KANNUR UNIVERSITY

(Abstract)

M.Sc Plant Science with Specialization in Ethnobotany Programme in the Department of Botany, Mananthavady Campus - Revised Scheme (All Semesters) & Syllabus (1st Semester Only) - Approved- Implemented w.e f 2023 admission- Orders Issued

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ACADEMIC C SECTION

ACAD C/ACAD C3/26940/2023 Dated: 13.02.2024

Read:-1. U.O.No ACAD C/ ACAD C3/22373/2019 dated 12/09/2023

2. Circular No dated ACAD C/ ACAD C3/22373/2019 dated 12/09/2023
3. Email dated 23/12/2023 from the Course Coordinator, Dept of Botany, Mananthavady Campus
4. Minutes of the meeting of the Department Council dated 06/11/2023
5. U.O of even number dated 11/01/2024
6. Email dated 20/01/2024 from the Course Coordinator, Dept of Botany, Mananthavady Campus
7. Orders of vice chancellor in file of even No. dtd.09.02.2024.

ORDER

1. The revised Regulations for Post Graduate Programmes under Choice Based Credit and Semester System in the University Teaching Departments/ Schools were implemented w.e.f 2023 admissions vide paper read 1 above.

2. As per paper read 2 above, Heads of all Teaching Departments were requested to submit the revised Syllabus in accordance with the approved Regulations along with a copy of the Department Council Minutes.

3. As per paper read 3 above, the Course Co-ordinator, Dept. of Botany, Mananthavady Campus submitted the Scheme (All Semesters) and the Syllabus (1st Semester Only) of M. Sc Plant Science with Specialization in Ethnobotany Programme to be implemented in the University Teaching Department w. e. f 2023 admissions.

4. Department Council vide the paper read 4 above approved the aforementioned scheme and syllabus of M. Sc Plant Science with Specialization in Ethnobotany Programme to be implemented in the Dept. of Botany, Mananthavady Campus w.e.f.2023 admission.

5. As ordered by the Vice chancellor, a Committee was constituted vide paper read 5 above, to scrutinize/evaluate the Scheme & Syllabus of the aforementioned Programme and authorized the Course Coordinator to coordinate the Committee and convene online meetings to scrutinize/evaluate the syllabus and to submit the final Scheme & Syllabus of the Programme after incorporating the corrections / modifications suggested by the Committee along with the minutes of the Department Council approving the same.

6. As per paper read 6 above, the Course Co-ordinator, Dept. of Botany submitted the Scheme (All Semesters) and the Syllabus (1st Semester Only) of M. Sc Plant Science with Specialization in Ethnobotany Programme to be implemented in the University Teaching Department w. e. f 2023 admissions, approved by the department council held on 19.01.2024.

7. The Vice Chancellor, after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11(1), Chapter III of Kannur University Act 1996, ***approved the Scheme (All Semesters) & Syllabus (1st Semester Only) of M.Sc Plant Science with Specialization in Ethnobotany Programme and accorded sanction to implement the same in the Dept. of Botany, Mananthavady Campus w.e.f 2023 admissions, subject to report to the Academic Council .***

8.The Scheme (All semesters) and Syllabus (1st Semester Only) of M.Sc Plant Science with Specialization in Ethnobotany Programme under CBCSS implemented in the Dept of Botany, Mananthavady Campus with effect from 2023 admission, is appended and uploaded in the University website (www.kannuruniversity.ac.in)

9. Orders are issued accordingly.

Sd/-

Narayanadas K

DEPUTY REGISTRAR (ACAD)

For REGISTRAR

To: 1. Course Coordinator, Dept of Botany, Mananthavady Campus
2. Convenor, Curriculum Committee

Copy To: 1.PS to VC/ PA to PVC/ PA to R
2. To Examination Branch (through PA to CE)
3. EP IV/ EXC I
4. Computer Programmer
5. Webmanager (to publish in the website)
6. SF/DF/FC

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY

M.Sc. PLANT SCIENCE

(Specialization in Ethnobotany)

SCHEME & SYLLABUS

(Under Choice Based Credit & Semester System)

2023 admission onwards

DEPARTMENT OF BOTANY

Kannur University

Mananthavady campus

Post Graduate Programme in Plant Science

The M.Sc. Plant Science course is a comprehensive two-year program designed to provide students with an advanced understanding of plant science divided into four semesters, each focusing on different areas of Plant Science.

VISION

To be a world class department with excellence in teaching and research by providing scientific and technological contributions

MISSION

Promote quality education and innovative research in Plant Science.

PROGRAMME OUTCOMES

PO 1 : Demonstrate and apply the fundamental knowledge of the basic principles of major fields of biology. Take informed actions after identifying the assumptions that frame our thinking and actions, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2 : Identify, formulate, conduct investigations, and find solutions to scientific problems based on in-depth knowledge of relevant domains.

PO 3 : Speak, read, write and listen clearly in person and through electronic media in English/language of the discipline, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 4 : Demonstrate empathetic social concern, and the ability to act with an informed awareness of environmental issues. Communicate scientific information in a clear and concise manner both orally and in writing

PO 5 : Apply knowledge to solve the issues related to plant sciences with the help of computer technology. Recognize different value systems including your own, understand the moral dimensions of issues, and accept responsibility for them.

PO 6 : Acquire the ability to engage in independent and life-long learning in the broadest context socio- technological changes.

PO 7 : Apply the knowledge to develop the sustainable and eco-friendly technology in Industrial Botany.

PROGRAMME SPECIFIC OUTCOMES

PSO 1 : A student completing the course can understand different specializations of Botany such as systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, Genetics and molecular biology of various life-forms.

PSO 2 : The students gets trained in various analytical techniques of plant biology, use of plants as industrial resources or as a human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.

PSO 3 : The student completing the course can identify various life forms of plants, design and execute experiments related to basic studies on evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, proteomics and transgenic technology.

PSO 4 : The students will get hands-on training in the field of ethnobotany and conservation biology and unique subjects like wetland ecology, landscape ecology etc. Students are also familiarized with the use of bioinformatics tools and databases for the identification of lead molecules for drugs and also to apply statistical tools on biological data.

PSO 5 : The student completing the course will be capable to execute short research projects incorporating various tools and techniques in any of the basic specializations of Plant Sciences, in addition to being specialised in ethnobotany and conservation biology

PSO 6 : The program will equip students with research skills required for independent study and original research in plant science. They will learn to conduct literature reviews, identify research gaps, formulate research questions, and develop research plans to explore and contribute to the field.

DURATION: 2 Years (4 semesters)

INTAKE: 13 Nos.

ELIGIBILITIES:

- Any B.Sc degree equivalent to B.Sc Botany/Plant Science with 50% marks.

ADMISSION:

- The selection of the candidate is based on Admission test. The admission test will cover Plant Science at the undergraduate level.

COURSE DETAILS:

A student must register for the required number of courses at the beginning of each semester. No students shall register for more than 24 credits and less than 16 credits per semester.

A total of 80 credits shall be the minimum for successful completion of the course in which a minimum of 56 credits for core course and electives and 8 credit s from outside are mandatory. Those who secure only minimum credit for core/ elective subjects has to supplement the deficiency for obtaining the minimum total credits required for successful completion of the program from the other divisions.

EVALUATION:

The faculty member who teaches the course shall do evaluation of the students for each course on the basis of Continuous Evaluation and End Semester Examination shall be evaluated by External Examiners. The proportion of the distribution of marks among the continuous evaluation and end semester examination shall be **40:60**.

Continuous Evaluation includes assignments, seminars, and written examination for each course. Weightage to the components of continuous evaluation shall be given for all theory papers of the course as follows:

Theory			Practical	
Components of CE	Minimum Number	Percentage	Components	Percentage
Test paper	2	40 %	Practical Test	80 %
Assignments	1	20 %	Record	20 %
Seminar, Viva, Presentation, Discussion and Debate	1	40 %	-	-

GRADE POINTS

A 7-point direct grading system is used for evaluation of the performance of each answer in an examination. Grade points corresponding to each is given below.

