontinent: A supplement to "A handbook of lichens"*.
10. Awasthi, D. D. (2007). *A compendium of the macrolichens from India, Nepal, and Sri Lanka*.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the polyphyletic origin of algae, their evolution through endosymbiosis, and their genetic advancements in systematics and bioengineering.	U, R	1, 3
CO-2	Analyze the industrial and biotechnological applications of algae, fungi, and lichens in fields like biofuels, pharmaceuticals, and agriculture.	An, Ap	2, 4
CO-3	Apply molecular and phylogenomic techniques to study algae, fungi, and lichens, focusing on their genetic, metabolic, and ecological aspects.	Ap, C	3, 5
CO- 4	Evaluate the environmental significance of thallophytes, their role in ecosystem services, and their response to climate change.	E, Ap	4, 6

CO-5	Assess the potential of thallophytes in sustainable industries, including biomaterials, food, medicine, and environmental remediation.	E, C	3, 6

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

Name of the Course: ADVANCES AND APPLIED ASPECTS OF THALOPHYTES

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the polyphyletic origin of algae, their evolution through endosymbiosis, and their genetic advancements in systematics and bioengineering.	1, 2	1, 3	U, R	F, C	L
CO2	Analyze the industrial and biotechnological applications of algae, fungi, and lichens in fields like biofuels, pharmaceuticals, and agriculture.	2, 3	2, 4	An, Ap	C, P	L,P/T
CO3	Apply molecular and phylogenomic techniques to study algae, fungi, and lichens, focusing on their genetic, metabolic, and ecological aspects.	3, 4	3, 5	Ap, C	C, P	L,P
CO4	Evaluate the environmental significance of thallophytes, their role in ecosystem services, and their response to climate change.	4, 5	4, 6	E, Ap	P, M	L,P
CO5	Assess the potential of thallophytes in sustainable industries, including biomaterials, food, medicine, and environmental remediation.	5, 6	3, 6	E, C	M, P	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK8DSCBOT 451.1**				
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
	4	3 hours	-	2 hours	5
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**		**9**
	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). Ecological and economic significance of Bryophytes.	
II		**Advances and applied aspects of Pteridophytes**	**8**
	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**	**9**
	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**	**4**

	14	Applied aspects of fossil archegoniates – A multi-disciplinary approach.	
	15	Recent research on Palaeobotany 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 them exploration.	
	19	Extant and extinct forms of gymnosperms- Threat status of gymnosperms- need and methods of conservation.	

Practicals: (30 hrs)

1. Techniques for the experimental culture of any bryophytes (Demonstration only)
2. Construction of a pilot-level plant for Azolla cultivation.
3. Eco physiological behaviour 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.

References

1. Chopra, R. N., & Kumara, P. K. (1988). *Biology of Bryophytes*. Wiley East, New Delhi.
2. Smith, G. M. (1976). *Cryptogamic botany, Vol. II*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Stewart, W. N. (1983). *Palaeobotany and evolution of plants*. Cambridge University Press, London.

4. Parihar, N. S. (1980). *An introduction to embryophyta, Vol. II: Pteridophyta*. Central Book Depot, Allahabad.
5. Scott, D. H. (1962). *Studies in fossil botany*. Hafner Publishing Co., New York.
6. Vashishta, P. C. (1999). *Gymnosperms*. S Chand & Company, New Delhi.
7. Sharma, O. P. (1997). *Gymnosperms*. Pragati Prakashan, Meerut.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the evolutionary significance, ecological roles, and conservation approaches for bryophytes, pteridophytes, and gymnosperms.	U, R	1, 3
CO-2	Analyze the phylogenetic relationships, molecular advancements, and gene families within archegoniates, including their roles in evolutionary biology.	An, Ap	2, 4
CO-3	Apply modern biotechnological techniques such as DNA barcoding, metabolomics, and transcriptomics to study archegoniates.	Ap, C	3, 5
CO- 4	Evaluate the economic and ecological significance of archegoniates, focusing on bioactive phytochemicals and their applications.	E, Ap	4, 6
CO-5	Assess the conservation status of extant and extinct archegoniate taxa and propose strategies for their sustainable utilization.	E, C	3, 6

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

Name of the Course: ADVANCES AND 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)
CO1	Understand the evolutionary significance, ecological roles, and conservation approaches for bryophytes, pteridophytes, and gymnosperms.	1, 2	1, 3	U, R	F, C	L/T
CO2	Analyze the phylogenetic relationships, molecular advancements, and gene families within archegoniates, including their roles in evolutionary biology.	2, 3	2, 4	An, Ap	C, P	L,P
CO3	Apply modern biotechnological techniques such as DNA barcoding, metabolomics, and transcriptomics to study archegoniates.	3, 4	3, 5	Ap, C	C, P	L,P
CO4	Evaluate the economic and ecological significance of archegoniates, focusing on bioactive phytochemicals and their applications.	4, 5	4, 6	E, Ap	P, M	L,P/T
CO5	Assess the conservation status of extant and extinct archegoniate taxa and propose strategies for their sustainable utilization.	5, 6	3, 6	E, C	M, P	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7

CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓	✓		✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK8DSCBOT 452.1**				
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
	4	3 hours	-	2 hours	5
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**	**5**
	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**	**7**
	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**	**8**
	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 (30 hrs)

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)
7. (Demonstration only)
8. Visit to a Bioinformatics laboratory.

References

1. Pevsner, J. (2009). *Bioinformatics and functional genomics* (2nd ed.). Wiley Blackwell.
2. Xiong, J. (2006). *Essential bioinformatics* (1st ed.). Cambridge University Press.
3. Mount, D. W. (2004). *Bioinformatics: Sequence and genome analysis* (2nd ed.). Cold Spring Harbor Laboratory Press.
4. Zar, J. H. (2012). *Biostatistical analysis* (4th ed.). Pearson Education.
5. Pandey, M. (2015). *Biostatistics: Basic and advanced*. M V Learning.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental concepts, scope, and applications of bioinformatics, including biological databases and computational biology.	U, R	1, 3
CO-2	Analyze different types of biological databases and retrieve relevant biomolecular data for research applications.	An, Ap	2, 4
CO-3	Apply bioinformatics tools for sequence alignment, molecular visualization, protein structure prediction, and phylogenetic analysis.	Ap, C	3, 5
CO- 4	Evaluate the significance of molecular phylogeny, genomics, proteomics, and metabolomics in biological research and drug discovery.	E, Ap	4, 6
CO-5	Utilize bioinformatics techniques in computational biology and systems biology for interdisciplinary research applications.	Ap, C	3, 6

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 Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Understand the fundamental concepts, scope, and applications of bioinformatics, including biological databases and computational biology.	1, 2	1, 3	U, R	F, C	L/T
CO2	Analyze different types of biological databases and retrieve relevant	2, 3	2, 4	An, Ap	C, P	L,P

	biomolecular data for research applications.					
CO3	Apply bioinformatics tools for sequence alignment, molecular visualization, protein structure prediction, and phylogenetic analysis.	3, 4	3, 5	Ap, C	C, P	L,P
CO4	Evaluate the significance of molecular phylogeny, genomics, proteomics, and metabolomics in biological research and drug discovery.	4, 5	4, 6	E, Ap	P, M	L,P
CO5	Utilize bioinformatics techniques in computational biology and systems biology for interdisciplinary research applications.	5, 6	3, 6	Ap, C	M, P	L,P

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

Mapping of COs with PSOs and POs :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**
CO1	3	2	-	-	-	-	-	3	-	-	2	-	-	-
CO2	-	3	2	-	-	-	-	3	2	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO4	-	3	-	-	-	2	-	-	-	3	-	3	-	-
CO5	-	-	3	-	-	-	3	-	-	3	-	3	2	-

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate)**,** 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">BOTANY</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK8DSCBOT 453.1</td></tr>
<tr><td>Course Title</td><td colspan="5">GEOSPATIAL ANALYSIS AND GIS FOR LIFE SCIENCES</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC</td></tr>
<tr><td>Semester</td><td colspan="5">VIII</td></tr>
<tr><td>Academic Level</td><td colspan="5">400 – 499</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3 hours</td><td>-</td><td>2 hours</td><td>5</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Basic understanding in ecology, statistics, data interpretation and computer litracy.</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the principles of geospatial analysis and Geographical interpretation systems, with a focus on ecosystem management. The students will learn spatial data collection, mapping and analysis techniques relevant to ecology , agriculture, and biodiversity conservation.</td></tr>
</table>