Letter Grade	Grade Points (P)
O (outstanding)	6
A+ (Excellent)	5
A (Very good)	4
B+ (Good)	3
B (Average)	2
C (Satisfactory)	1
F (Poor/ Not attempted)	0

Then the Weighted Grade Point Average (WGPA) is computed as follows

$$\textbf{(WGPA)} = \Sigma \textbf{ (Pi x Wi)/ } \Sigma \textbf{ (Wi)}$$

Where Pi is the grade point awarded to i^{th} answer and Wi is the weightage assigned to that question. Σ (Wi) indicate the total weightage of the examination.

The weighted grade point average of Continuous Evaluation (P_{CE}) is computed as follows.

$$\mathbf{P_{CE} = (P1 \text{ x } W1 + P2 \text{ x } W2 + P3 \text{ x } W3 + ...) / (W1 + W2 + W3 + ...)}$$

Where Pl, P2, P3 etc. are the grade points of different components and W1, W2, W3 etc. are the weightages of the components. If the candidate is absent in any of the components. '0' point should be awarded to that component and included in the computation.

The weighted grade point average of a course (G) (scaling-up to maximum grade point 10) is computed as given below.

$$\mathbf{G = (P_{CE} \text{ x } 40 + P_{ESE} \text{ x } 60) /60}$$

Where P_{CE} is the WGPA of CE and P_{ESE} is the WGP.A of ESE. The grade points should be rounded off to two decimal places.

Test Paper: For each course there shall be at least two class tests during a semester.

Assignments: Each student shall be required to do one assignment for each course.

Seminar: Students are required to present a seminar on a selected topic in each paper. The

evaluation of the seminar shall be done by the concerned teacher handling the course.

Attendance: Minimum attendance required for each paper shall be 75% of the total number of classes conducted for that semester. Those who secured the minimum requirement of attendance only be allowed to register/appear for End Semester Examination.

Condonation of attendance to a maximum of 10 days in a semester subject to a maximum of two times during the whole period of the PG program may be granted by the university as per university rules.

Conduct of Examination:

The vice chancellor will approve the panel of examiners submitted by the Head of the Department. All the teachers of the Department will be the members of the Board of examiners with Head of the Department as the Chairperson. There shall be a minimum of two external examiners. The panel approved by the Vice-Chancellor will be entrusted with the setting of question papers, conduct and evaluation of examination.

Research Project:

The students have to complete a project during IV Semester under the guidance of a faculty in the department or with other institutions.

GRADING

An alphabetical Grading System shall be adopted for the assessment of a student's performance in a Course. The following tables gives the WGPA and corresponding letter grade in course.

WGPA	Letter Grade
9.5 and above	O
8.5 and above but less than 9.5	A+
7.5 and above but less than 8.5	A
6.5 and above but less than 7.5	B+
5.5 and above but less than 6.5	B
4.5 and above but less than 5.5	C
4.0 and above but less than 4.5	D
Less than 4.0	F

Based on CGPA the overall letter grade of the student and the classification shall be in the following way

CGPA	Overall Letter Grade	Classification
9.5 and above	O	Outstanding
8.5 and above but less than 9.5	A+	Excellent

7.5 and above but less than 8.5	A	Very Good
6.5 and above but less than 7.5	B+	Good
5.5 and above but less than 6.5	B	Above Average
4.5 and above but less than 5.5	C	Average
4.0 and above but less than 4.5	D	Pass
Less than 4.0	F	Fail

SCHEME

Total Credits: 21, Discipline Specific Core Courses (DSC): **18**, Discipline Specific Elective Course (DSE): **3**

FIRST SEMESTER							
Course Code	**Title of Paper**	**Contact hrs./Week**			**Grade**		**Credits**
		L	**T/S**	**P**	**ESE**	**CE**	
Discipline Specific Core Courses (DSC)							
MSPSC 01DSC01	Biology of Archegoniate	3	1	-	60%	40%	3
MSPSC 01DSC02	Anatomy and Microtechnique	3	1	-	60%	40%	3
MSPSC 01DSC03	Genetics and Evolution	3	1	-	60%	40%	3
MSPSC 01DSC04	Mycology and Plant Pathology	3	1	-	60%	40%	3
MSPSC 01DSC05	**PRACTICAL 1** Biology of Archegoniate, Anatomy of Angiosperms and Microtechnique	-	-	5	60%	40%	3
MSPSC 01DSC06	**PRACTICAL 2** Genetics, Mycology and Plant Pathology	-	-	5	60%	40%	3
	Total	**12**	**4**	**10**	**60%**	**40%**	**18**
Discipline Specific Elective Courses (DSE)							
MSPSC 01DSE01	Methodology and Philosophy of Science	3	1	-	60%	40%	3
	Total	**30**			60%	40%	**21**

Total Credits: 27, Discipline Specific Core Courses (DSC): **15**, Discipline Specific Elective Course (DSE): **6**, Multidisciplinary Elective (MDC) to be obtained from other departments: **2**, Ability Enhancement Course (AEC) to be obtained from other departments: **2**, Skill Enhancement Course to be obtained from other departments (SEC): **2**.

SECOND SEMESTER							
Course Code	**Title of Paper**	**Contact hrs./Week**			**Grade**		**Credits**
		L	**T/S**	**P**	**ESE**	**CE**	
Discipline Specific Core Courses (DSC)							
MSPSC 02DSC07	Taxonomy and Advanced Plant Systematics.	3	1	-	60%	40%	3
MSPSC 02DSC08	Cell and Molecular Biology	3	1	-	60%	40%	3
MSPSC 02DSC09	Plant Physiology and Biochemistry	3	1	-	60%	40%	3
MSPSC 02DSC010	**Practical III** Taxonomy and Advanced Plant Systematics.	-	-	5	60%	40%	3
MSPSC 02DSC011	**Practical IV** Cell and Molecular Biology and Plant Physiology and Biochemistry	-	-	5	60%	40%	3
	Total	**9**	**3**	**10**	**60%**	**40%**	**15**
Discipline Specific Elective Courses (DSE) (Any 2 courses to be chosen)							
MSPSC 02DSE02	Developmental Biology of Plants	3	1	-	60%	40%	3
MSPSC 02DSE03	Environmental Science	3	1	-	60%	40%	3
02DSE04	Seed Technology	3	1	-	60%	40%	3
	Total	**6**	**2**		**60%**	**40%**	**6**
Multidisciplinary Elective (MDC) offered for other departments							
MSPSC 02MDC01	Ecology and Environment	2	1	-	60%	40%	2
MSPSC 02MDC02	Philosophy of Science						
Multidisciplinary Elective (MDC) To be obtained from other departments							
------		2	1	-	60%	40%	2

Ability Enhancement Course (AEC) offered for other departments							
MSPSC 02AEC01	Organic Farming	2	1	-	60%	40%	2
MSPSC 02AEC02	Floriculture						
Ability Enhancement Course (AEC) To be obtained from other departments							
-----		2	1	-	60%	40%	2
Skill Enhancement Course (SEC) offered for other departments							
MSPSC 02SEC01	Mushroom Technology	2	1	-	60%	40%	2
Skill Enhancement Course (SEC) To be obtained from other departments							
--------		2	1	-	60%	40%	2
Total		**44**			**60%**	**40%**	**27**
*** Value Added Course (VAC)**							
MSPSC 02VAC01	Biology-Ethics and Philosophy	1	1	-	60%	40%	2

* Not to be added to the total credit of the program

Total Credits: 23. Discipline Specific Core Courses (DSC): **15**, Discipline Specific Elective Courses (DSE): **6**, Multidisciplinary Elective (MDC) to be obtained from other departments: **2**