Detailed Syllabus:

<table>
<tr><th>Module</th><th>Unit</th><th>Content</th><th>Hrs</th></tr>
<tr><td rowspan="5">I</td><td colspan="2">Introduction to Geospatial Science</td><td>5</td></tr>
<tr><td>1</td><td>Fundamentals of Geospatial Science</td><td></td></tr>
<tr><td>2</td><td>Basics of Remote Sensing and GIS</td><td></td></tr>
<tr><td>3</td><td>Types of Spatial Data: Raster and Vector</td><td rowspan="2"></td></tr>
<tr><td>4</td><td>Coordinate Systems and Map Projections</td></tr>
<tr><td></td><td colspan="2">Spatial Data Collection and Management</td><td>5</td></tr>
</table>

II	5	Sources of Spatial Data: Satellite Imagery, GPS, and Drones	
	6	Data Formats and Database Management in GIS	
	7	Georeferencing and Digitization	
	8	Introduction to Open-Source GIS Software (QGIS, Google Earth Engine)	
III		**GIS Applications in Plant Sciences**	**10**
	9	Ecological and Biodiversity Mapping	
	10	Agricultural and Forestry Applications	
	11	Environmental Monitoring and Conservation Planning	
	12	Disease Mapping and Epidemiological Studies	
IV		**Spatial Analysis Techniques**	**10**
	13	Overlay Analysis, Buffering, and Interpolation	
	14	Habitat Suitability Modeling	
	15	Land Use and Land Cover Change Analysis	
	16	Climate Change Impact Assessment	
V		**Advanced GIS and Emerging Trends**	**15**
	17	Machine Learning and AI in Geospatial Analysis	
	18	Remote Sensing for Vegetation and Soil Studies	
	19	Web GIS and Cloud-Based Spatial Analysis	
	20	Ethical and Legal Aspects of GIS in Research and Industry	

Practicals (30 hrs)

1. Introduction to GIS Software:- Hands-on experience with GIS software (e.g., QGIS, ArcGIS). Understanding the interface and basic functions.
2. Georeferencing and Digitization of Maps: Georeferencing scanned maps to real-world coordinates. Digitizing raster maps into vector layers.
3. Remote Sensing Image Interpretation: Working with satellite imagery (e.g., Landsat, MODIS). Identifying different land covers and objects from images.
4. Spatial Analysis: Performing overlay analysis and buffering operations. Creating and interpreting suitability models using spatial analysis techniques.
5. Ecological and Biodiversity Mapping: Mapping biodiversity hotspots and ecosystems using GIS. Analyzing spatial patterns of ecological data.

References

1. Bolstad, P. (2016). *GIS fundamentals: A first text on geographic information systems* (5th ed.). XanEdu Publishing Inc.
2. Campbell, J. B., & Wynne, R. H. (2011). *Introduction to remote sensing* (5th ed.). Guilford Press.
3. Geospatial Data Science Society. (2020). *Geospatial data science: Fundamentals and applications*. Springer.
4. Heywood, I., Cornelius, S., & Carver, S. (2011). *An introduction to geographical information systems* (4th ed.). Pearson Education.
5. Jensen, J. R. (2007). *Remote sensing of the environment: An earth resource perspective* (2nd ed.). Pearson Education.
6. Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). *Geographic information systems and science* (4th ed.). Wiley.
7. Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote sensing and image interpretation* (7th ed.). Wiley.
8. McKinney, D. C., & Wolf, E. L. (2009). *GIS and remote sensing applications in plant sciences* (1st ed.). Springer.
9. Qin, H., & Wang, F. (2018). *Geospatial analysis: A comprehensive guide* (2nd ed.). CRC Press.
10. Schneider, A., & Ye, X. (2013). *Introduction to spatial data analysis* (1st ed.). Routledge.
11. Tomlinson, R. F. (2007). *Geographic information systems and cartography: Exploring the world through spatial data* (2nd ed.). Springer.
12. Zhou, W., & Deng, Z. (2014). *Emerging trends in GIS and remote sensing: Environmental applications* (1st ed.). Springer.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain fundamental concepts of geospatial science and GIS	U	1, 2
CO-2	Apply GIS tools to collect, manage, and analyze	Ap	3, 4