THIRD SEMESTER							
Course Code	**Title of Paper**	**Contact hrs./Week**			**Grade**		**Credits**
		L	**T/S**	**P**	**ESE**	**CE**	
Discipline Specific Core Courses (DSC)							
MSPSC 03DSC12	Biotechnology and Nano Biology	3	1	-	60%	40%	3
MSPSC 03DSC13	Bioinformatics	3	1	-	60%	40%	3
MSPSC 03DSC14	Ethnobotany and Ethnopharmacology	3	1	-	60%	40%	3
MSPSC 03DSC15	**Practical V** Plant Biotechnology, Tissue Culture and Bioinformatics	-	-	5	60%	40%	3
MSPSC 03DSC16	**Practical VI** Ethnobotany and Ethnopharmacology	-	-	5	60%	40%	3
	Total	**9**	**3**	**10**	**60%**	**40%**	**15**
Discipline Specific Elective Courses (DSE) (Any 2 course to be chosen)							
MSPSC 03DSE05	Methods in Plant Biology	3	1	-	60%	40%	3
MSPSC 03DSE06	Tissue culture and Plant Breeding	3	1	-	60%	40%	3
MSPSC 03DSE07	Microbiology						
	Total	**6**	**2**		**60%**	**40%**	**6**
Multidisciplinary Elective (MDC) offered for other departments							
MSPSC03 MDC03	Agri-business	2	1	-	60%	40%	4
MSPSC 03MDC04	Environmental Auditing and Impact Assessment	2	1	-	60%	40%	4
	Plant Tissue Culture and Conservation	2	1	-	60%	40%	4
MSPSC 03MDC05 MSPSC 03MDC06	Ethnobotany and Conservation	2	1	-	60%	40%	4
Multidisciplinary Elective (MDC) to be obtained from other departments							

-----		2	1	-	60%	40%	2
	Total	**39**			**60%**	**40%**	**23**

Total credits: 16, Discipline Specific Core Courses (DSC): **3**, Discipline Specific Elective Courses (DSE): **3**, Project (P): **10**

Fourth Semester							
Course Code	**Title of Paper**	**Contact hrs./ Week**			**Grade**		**Credits**
		L	**T/S**	**P**	**ESE**	**CE**	
Discipline Specific Core Courses (DSC)							
MSPSC04 DSC17	Conservation Biology	3	1	-	60%	40%	3
Discipline Specific Elective Courses (DSE) (Any 1 course to be chosen)							
MSPSC04 DSE08	Forest Botany	3	1	-	60%	40%	3
MSPSC04 DSE09	Land Scape Ecology	3	1	-	60%	40%	3
MSPSC04 DSE10	Wetland Ecology	3	1	-	60%	40%	3
Project (P)							
MSPSC04 DSC18	Project Work	-	-	24	60%	40%	10
Total		**32**			**60%**	**40%**	**16**
Grand Total		**145**			**60%**	**40%**	**87**

FIRST SEMESTER M.Sc. PLANT SCIENCE PROGRAMME

CORE COURSE

Course Code& Title:	MSPSC01DSC01: BIOLOGY OF ARCHEGONIATAE	Module Outcome
Course Objectives:	1. To study the various groups of Algae, Bryophytes, Pteridophytes, Gymnosperms 2. To compare the similarities and differences in these groups	
Module1 **16 hours**	**Algae:** Introduction-History of Phycology-General characteristics. 1. Classification of Algae according to van den Hoek et al. 1995. A brief account of the recent development in molecular phylogenetics and DNA barcoding of algae. 2. Diversity of algae and cyanobacteria. 3. Morphology: Range of thallus structure. 4. Reproduction and life history. 5. Collection, identification, preservation (including herbarium techniques) of algae. 6. General account of the structure, reproduction and relationships in the following group Chlorophyta; Xanthophyta; Phaeophyta, Bacillariophyta, Euglenophyta and Rhodophyta. Cyanophyta: structure of cell, akinete and heterocyst, pigments, chromatic adaptation, thallus organization and reproduction. 7. Applied aspects of algae and cyanobacteria: biodiesel, hydrogen, methane and ethanol production, carbon dioxide sequestration, industrial applications, food supplements, pharmaceutical industries, biofertilizers, bioremediation, biodegradation, algal blooms, commercial cultivation of algae, mass production and field application of cyanobacteria.	1. The students will be able to collect, preserve, study and describe the general characteristics, classification and diversity of algae and cyanobacteria, their morphology, anatomy, reproduction and life history. 2. The students will also be able to evaluate the applied aspects of algae and cyanobacteria, such as biofuel production, carbon sequestration, industrial applications, food supplements, biofertilizers, bioremediation, algal blooms and commercial cultivation.

	8. Fossil algae and cyanobacteria. **References** Chapman, V. J. 1941. An Introduction to the Study of Algae. Cambridge University Press. Chapman, V. J. & Chapman, D. J. 1973. The Algae. Macmillan. Desikachary, T. V. 1959. Cyanophyta. Indian Council of Agricultural Research. Fritsch, F. E. 1961. The Structure and Reproduction of Algae. Vol. 2. Cambridge University Press. Irvine, D. E. & D. M. John. 1984. Systematics of the Green Algae. Academic Press. Stevensen, J. et al. 1996. Algal Ecology. Freshwater benthic ecosystems. Academic Press. Krishnamurthy, V. 1998. Algae of India and Neighboring Countries. 1. Chlorophycota. Oxford & IBH publishing Co. Pvt. Ltd. Kumar, H. D. 1990. Introductory phycology. East West Press Pvt. Ltd. Prescott, G. W.1969. The Algae. A Review. Thomas Nelson and Sons Ltd Round, F. E. 1975. The Biology of Algae. Edward Arnold. Smith, G. M. 1978. Manual of Phycology. The Ronald Press Company. Trainor, F. R. 1978. Introductory Phycology. John Wiley and Sons. Van Den Hock, Mann, D.G. and Jahns, H.M. 1995. Algae: An Introduction to Phycology. Cambridge University Press. Venkataraman, G. S. 1972. Algal Biofertilizers and Rice Cultivation. Today and Tomorrow's publishers. Venkataraman, G. S., Goyal, S. K., Kaushik B. D., and Roychaudhary, P. 1974. Algae form and function. Today and Tomorrow's printers. Vijayaraghavan, M. R. & Bhatia, B. 1997. Red Algae: Structure, Ultrastructure and Reproduction. APH Publishing Corporation.	

Module2 **12 hours**	**Bryophytes:** 1. General habit, habitat, distribution, biogeography, growth forms and systems of classification of bryophytes. A brief account of the recent developments in molecular phylogenetics and DNA barcoding of bryophytes. 2.Origin of bryophytes 3. General account of the anatomy, reproduction and life history of Marchantiales, Jungermanniales, Polytrichales and Anthocerotales. 4. Applied bryology: Ecological uses, household uses, medicinal uses (herbal medicines, transgenic products), decorative bryophytes, aquarium bryophytes, heavy metal detection and clean up, erosion control, horticultural uses (soil conditioning, air layering, pot culture, container gardens and hanging baskets), bioindicators of pollution. 5.Fossil bryophytes: a general account.	1. The students will be able to explain the general habit, habitat, distribution, anatomy, reproduction and classification of bryophytes. 2. The students will be also able to assess the applied bryology of bryophytes, such as their ecological, household, medicinal, decorative, horticultural and bioindicator uses.
	References Smith, A. J. E. (ed.). 1982. Bryophyte Ecology. Chapman & Hall. Shaw, A. J. & Goffinet, B. (eds.). 2000. Bryophyte Biology, Cambridge University Press. Glime, J. M. & Saxena, D.1991. Uses of Bryophytes. Today and Tomorrows Printers & Publishers. Schofield, W. B. 2001. Introduction to Bryology. The Blackburn Press. Nair, M. C. et al. 2005. Bryophytes of Wayanad, Western Ghats. MNHS, Calicut	
Module 3 **14 hours**	**Pteridophytes:** 1. Introduction to pteridophytes: general characteristics, life cycle, classification. Brief account of the recent developments in molecular phylogenetics and DNA barcoding of pteridophytes. 2. Diversity of forms among pteridophytes: general morphology with special reference to South Indian species of Lycopodiales, Isoetales, Marattiales, Filicales (Gleicheniaceae, Adiantaceae, Cyatheaceae). 3. Fossil pteridophytes: Psilophytales, Lepidodendrales,	1. The students will be able to understand the general characteristics, morphology, anatomy, life cycle and classification of pteridophytes, 2. The students will be able to understand the stelar evolution, heterospory and seed habit in pteridophytes.

	4. Habitat diversity of pteridophytes: epiphytes, lithophytes, climbers, halophytes, saprophytes, sciophytes, xerophytes, mesophytes, hydrophytes. 5. Stelar evolution: protostele, siphonostele, solenostele, dictyostele and special stellar types; vessels in pteridophytes. 6. The fern gametophytes: pattern of development, the morphology of mature gametophytes. 7. Heterospory and evolution of seed habit. 8. Cytology: chromosome number and morphology; polyploidy, the origin of polyploids, apospory, apogamy, agamospory. 9. Applied pteridology: bio-fertilizer production from Azolla: Azolla - Anabaena symbiosis; Pteridophytes as weeds: Salvinia (aquatic) and Pteridium (terrestrial); ornamental and medicinal pteridophytes. **References** Bierhost, D. W. 1971. Morphology of Vascular Plants. Macmillan Co. Dyer, A. C. 1979. The experimental Biology of Ferns. Academic Press. Hameed, C. A., Rajesh, K. P. and Madhusoodanan, P. V. 2003. Filmy Ferns of South India. Penta Book Publishers & Distributors. Jermy, A. C. 1973 (Ed.). The Phylogeny and Classification of Ferns. Academic Press. Kramer, K. U. & Green, P. S. 1991. The families and genera of Vascular Plants, Narosa. Nampy, S. and Madhusoodanan, P. V. 1998. Fern Flora of South India-Taxonomic Revision of Polypodioid Ferns. Daya Publishing House.	
Module 4 **14 hours**	Gymnosperms: 1. General characters, classification. A brief account of the recent developments in molecular phylogenetics and DNA barcoding of gymnosperms. 2. Geological horizon, distribution, general account including morphology, anatomy, phylogeny and interrelationship of the following orders a) Pteridospermales:. b) Glossopteridales: c)	The students will be able to outline the general characters, classification, morphology, anatomy, interrelationships, phylogeny and evolution of gymnosperms and

	Caytoniales : d) Cycadeoidales: e) Pentoxylales: f) Cycadales: g) Ginkgoales: h)Cordaitalesi) Coniferales: j) Taxales: k) Ephedrales: l) Welwitschiales: m) Gnetales: 3. Evolution of gymnosperms 4. Distribution of living and fossil gymnosperms in India. 5. Economic importance of gymnosperm **References** Andrews Jr., H. N. 1961. Studies in Paleobotany. John Wiley, New York Arnold, C. A. 1953. Origin and relationships of the cycads. Phytomorphology 3: 51-65 Beck, C. B. 1985. Gymnosperm phylogeny: A commentary on the views of S.V. Meyen. Bot. Rev. 51: 273-294 Chamberlain, C. J. 1919. The Living Cycads. Chicago University Press, Chicago. Chemberlain, C. J. 1935. Gymnosperms: Structure and Evolution. Chicago University Press. Crepet, W. L. 1972. Investigations of North American cycadeoids: Pollination mechanisms in Cycadeoidea. Amer. J. Bot. 59: 1048-1056 Dallimore, W. & Jackson, A. B. 1966. A Handbook of Conifera. 4th edn, E. Arnold. Delevoryas, T. 1962. Morphology and evolution of fossil plants. New York. Favre-Duchartre, M. 1958. Ginkgo, an oviparous plant. Phytomorphology 8: 377-390 Freedman, W.E. 1992a. Double fertilization in non-flowering seed plants and its relevance to the origin of flowering plants. Intl. Rev. Cytol. 140: 319-355. Freedman, W. E. 992b. Evidence of a pre-angiosperm origin of endosperm: Implications for the evolution of flowering plants. Science 235: 336-339. Greguss, P. 1955. Identification of Living Gymnosperms based on Xylotomy. AkadKiado. Harris, T. M. 1951. The relationships of the Caytoniales. Phytomorphology 1: 29-39.	their transition to angiosperms.

	Mehra, P. N. 1988. Indian Conifers: Gnetophytes and Phylogeny of Gymnosperms. Pramodh P. Kapur, Raj Bandhu Ind. Complex, New Delhi Meyen, S. V. 1984. Basic features of gymnosperm: Systematics and phylogeny as evidenced by the fossil record. Bot. Rev. 50: 1-111 Meyen, S. V. 1986. Gymnosperm systematics and phylogeny: A reply to commentaries by CB Beck, CN Miller, and GW Rothwell. Bot. Rev. 52: 300-320 Millay, M. A., & Taylor, T. N. 1976. Evolutionary trends in fossil gymnosperm pollen. Rev. Palaeobot. Palynol. 21: 65-91. Miller Jr., C.N. 1977. Mesozoic confers. Bot. Rev. 43: 217-280 Pant, D. D. 1975. The classification of gymnospermous plants. Palaebot. 6: 65-70 Pearson HHW (1929) Gnetales, Cambridge Univ. Press, London Madhulata, Sanwal. 1962. Morphology and embryology of Gnetumgnemon L. Phytomorphology 12: 243-264 Scott, D. H. 1909. Studies in Fossil Botany, 2nd edn. Vol 1 A and C Black, London Scott, D. H. 1923. Studies in Fossil Botany, Vol 2. A and C Black, London. Sharma, B. D. 1994. Gymnosperms: Morphology, Systematics, Reproductive Biology, In: Johri, B.M. (ed.), Botany in India: History and Progress. Vol. 2. Oxford & IBH, New Delhi. pp 1-23. Singh, H. 1978. Embryology of Gymnosperms. Geb Borntrager, Berlin. Stewart, W.N. 1981. The Progymnospermospsida: The construction of a concept. Can. J. Bot. 59: 1539-1542. Stewart, W. N. 1983. Palaeobotany and the evolution of plants. Cambridge University Press	

Course Code& Title:	**MSPSC01DSC02 ANATOMY AND MICROTECHNIQUE**	**Module Outcome**

Course Objectives:	To study the internal organisation of plants and the techniques associated with the study.	
Module I **16 hrs**	**Anatomy:** Introduction -Internal organisation of plant body -Methods of studying the Anatomy of the plant. Meristems: Shoot apical meristem and functional zones, axillary floral and inflorescence meristems – structural diversity of the vegetative meristems. Cell differentiation: tracheary element differentiation, secondary wall formation, vascular differentiation, development of aerenchyma, development of laticifers. Origin and structure of secondary plant body: vascular cambium formation-structure and formation of vascular cambium, anomalous secondary growth-classification, origin and function, primary thickening meristem in monocots, secondary growth in arborescent Liliaceae. **References** Beck, C. B. (2005) An Introduction to Plant Structure and Development. Cambridge University Press. Esau, K. (1977) Anatomy of Seed Plants. 2nd edition. John Wiley & Sons. Fahn, A. (1990) Plant Anatomy. 4th edition. ButterworthHeinemann Ltd. Mauseth, J. D. (1988) Plant Anatomy. The Benjamin Cummings Publishing Co. Raghavan V. (1999) Developmental Biology of Flowering Plants. Springer.	The module aims to provide students with a thorough understanding of the anatomy of the plant body, the development and differentiation of plant cells and tissues, the differentiation, structure and function of vascular systems and the origin and structure of secondary plant body with various types anatomical adaptations during secondary growth
Module II **14 hrs**	Structure and function of vascular tissues: xylem - structure and water movement. Phloem - structure and metabolite translocation, transfer cells, phloem loading and unloading. Secondary cambium: classification, origin and constitution of cambium, cambial activity, cambium in wound healing and grafting, cork-cambium, origin and function. Root: development, structural organization of root apical meristem, developmental activities, developmental zones, longitudinal files of cells, Q. C. concept and pro-meristem concept. T- division. Leaf: development, structural diversity, anatomy of C3 and C4 plants.	Students will get interrelated concept of the structure and function of vascular tissues, such as xylem and phloem, and their role in water and nutrient transport in plants. To comprehend development and diversity of root and leaf anatomy, and their adaptations to different ecological conditions. The course also examines