	spatial data		
CO-3	Utilize spatial analysis techniques for biodiversity, ecology, and environmental monitoring	An	5, 6
CO- 4	Assess the impact of GIS in agriculture, conservation, and health sciences	E	2, 6
CO-5	Develop solutions using GIS for sustainable environmental and resource management	C	6, 7

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

Name of the Course: GEOSPATIAL ANALYSIS AND GIS FOR LIFE SCIENCES

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain fundamental concepts of geospatial science and GIS	1, 2	1, 2	U	F, C	L
CO2	Apply GIS tools to collect, manage, and analyze spatial data	1, 5, 6	3, 4	Ap	P	P
CO3	Utilize spatial analysis techniques for biodiversity, ecology, and environmental monitoring	2, 3, 6	5, 6	An	C, P	L,P
CO4	Assess the impact of GIS in agriculture, conservation, and health sciences	3, 5, 7	2, 6	E	P, M	L
CO5	Develop solutions using GIS for sustainable environmental and resource management	3, 6, 7	6, 7	C	M	P

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	2	-	-	-	-	-
CO2	3	-	-	-	3	2	-	-	-	3	3	-	-	-

CO3	-	3	3	-	-	3	-	-	-	-	-	3	3	-
CO4	-	-	3	-	2	-	3	-	-	-	3	-	-	3
CO5	-	-	3	-	-	3	3	-	-	-	-	-	3	3

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓	✓		✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK8DSCBOT 454.1**				
Course Title	**COMPUTATIONAL BIOLOGY AND DATA VISUALIZATION**				
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
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge in computing.				
Course Summary	This course introduces computational tools and data visualization techniques used in life sciences. Students will gain hands-on experience with programming languages such as R and Python for analyzing biological datasets, visualizing complex biological interactions, and applying bioinformatics techniques to real-world challenges in genomics, ecology, and systems biology.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Computational Biology**	**5**
	1	Overview of Computational Biology: Scope and Applications	
	2	Introduction to Biological Data Types (Genomic, Proteomic, Ecological, and Biochemical Data)	

	3	Basics of Scripting in R and Python for Life Sciences	
	4	Data Handling and Preprocessing	
II		**Bioinformatics and Data Analysis**	**10**
	5	Sequence Alignment and Phylogenetic Analysis	
	6	Structural and Functional Genomics	
	7	Metagenomics and Microbiome Data Analysis	
	8	Data Mining Techniques in Life Sciences	
III		**Data Visualization in Life Sciences**	**7**
	9	Principles of Data Visualization for Biological Research	
	10	Creating Graphs, Charts, and Heatmaps using ggplot2 (R) and Matplotlib (Python)	
	11	Network Visualization for Protein-Protein Interactions	
	12	Case Studies: Epidemiological Data, Plant Genomics, and Ecological Trends	
IV		**Machine Learning and AI in Life Sciences**	**8**
	13	Introduction to Machine Learning for Biological Data	
	14	Supervised vs Unsupervised Learning in Genomic and Ecological Studies	
	15	Dimensionality Reduction and Principal Component Analysis (PCA)	
	16	Applications of AI in Computational Biology	
V		**Applied Computational Biology and Future Trends**	**15**
	17	Predictive Modeling in Biotechnology and Agriculture	
	18	Applications of GIS in Biodiversity Studies	
	19	AI-driven Drug Discovery and Molecular Docking	
	20	Ethical and Legal Considerations in Computational Biology	

Practicals (30 hrs)

1. Introduction to Biological Data Types: explore genomic, proteomic, ecological, and biochemical data using sample datasets and understanding the structure and content of each type of biological data.
2. Basic Scripting in R and Python for Life Sciences:
3. Sequence Alignment and Phylogenetic Analysis: alignment using tools such as BLAST, ClustalW, and MAFFT. Build phylogenetic trees from aligned sequences and interpret the results in the context of evolutionary studies.
4. Data Mining Techniques in Life Sciences: l apply data mining techniques such as clustering, classification, and association rule mining on biological datasets, focusing on the discovery of patterns and insights from large datasets.
5. Creating Graphs, Charts, and Heatmaps using ggplot2 and Matplotlib:
6. Perform principal component analysis (PCA) on biological datasets.