	Ecological leaf anatomy, sun and shade leaves, xeromorphic leaves, succulent leaves, halophytic leaves and hydromorphic leaves. Stress anatomy: anatomy and pollution, anatomical response to water stress and mineral deficiency, effects of pollution, insecticides and herbicides. **References** Beck, C. B. (2005) An Introduction to Plant Structure and Development. Cambridge University Press. Esau, K. (1977) Anatomy of Seed Plants. 2nd edition. John Wiley & Sons. Fahn, A. (1990) Plant Anatomy. 4th edition. Butter worth Heinemann Ltd. Mauseth, J. D. (1988) Plant Anatomy. The Benjamin Cummings Publishing Co. Raghavan V. (1999) Developmental Biology of Flowering Plants. Springer.	the effects of stress factors, such as pollution, water deficiency, and mineral deficiency, on plant anatomy.
Module III 14hrs	**Microtechnique:** 1. Microscope-Construction and Use-Light microscope, Phase contrast and electron microscope, Micrometric measurements and camera lucida. 2. Microtomes: Rotary, Sledge, and Cryostat. 3. Processing procedure for micro preparation: (i) Fixation and Storage-Killing and fixing: Principle and purpose, Common chemical fixatives, their preparation and specific uses; FAA, Carnoy's fluid, acetic alcohol, CRAF, Nawashins fluid, and Zircle's fluid. (ii) Dehydration: Principle and procedure, Dehydrating agents – Ethyl alcohol, n-Butyl alcohol, Tertiary butyl alcohol, Isopropyl alcohol and Chloroform. Different dehydrating series: Alcohol-Xylene method, Alcohol-TBA method & Alcohol Chloroform method. (iii) Paraffin infiltration – use of embedding oven (iv) Embedding: Preparation of blocks. 'L' block and paper boat. (v) Sectioning of paraffin blocks using rotary microtome: Trimming individual blocks and section cutting. **References**	Students will be familiarised with of various types of microscopes, microtomes, and staining techniques to prepare and observe plant specimens. They will be exposed to the principles and procedures of fixation, dehydration, embedding, sectioning, mounting, and clearing of plant tissues Perform histochemical staining, enzyme histochemistry, and vital staining to localize and detect various molecules and

	Miksche, J. P. (1976). Botanical Microtechnique and Cytochemistry. Iowa State University Press. Gahan, P. B. (1984) Plant Histochemistry. Academic Press. Jensen, W. A. (1962) Botanical Histochemistry. WH Freeman & Company. Johansen, D. A. (1940) Plant Microtechnique. McGraw Hill. Khasim, S. M. (2002) Botanical Microtechnique: Principles and Practice. Capital Publishing Company. Pearse, A. G. E. (1980) Histochemistry, Theoretical and Applied. 4th Edition, Vol. 1 & 2. Churchill Livingstone. Sanderson, J. B. (1994). Biological Microtechnique. Bios Scientific Publishers.	enzymes in plant tissues
Module IV **10 hrs**	Adhesives and their preparations. Mounting and spreading of paraffin ribbons on micro slides. Staining: Stains used in microtechnique; Classification – Natural – Hematoxylene, Carmine, Orcein.Synthetic (coal tar) – Basic: Safranin, Crystal violet, Basic fuchsin, Cotton blue - Acidic: Fast green, Orange G, Erythrosine, Eosin, and Toluidine blue.Staining procedure: Single, double and triple staining. Staining combination: safranin and fast green /cotton blue crystal violet and orange-G/erythrosine, Hematoxyline, and safranin. Techniques of clearing, mounting, labelling and storing of permanent slides.Whole mounts, Vein clearing, and tissue maceration. Histochemical staining: Localization of proteins, nucleic acids, insoluble carbohydrates & lipids. Enzyme histochemistry – General account. Vital staining: Principle, procedure, and applications. **References** Miksche, J. P. (1976). Botanical Microtechnique and Cytochemistry. Iowa State University Press. Pearse, A. G. E. (1980) Histochemistry, Theoretical and Applied. 4th Edition, Vol. 1 & 2. Churchill Livingstone. Sanderson, J. B. (1994). Biological Microtechnique. Bios Scientific Publishers. Krishnamoorthy K. V. (1999) Methods in Cell Wall Cytochemistry. C.R.C. Press.	The module enables students to acquire the knowledge and skills of using various adhesives, mounting techniques, and staining procedures to prepare and observe plant specimens. Train students to perform single, double, and triple staining, and to use various staining combinations to enhance the contrast and visibility of plant tissues Introduce students to the methods and applications of histochemistry, whole mounts, vein clearing, and tissue maceration techniques

Course Code & Title	MSPSC01DSC03 GENETICS AND EVOLUTION	Module Outcome
Course Objectives:	Understand the basic principles of genetics and heredity like Mendelian laws of inheritance, chromosome theory of inheritance, sex determination, linkage and mapping, extrachromosomal inheritance, prokaryotic genetics and population genetics.	
Module 1 **12 hours**	**Science of Genetics :** An overview of modern history of the science of Heredity-Classical, Molecular and Evolutionary Genetics-The discovery and re discovery of Genes. Probability factor in Mendelian genetics- A critical analysis. Chi- square analysis, pedigree analysis and probability. **Allelic interactions**- Incomplete Dominance and Codominance, Lethal Alleles, Hierarchy of Dominance, Multiple Alleles, Pleiotropy, **Non allelic interactions**-Epistasis Polygenic inheritance, Quantitative trait loci (QTL), Statistics of quantitative genetics- Heritability. Genetic analysis pathways-Complementation test for alleles, Penetrance and Expressivity, Genes and Environment-Genetics and society. **Chromosomal Basis of Inheritance**: Chromosomal theory of inheritance, Sex-linked traits, Pedigree analysis of sex-linked traits, Activation and inactivation of X-chromosome, Sex-influenced traits, Sex-limited traits, Sex Determination.	The students will be able to solve the problems related to allelic interactions and understand the chromosomal basis of inheritance
References Module I	1. Snustad PD, Simmons MJ. 2015. Principles of Genetics, 7th edition. Wiley. 2. Klug WS, Cummings MR, Spencer CA, Palladino MA, Darrell Killian. 2018. Concepts of Genetics, 12th edition. Pearson. 3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. 2015. Introduction to Genetic Analysis, 11th edition. W.H. Freeman & Worth Publishers. 4. Pierce BA. 2016. Genetics: A Conceptual Approach 6th edition. W. H. Freeman. Strickberger MW. 2015. Genetics, 3rd edition. Pearson. 5. Samuels ML, Witmer JA, Schaffner A. 2015. Statistics for the Life Sciences, 5th edition. Pearson. 6. Brooker R. 2017. Genetics: Analysis and Principles, 5th edition. McGraw-Hill Higher	

	Education 7. Tamarin R, 7th edition. 2017. Principles of Genetics. McGraw Hill Education. 8. Elrod S, Stansfield W. 2010. Schaum's Outline of Genetics, 5th edition. McGraw-Hill	
Module 2 **12 hours**	**Linkage and Gene Mapping:** Linkage, Crossing over, Evolutionary significance ofrecombination, Two-point test cross, Three-point test cross, Genetic Mapping, Genetic mapping in Drosophila, Linkage and mapping using tetrads, Physical mapping, Application of mapping. **Eukaryotic chromosomes-structure, classification and organization**, Banding, karyotyping,Chromosomal aberrations. Extra chromosomal inheritance: Cytoplasmic inheritance, Mitochondrial DNA, interplay between mitochondria and nuclear gene products, Chloroplast DNA, chloroplast biogenesis, Origin and evolution of mitochondria and chloroplast, Maternal effect. Introduction to Epigenetic inheritance: Epigenetic inheritance, Genomic Imprinting and Anticipation	Students will be able to describe about the molecular, quantitative and evolutionary genetics.
References **Module 2**	1. Snustad PD, Simmons MJ. 2015. Principles of Genetics, 7th edition. Wiley. 2. Klug WS, Cummings MR, Spencer CA, Palladino MA, Darrell Killian. 2018. Concepts of Genetics, 12th edition. Pearson. 3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. 2015. Introduction to Genetic Analysis, 11th edition. W.H. Freeman & Worth Publishers. 4. Pierce BA. 2016. Genetics: A Conceptual Approach 6th edition. W. H. Freeman.	