References

1. Altman, R. B., & Dunker, A. K. (2007). *Computational biology: A practical introduction to bioData analysis and machine learning*. Wiley-Blackwell.
2. Ben-Hur, A., & Noble, W. S. (2005). *Kernel methods for computational biology*. MIT Press.
3. Bishop, C. M. (2006). *Pattern recognition and machine learning*. Springer.
4. Bolstad, P. (2016). *GIS fundamentals: A first text on geographic information systems* (5th ed.). XanEdu Publishing.
5. Cline, M. S., & Smoot, M. E. (2007). *Bioinformatics for biologists*. Elsevier.
6. Ghosh, Z., & Bibekanand, M. (2008). *Bioinformatics: Principles and applications*. Oxford University Press.
7. Guan, Y., & Lo, Y. M. (2007). *Bioinformatics for biomedical science and clinical applications*. CRC Press.
8. Jojic, V., & Sidiropoulos, P. (2011). *Computational biology: A practical introduction to bioData analysis and machine learning*. Wiley-Blackwell.
9. Kanehisa, M., & Goto, S. (2000). *KEGG: Kyoto encyclopedia of genes and genomes*. Nucleic acids research, 28(1), 27-30.
10. Korf, I., Yandell, M., & Bedell, J. (2003). *Using bioinformatics: A practical guide to bioData analysis*. Pearson Education.

11. Kumar, S., & Kahl, G. (2013). *Computational biology in bioinformatics and system biology*. Springer.
12. Ragan, M. A. (2014). *Bioinformatics for biologists: What every student should know*. Wiley-Blackwell.
13. Rajeev, K., & Rajagopalan, P. (2013). *Bioinformatics: Methods and protocols*. Springer.
14. Rhee, S. Y., & Bevan, M. W. (2003). *Biological databases and computational biology: Tools for genomic research*. Springer.
15. Searls, D. B. (2009). *Bioinformatics: A practical guide to the analysis of genes and proteins*. Wiley.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the fundamental principles of computational biology and its applications in life sciences	U	1, 2
CO-2	Apply R and Python for biological data analysis and visualization	Ap	3, 4
CO-3	Utilize bioinformatics tools for sequence alignment, genomics, and phylogenetic analysis	An	5, 6
CO- 4	Develop data-driven solutions for biological research using visualization and statistical modeling	E	2, 6
CO-5	Implement AI and machine learning techniques for life science applications	C	6, 7

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

Name of the Course: COMPUTATIONAL BIOLOGY AND DATA VISUALIZATION

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the fundamental principles of computational biology and its applications in life sciences	1, 2	1, 2	U	F, C	L
CO2	Apply R and Python for biological data analysis and visualization	1, 5, 6	3, 4	Ap	P	P
CO3	Utilize bioinformatics tools for sequence alignment, genomics, and phylogenetic analysis	2, 3, 6	5, 6	An	C, P	L,P
CO4	Develop data-driven solutions for biological research using visualization and statistical modeling	3, 5, 7	2, 6	E	P, M	L
CO5	Implement AI and machine learning	3, 6,	6, 7	C	M	P

	techniques for life science applications	7				

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	2	-	-	-	-	-
CO2	3	-	-	-	3	2	-	-	-	3	3	-	-	-
CO3	-	3	3	-	-	3	-	-	-	-	-	3	3	-
CO4	-	-	3	-	2	-	3	-	-	-	3	-	-	3
CO5	-	-	3	-	-	3	3	-	-	-	-	-	3	3

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓			✓
CO5	✓			✓

Mar Ivanios College (Autonomous)

Discipline	**BOTANY**				
Course Code	**MIUK8DSCBOT 455.1**				
Course Title	**SCIENCE COMMUNICATION AND PUBLISHING IN 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
	4	3 hours	-	2 hours	5
Pre-requisites	Language proficiency and subject knowledge.				
Course Summary	This course introduces students to **science** communication, academic publishing, and botanical documentation. It covers effective writing for scientific and public audiences, research documentation, and digital tools for publishing. Students will develop skills in manuscript writing, botanical illustration, and digital content creation for books, journals, and public science platforms.				

Detailed Syllabus:

Module	**Unit**		**Hrs**
I		**Fundamentals of Science Communication**	**5**
	1	Principles of effective science communication.	
	2	Writing for different audiences: Scientific journals vs. popular science.	

	3	The role of science communicators, journalists, and educators	
	4	Principles of effective science communication.	
II		**Botanical Documentation and Research Writing**	**10**
	5	Collection , recording and preservation of plant related data and materials for scientific study and reference.	
	6	Research papers and reports (Introduction, Materials and Methods, Results, Discussion); Theses and Dissertations; Review articles; Scientific communication skills; Citation and Referencing (brief account only).	
III		**Botanical Illustration and Visual Science Communication**	**7**
	7	The role of visual elements in botanical research.	
	8	Scientific diagrams, plant morphology sketches, and herbarium imaging.	
	9	Creating botanical infographics and figures using BioRender, Inkscape, and Photoshop.	
IV		**Academic Publishing and Open Science**	**8**
	10	Understanding the **peer-review process** and journal selection.	
	11	Avoiding predatory journals and unethical publishing practices.	
	12	Open-access publishing, preprints, DOI systems, and digital repositories	
V		**Digital Media, Books, and Public Engagement**	**15**
	13	Writing for science blogs, botanical magazines, and outreach programs.	
	14	Formatting botanical books, field guides, and e-books (LaTeX, InDesign).	
	15	Podcasting, social media, and online platforms for science communication.	
	16	Ethical considerations in science communication and publishing.	

Practicals (30 hrs)

1. Botanical Documentation: creating field notes and herbarium records.
2. Reference Management: using Mendeley or Zotero
3. Peer-Review Process Simulation: Practice participating in a mock peer-review process by reviewing a research paper and providing constructive feedback. Gain insight into the peer-review and publication process.
4. Book Formatting: Practice formatting a botanical field guide or e-book using LaTeX or InDesign. Learn about layout design, image incorporation, and text formatting for professional publication.
5. Podcasting and social media for Science Communication: Practice creating a short science podcast or video for public engagement. Learn about different platforms, ethical considerations, and strategies to communicate effectively with a non-expert audience.

References

1. Bucchi, M., & Trench, B. (Eds.). (2014). *Routledge handbook of public communication of science and technology*. Routledge.
2. Burns, T. W., O'Connor, D. J., & Stocklmayer, S. M. (2003). *Science communication: A contemporary definition*. Public Understanding of Science, 12(2), 183-202.
3. Carter, H., & Johnson, J. (2007). *Writing for academic journals*. SAGE Publications.
4. Hall, N., & Gregory, J. (2001). *Public understanding of science: A review of the literature*. National Endowment for the Humanities.
5. Hicks, D. (2012). *The role of science communication in the public sphere*. Science and Engineering Ethics, 18(4), 673-684.
6. Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). University of Chicago Press.
7. Lankford, J. (2014). *The essentials of writing a scientific paper*. Academic Press.
8. Levine, A. (2007). *Science writing: A guide for students*. Pearson Education.
9. Pielke Jr., R. A. (2007). *The honest broker: Making sense of science in policy and politics*. Cambridge University Press.
10. Wiggins, A., & Crowston, K. (2011). *From conservation to crowdsourcing: A typology of citizen science*. In *Proceedings of the 44th Annual Hawaii International Conference on System Sciences* (pp. 1-10). IEEE.