Module 3 **12 hours**	**Methods of gene transfer in prokaryotes**- Transformation, Conjugation and Transduction mapping.Phage genetics and mapping. Developmental genetics- genetic control of development in plants- genetic control of cell lineages. Behavioural genetics- general account Applied genetics- Eugenics, euphenics and euthenics. Immunogenetics. **Evolutionary Genetics-Population genetics** Genetic variation in populations and measuring - changes in genetic structure, causes and consequences – speciation and evolution. Hardy - Weinberg Equilibrium, Sewall Wright effect, Inbreeding, Natural selection, inbreeding and co-ancestry.**Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.	Describe major evolutionary lineages of plants and their defining characteristics
References **Module 3**	1. Snustad PD, Simmons MJ. 2015. Principles of Genetics, 7th edition. Wiley. 2. Klug WS, Cummings MR, Spencer CA, Palladino MA, Darrell Killian. 2018. Concepts of Genetics, 12th edition. Pearson. 3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. 2015. Introduction to Genetic Analysis, 11th edition. W.H. Freeman & Worth Publishers. 4. Pierce BA. 2016. Genetics: A Conceptual Approach 6th edition. W. H. Freeman. 5. Hartl DL, Clark AG. 2006. Principles of Population Genetics 4th edition. Sinauer Associates is an imprint of Oxford University Press. 6. Crow JF, Kimura M. 2009. An Introduction to Population Genetics Theory. The Blackburn Press. 7. Hedrick PW. 2010. Genetics of Populations, 4th edition. Jones & Bartlett Learning 8 Brooker R. J. Genetics: Analysis and Principles. Addison Wesley Longman Inc. 9 Hedrick P. W. Genetics of Populations. Jones and Bartlett Publishers.	
Module 4 **12 hours**	**Evolution** **History of development of early evolutionary principles-** Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.Neo Darwinism	The students will be able to explain the mechanisms which

	The Origin and Early history of life: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. **Palaeontology and Evolutionary History**: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo sapiens. **Origin of species-**Species are the basic unit of evolution-Species maintain their genetic distinctiveness through the barriers to reproduction-clustures of species reflect rapid evolution. Adaptive radiation; Isolating mechanisms; Evolution and Speciation; -Allopatric and Sympatric; Convergent evolution; Sexual selection; Co-evolution. **Evolution and Plant diversification-**The universal tree of life-an overview-cladistics-From single cell organisms to Kingdoms-Early plant life-The algal ancestry-Bryophytes—Early vascular plants-origin of land plants-Angiosperms—The culmination of plant Evolution-The main line of plant evolution-Retrospect and prospect.	underlie evolution at the molecular level.
References Module 4	1.Futuyma, Douglas J Evolution - Sunderland, Sinauer Associates, 2013 - 656p. 2.Guttman, Burton S. Evolution : a beginner's guide - Oxford Oneworld 2005. - 203p. 3.Young, David, The discovery of evolution - 2 - Cambridge ; New York : Cambridge University Press, in association with Natural History Museum, London, 2007. - viii, 281 p 4.Hall, Brian Keith, Strickberger's evolution - 5 - Burlington, Mass. Jones & Bartlett Learning, c2014. - xxvi, 644 p. ill. 5.Lull, Richard Swann Organic evolution - New York, The Macmillan Company, 2009 - 744p.ISBN:9788181160447 6.Ingrouille, Martin Plants : Diversity and Evolution - Cambridge : Cambridge University Press, 2006. - 440p. 7.Charles Darwin Origin of Species - New Delhi Goyl Saab - 479p. 8.Benton, M. J.Introduction to paleobiology and the fossil record - Chichester, UK Hoboken, NJ Wiley Blackwell, 2009. - xii, 592 p. 9. Delevoryas, Theodore Plant Diversification (2ndEdn),Halt,rinehart and winston 10. Dobzhansky, B (1961) Genetics and the origin of species Columbia University press,New york. 11. Simmonds N.W.(Ed)(1976) Evolution of crop plants. Longman London and NewYork	

	12.Stebins G.L(1950)Variation and Evolution in plants.Columbia University press, Newyork 13. StebinsG.L(1970) The process of organic evolution. prenticehall, new Delhi 14. Strwart W.N (1983) paleobotany and Evolution of plants-Cambridge University press. 15.Harlan.P.Banks(1972) Evolution and plants of the past,Macmillan 16. Jay.M.Savage (1977) Evolution .Halt,rinehart and winston,New York 17. Joan Eiger Gottlieb (1971) Plants Adaptation through evolution. 18.Delevoryas,Theodore-PlantDiversification(2nd Edn),Halt, Rinehart and winston 19. Dobzhansky,B(1961) Genetics and the origin of species Columbia University press,Newyork.	

Course Code:	MSPSC01DSC04 MYCOLOGY AND PLANT PATHOLOGY	Module Outcome
Course objectives:	1. To learn about major pathogen groups that infect plants 2. The impact of plant diseases on food security and ecosystems 3. To learn about how plant defend against the pathogens and how to manipulate plant pathogen interaction in favour of plants.	
Module I **12hrs**	**Introduction:** Need to study plant diseases- important plant diseases that shaped the history of human civilization. 10 most important plant diseases of the world & India. Plant- Virus-Vector Interactions: Plant viral diseases, symptoms, major viral pathogens. Viral genomes, size and nature of proteins, viral replication within the host cell and viral movement from cell to cell within the host. Viral movement from plant to plant. Insect vectors involved in transmission, persistent and non-persistent transmission. Plant response to viral pathogens and resistance mechanisms. **References** Agrios, G. N. 2006. Plant Pathology, Academic Press. Dickinson,M. Molecular Plant Pathology. 2003. BIOS Scientific Publishers. J.S. Huang. 2001. Plant pathogenesis and resistance: biochemistry and physiology of plant-microbe interactions. Kluwer Academic.	The students will be able to acquire knowledge on diverse groups of viruses that affect plants
Module **12hrs**	**Plant- Bacterial Interactions:** Plant bacterial diseases, classes of plant pathogenic bacterium, general symptoms. Alpha and beta proteobacterial phytopathogens (Agrobacterium and Ralstonia), gamma proteobacterial phytopathogens (Erwinia, Xanthomonas). Gram-positive and fastidious phytopathogenic bacteria: Clavibacter and Xylella. Plant pathogenic mycoplasmas. Quorum sensing, Virulence factors- Toxins, EPS, Cell wall degrading enzymes, type I, II, III and IV	The students will be able to Recognize the host and pathogen interaction

	secretion system. Regulation of Hrp genes, hairpins and type III effectors. Modes of transmission. Plant response to pathogenic bacteria. **References** Clarence I. Kado Plant Bacteriology, Published by American Psychopathological Society. Agrios, G. N. 2006. Plant Pathology, Academic Press. Dickinson,M. Molecular Plant Pathology. 2003. BIOS Scientific Publishers. J.S. Huang. 2001. Plant pathogenesis and resistance: biochemistry and physiology of plant-microbe interactions. Kluwer Academic.	
Module III **12 hrs**	**Plant –Fungal interactions:** Necrotrophic phytopathogenic fungi –Diseases, symptoms, mode of pathogenesis, Host selective toxins, non-host selective toxins, Genetics of toxin biosynthesis and toxin resistance, Plant susceptibility to toxins. Biotrophic phytopathogenic fungi – Diseases, symptoms, mode of pathogenesis, Specialized structures for nutrition, Effectors - apoplastic and cytoplasmic., Plant response to fungal infection and resistance. Quelling Importance of the plant diseases; the concept of plant disease; causes of plant diseases; classification of plant diseases; parasitism and pathogenesis; Koch's postulates; effect of the pathogen on the plants; symptoms of plant diseases; development of epidemics; plant disease management; major crop diseases of Kerala. **References** H.H. Prell and P. Day, Plant–Fungal Pathogen Interaction: A Classical and Molecular View; Published by Springer-Verla Agrios, G. N. 2006. Plant Pathology, Academic Press. Dickinson, M. Molecular Plant Pathology. 2003. BIOS Scientific Publishers.	Students will be able for handling disease free varieties and Implement the disease management techniques in the fields.

Module IV **12 hrs**	**Plant – Nematode interactions:** Classes of plant parasitic nematodes, feeding organs, Ecto and Endo parasitic nematodes, Nematode dissemination, important plant diseases caused by nematodes, Nematode effectors and host targets, Plant response to nematodes and resistance mechanisms. Plant interaction with parasitic plants. Plant Resistance and Susceptibility factors: Preformed defence, Host resistance and non-host resistance, Induced resistance and Systemic Acquired Resistance, PAMPS and PAMP Triggered Immunity (PTI), Effector Triggered Immunity (ETI), Effector Triggered Susceptibility (ETS). Theories and models on Plant Resistance to pathogens. Applied Plant Pathology: Methods of Plant pathogen diagnostics. Evolution of Plant-Pathogen interactions- its significance on breeding disease-resistant plants, Genetic engineering of Plants for resistance. **References** Roland N. Perry and Maurice Moens. Plant Nematology, Published by CABI	Students will be able to understand how plant defend against the pathogens and how to manipulate plant pathogen interaction in favour of plants.

Course Code and Title	MSPSC01DSE01 METHODOLOGY AND PHILOSOPHY OF SCIENCE	Module Outcome
Course Objectives	i) Understand what science is and in what ways science differs from non-science and pseudoscience subjects ii) Understand the different methods of reasoning in Science. iii) Get an idea about the modes of scientific explanations. iv)Understand the role of paradigm shifts in various branches of scientific research; also get an idea about the scientific revolutions in various branches of science v) Understand the value, its acceptance and the criticism to Science. vi)Understand the historical milestones in the evolution of scientific thoughts and research. vii)Distinguish between different centuries concerning the growth of science and scientific thoughts.	
Module I **12hrs**	**1.What is science?** Scientific knowledge- Streams of Science-Basic and applied science- A summary of the History of science - Science and society – Science as a human activity - Origin of modern science. Philosophy of Science- A brief Historical introduction-definition, scope and the evolution of concepts - Science and pseudo-science. **2. Scientific Method and Reasoning** Scientific method - Observations, pieces of evidence and proofs- Hypothetico-deductive model, Inductive model home's problem of induction-Significance of verification (proving) - corroboration and falsification (disproving)- Positivism. Karl popper and the concept of falsification. Realism and Antirealism- Observable and unobservable distinctions. **3. Explanation in science** Hempel's covering law model of explanation - The problem of symmetry Explanation and causality - Can science explain everything? - Explanation and Reduction.	To understand what science is and in what ways science differs from non-science and pseudoscience subjects and Students will be able to understand the different methods of reasoning in Science.

Module II **10hrs**	**4. Scientific Change and Scientific Revolutions** Logical positivist philosophy of science – Empiricism-New Paradigms and Scientific Change -The structure of scientific revolutions - Incommensurability and theory-ladenness of data - Thomas Kuhn and the rationality of science **5. Scientific temper and its fostering.** Critical thinking and logical reasoning in science. Science and its critics- Science as just one narrative -scientism- Science and religion debates, Science and values. Is Science value-free?	Understand the historical milestones in the evolution of scientific thoughts and research.
Module III **14hrs**	**Experimentation in science** Introduction-Selecting a problem-Hypothesis-auxiliary hypothesis and ad-hoc hypothesis. Experimental Design-Variables-Correlation and causality-sampling—control in experiments.-Experimental bias-performing experiments-Measurement error. **Philosophy of Biology.** What is biology? -The nature and logic of biological sciences -Logic of life. -Molecular logic of life-Problems of Biological classification — biological species concept- Evolution and Natural selection- Function and adaptation-The gene-centric view of evolution- Philosophical issues in Genetics - Classical and Molecular -Genes and information -Genetic determinism. Reductionism in Biology – argument from molecular biology-Ecological concepts- Anthropocentric and Ecocentric- Deep and Shallow - Biological determinism. Biology and Ethics. -Early history and development of methods in Biology.	Get an idea about the modes of scientific explanations based on experiments
Module IV **12hrs**	**History of Biology in the Seventeenth century:** Anatomists, Microscopists History of Biology in the Eighteenth century: Carolus Linnaeus-The founder of biological Taxonomy; Precursors to modern evolutionary theory- Lamarck and Cuvier **History of Biology in the Nineteenth century:** Birth of associations and societies to promote science; Charles Darwin; Pre-Darwinian evolution; Origin of species-Gregor Mendel's	The students will have an understanding of the ups and downs in the history of science, the pace of scientific research during the 17th to 20th

	Experiments - The emergence of biological disciplines; Experimental Physiology; Cell theory, cell pathology and germ theory. **History of Biology in the Twentieth century:** The first half of 20thcentury: Growth of microbiology and Biochemistry; Genetics and heredity Second half of 20thcentury: The architects of life - proteins, DNA and RNA; The origins and borderlines of life; Growth of genetic engineering; Growth of Biotechnology; Growth of Genomics; Growth of Recombinant DNA.	Centuries, contributions made by scientists in the past centuries and the methods and philosophy behind scientific experimenting.
REFERENCES	**Philosophy of Science** 1. Alan Chalmers. What is this thing called science? University of Queensland Press, Open University Press, 3rd revised edition, Hackett,1999 2. Elliott Sober. Philosophy of Biology, West view press2000 3. Richard Dewitt. Worldviews: an introduction to history and philosophy of science. Blackwell publishing 2004. 4. Boyd, R., Gasper, P., and Trout, J.D. (eds., 1991), The Philosophy of Science, Blackwell Publishers, Cambridge, MA. 5. Glaze brook, Trish (2000), Heidegger's Philosophy of Science, Fordham University Press. 6. Gutting, Gary (2004), Continental Philosophy of Science, Blackwell Publishers, Cambridge, MA. **History and Philosophy of Biology** 1. Allen, Garland E. Thomas Hunt Morgan: The Man and His Science. Princeton University Press: Princeton, 12 1978. ISBN 0-691-08200-6 2. Allen, Garland E. Life Science in the Twentieth Century. Cambridge University Press,1975. 3. Annas, Julia Classical Greek Philosophy. In Boardman, John; Griffin, Jasper; Murray, Oswyn (ed.) The Oxford History of the Classical World. Oxford University Press: New York, 1986. ISBN0-19-872112-9 4. Bowler, Peter J.The Earth Encompassed: A History of the Environmental Sciences. W. W.	

Norton & Company: New York, 1992. ISBN0-393-32080-4
5. Bowler, Peter J. Evolution:The History of an Idea. California University Press, 2003. ISBN0-52023693-9.
6. Browne, Janet. The Secular Ark: Studies in the History of Biogeography. Yale University Press: NewHave, 1983. ISBN 0300024606
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18. Mayr, Ernst. The Growth of Biological Thought: Diversity, Evolution, and Inheritance. The Belknap Press of Harvard University Press: Cambridge, Massachusetts, 1982. ISBN0- 674-36445-7
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20. Morange, Michel. A History of Molecular Biology, translated by Matthew Cobb. Harvard University Press: Cambridge, 1998. ISBN0-674-39855-6
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Course Code& Title	PRACTICAL 1: MSPSC01DSC05 BIOLOGY OF ARCHEGONIATE, ANATOMY OF ANGIOSPERM AND MICROTECHNIQUE	Module Outcome
Course Objectives	To gain knowledge on the diversity, structural organization and reproduction of algae, Bryophytes, Pteridophytes and Gymnosperms To compare the similarities and differences in these groups To acquire knowledge about the anatomical features of Plants	
Module I 24hrs	**Module I. Algae and Bryophytes** **Algae** 1. Collection, preparation and presentation of algal herbarium (minimum 5 herbarium sheets). 2. Field collection and study of the types mentioned below and their classification up to generic level. Cyanobacteria: Nostoc, Anabaena Chlorophyta: Cosmarium, Cladophora, Pithophora, Bryopsis, Codium, Xanthophyta: Botrydium, Vaucheria. Bacillariophyta: Pinnularia, Navicula Phaeophyta: Padina, Sargassum, Rhodophyta: Gracilaria, Batrachospermum, Bryophytes: Field collection, Morphological and structural study of the following genera: Asterella, Cyathodium, Anthoceros, Bryum, Pogonatum, Porella, Marchantia.	**Module I. Algae and Bryophytes** The module aims to teach students how to collect, prepare, and present algal and bryophyte specimens for taxonomic and morphological study. The course also covers the identification and classification of various genera of algae and bryophytes, based on their external and internal features. The course also introduces students to the diversity and distribution of algae and bryophytes in different habitats.
Module II 20 hrs	**Pteridophytes** 1. Morphological, anatomical and reproductive features of Lycopodium, Isoetes, Angiopteris, Osmunda, Lygodium, Salvinia. 2. Fossils: Rhynia, Lepidodendron, 3. Habitat study of Lycopodium, Selaginella, Actiniopteris, Drynaria and Salvinia. 4. Spore germination and development of prothallus in Knop's Agar medium. 5. Submission of a field study report and 5 herbarium specimens of common, local pteridophytes.	**Module II. Pteridophytes** The module aims equip students to observe and analyze the morphological, anatomical, and reproductive features of various pteridophytes. It also covers the identification and classification of different orders and genera of pteridophytes, based on