11. Buehler, M. (2011). *Mastering LaTeX*. Springer.
12. Sarkar, S. (2004). *The ethics of scientific publishing*. In *Science and Technology Ethics* (pp. 25-43). Springer.
13. VandeBerg, J. (2012). *The art of science communication: A guide for scientists and educators*. National Academies Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the fundamentals of science communication and its role in botany	U	1, 2
CO-2	Structure and write botanical research papers and science articles	Ap	3, 4
CO-3	Develop botanical illustrations and visual communication aids for research	An	5, 6
CO- 4	Understand the academic publishing process and ethical considerations	E	2, 6
CO-5	Create engaging digital and print content for science outreach and education	C	6, 7

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

Name of the Course: SCIENCE COMMUNICATION AND PUBLISHING IN BOTANY

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

CO No.	CO	PO	PSO	Cognitive Level	Knowledge Category	Lecture (L) /Tutorial (T)/ Practical (P)
CO1	Explain the fundamentals of science communication and its role in botany	1, 2	1, 2	U	F, C	L
CO2	Structure and write botanical research papers and science articles	1, 5, 6	3, 4	Ap	P	P
CO3	Develop botanical illustrations and visual communication aids for research	2, 3, 6	5, 6	An	C, P	L/P
CO4	Understand the academic publishing process and ethical considerations	3, 5, 7	2, 6	E	P, M	L
CO5	Create engaging digital and print	3, 6,	6, 7	C	M	P

	content for science outreach and education	7				

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

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	2	-	-	-	-	-	3	2	-	-	-	-	-
CO2	3	-	-	-	3	2	-	-	-	3	3	-	-	-
CO3	-	3	3	-	-	3	-	-	-	-	-	3	3	-
CO4	-	-	3	-	2	-	3	-	-	-	3	-	-	3
CO5	-	-	3	-	-	3	3	-	-	-	-	-	3	3

Correlation Levels: - (NA), 1 (Mild), 2 (Moderate), 3 (High)

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	✓		✓	✓
CO5	✓			✓

MAR IVANIOS COLLEGE (AUTONOMOUS), THIRUVANANTHAPURAM

BOARD OF STUDIES IN BOTANY, 2023 – 2026

No	Name	Designation	Category and Guidelines
1.	Dr. Bindu Alex (Chairman)	Assistant Professor, Dept of Botany, Mar Ivanios College.	Head of the Department
2.	Prof. (Dr.) Shiburaj Sugathan	Professor, Dept of Botany, University of Kerala, Kariavattom.	Subject expert (University Nominee)
3.	Dr. Victoria P K	Associate Professor, Dept of Botany, Mar Ivanios College.	Former faculty member of the Department
4.	Dr. C. Suju Skaria	Assistant Professor, Dept of Botany, Mar Ivanios College.	Faculty member of the Department
5.	Dr. Rejitha L R	Assistant Professor, Dept of Botany, Mar Ivanios College.	Faculty member of the Department
6.	Dr. Kavitha C.H.	Assistant Professor, Dept of Botany, Mar Ivanios College.	Faculty member of the Department
7.	Dr. Preetha S S	Assistant Professor, Dept of Botany, Mar Ivanios College.	Faculty member of the Department
8.	Dr. Mary Sheeba A	Assistant Professor, Dept of Botany, Mar Ivanios College.	Faculty member of the Department
9.	Dr. Basil George	Assistant Professor Dept of Botany, CMS College, Kottayam.	Subject expert from outside the parent University
10.	Dr. M. Anilkumar	Associate Professor & Principal Sree Shankara College Angamali	Subject expert from outside the parent University nominated by the Academic Council

11.	Dr. K.K. Sabu	Principal Scientist and Head, Biotechnology & Bioinformatics Division, JNTBGRI, Palode.	Subject expert Botany
12.	Dr. Jude Emmanuel	Environmental Scientist, Directorate of Environment & Climate Change, Thampanoor.	Representative from allied areas nominated by the Principal
13.	Dr. TK. Hrideek	Senior scientist, Kerala Forest Research Institute, Peechi.	Subject expert from outside the parent University nominated by the Academic Council
14.	Dr. Vignesh RM	Farm Superintendent, Pharmacognosy Unit, Govt. Ayurveda Research Institute.	Representative from industry nominated by the Principal
15.	Dr. Mahesh S	Asst. Professor and HOD, Dept. of Botany, Christian College, Kattakada.	Subject expert Botany
16.	Mr. Shalaj R	Asst. Professor, Dept. of Botany, St. Gregorios College, Kottarakara.	Subject expert Botany