		their external and internal characteristics. The course also trains students to perform spore germination and prothallus development experiments in laboratory conditions.
Module III **20 hrs**	**Module III. Gymnosperms:** 1. Identification of petrifactions, compressions, impressions, slides of fossil types included in gymnosperm groups mentioned above 2. Comparative study of vegetative and reproductive structures of Zamia, Araucaria, Cupressus, Podocarpus and Ephedra (living gymnosperms) 3. Morphological and anatomical studies of the above-mentioned taxa	**Module III. Gymnosperms:** After completing this modulestudents will be able to identify mentioned gymnosperms using morphological and anatomical characters of vegetative and reproductive structures
Module IV **30 hrs**	**Anatomy of Angiosperms and Microtechnique** Anomalous secondary growth: Dracaena, Bignonia, Amaranthus, Nyctanthes, Mirabilis, Bougainvillea and beetroot. **Leaf anatomy**: C3 and C4 plants, succulents, xeromorphic leaves, halophytes and hydrophytes. Stomata: types, stomatal index. **Microtechnique:** Preparation of stained permanent slides of the following: Whole mounts, freehand sections, maceration and serial microtome sections using double, triple, and histochemical staining procedures. At least twenty permanent micro preparations representing whole mounts, freehand sections and serial sections should be submitted for evaluation	**Module IV. Anatomy of Angiosperms and Microtechnique** The course aims to train students to prepare and identify sections of plant tissues that show anomalous secondary growth. The course also covers the microtechnique skills of preparing stained permanent slides of various plant tissues, using whole mounts, freehand sections, maceration, and serial microtome sections. The course also trains students to use different types of staining procedures, such as double, triple, and histochemical staining.

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Course Code& Title	PRACTICAL 2: MSPSC01DSC06 GENETICS, MYCOLOGY AND PLANT PATHOLOGY	Module Outcome
Course Objectives	To learn about major pathogen groups that infect plants To analyse the impact of plant diseases on food security and ecosystems Apply quantitative problem-solving skills to genetics problems and issues.	
Module 1 **36 hrs**	**Genetics**: **Independent assortment**-Systems for solving dihybrid crosses. **Genetic Interactions-**Two factor interactions-Epistatic interactions-Non Epistatic Interactions-Multiple allelism and Quantitative genetics. **Linkage and chromosome Mapping**,Tetrad analysis in Ascomycetes-Recombination Mapping with Tetrads **The Binomial and Chi square distributions**-Testing genetic ratios. **Genetics of Microorganisms**-Problems on prokaryotic chromosome mapping **Population genetics**- Calculating gene frequencies	The students will be able to apply the basic principles of genetics for genetic improvement of plants.
Module 2 **20 hrs**	**Mycology** 1. Plant disease symptoms: recognition and identification 2. Isolation of pure culture of a fungal plant pathogen from a diseased plant. 3. Application of Koch's postulate 4. Preparation of culture media 5. Isolation of fungi from soil by dilution-plate method. 6. Isolation of fungi from dung.	The students will be able to recognize the host and pathogen interaction
Module 3 **20 hrs**	**Study of morphology and anatomy of the reproductive structures of the following genera of fungi**: *Phytophthora, Pythium, Albugo, Pilobolus, Glomus, Mucor, Rhizopus, Saccharomyces, Taphrina, Ascobolus, Xylaria, Trichoglossum, Phomopsis, Drechslera, Aspergillus, Penicillium,*	The students will get a knowledge on disease forecasting and management.

Module 4 **14 hrs**	*Alternaria, Cercospora, Fusarium, Tremella, Auricularia, Puccinia.* **Plant pathology** 1. Study of the symptoms and signs of the following plant diseases in the laboratory and in the field and identification of the pathogens: abnormal leaf fall of rubber, coffee rust, plumeria rust, blister-blight of tea, quick wilt of pepper, white rust of amaranth, Cercospora leaf-spot of okra, powdery mildew of any locally available crop, rice blast, brown spot of rice, whip-smut of sugar cane, soft rot of carrot, sesamum phyllody, cassava mosaic. 2. Molecular diagnostics of plant-pathogen using PCR 3. Detection of plant virus using ELISA	The students will be able to analyze the plant-pathogenic interaction and implement the disease management techniques in the fields.
REFERENCES	**References** Kowles R. Solving Problems in Genetics. Springer. Sambamurthy A. V. S. S. Genetics. Narosa Publishing House. Brooker R. J. Genetics: Analysis and Principles. Addison Wesley Longman Inc. Hedrick P. W- Genetics of Populations. Jones and Bartlett Publishers. Griffiths A. J. F., Gelbbart W. M., Lewontin R. C., Miller J. H.- Modern Genetic Analysis. W.H. Freeman & Company. Dabholkar A. R. Elements of Biometrical Genetics. Concept Publishing Company. Frankel O. H. and Bennet E. Genetic Resources in Plants. Blackwell. Hotter P. Textbook of Genetics. Ivy Publishing House. Satpathy G. C. Genetics. Kalpaz Publications. Joshi R. M. Biosafety and Bioethics. Isha Books. Pagano M. and Gauvreau K. Principles of Biostatistics. Duxbury. Panse V. G. and Sukhatme, P. V. Statistical Methods for Agricultural Workers. ICAR. Rangaswamy R. A Text Book of Agricultural Statistics. New Age International Publishers.	

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KANNUR UNIVERSITY

(Abstract)

M.Sc Plant Science with Specialization in Ethnobotany Programme in the Department of Botany, Mananthavady Campus - Syllabi of II, III & IV Semesters - Approved- Implemented w. e. f 2023 admission- Orders Issued

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ACADEMIC C SECTION

ACAD C/ACAD C3/26940/2023 Dated: 05.05.2024

Read:-1. UOs No ACAD C/ACAD C3/22373/2019 dated 12/09/2023, 08/11/2023 & 16/02/2024

2. U.O. of even number dated 13/02/2024

3. Circulars No dated ACAD C/ ACAD C3/22373/2019 dated 01/02/2024 & 12/03/2024

4. Email dated 25/03/2024 from the Course Coordinator, Dept of Botany, Mananthavady Campus

5. Minutes of the meeting of the Department Council dated 06/03/2024

6. Orders of Vice chancellor dated 2-5-2024.

ORDER

1. The revised regulations for PG Programmes under CBCSS in the University Teaching Depts/ Schools were implemented w.e.f 2023 admissions vide paper read (1) above.

2. As per paper read (2) above, revised Scheme (All Semesters) & Syllabus (1st Semester Only) of M. Sc Plant Science with Specialization in Ethnobotany Programme was approved and implemented in the Dept. of Botany, Mananthavady Campus w. e. f 2023 admission.

3. As per paper read (3) above, Heads of all Teaching Departments were requested to submit the Syllabi of the remaining semesters in accordance with the approved Regulations and along with a copy of the Department Council Minutes.

4. As per paper read (4) above, the Course Co-ordinator, Dept. of Botany, Mananthavady Campus submitted the Syllabi (II, III & IV Semesters) of M. Sc Plant Science with Specialization in Ethnobotany Programme to be implemented in the University Teaching Department w. e. f 2023 admissions.

5. Department Council vide the paper read (5) above approved the aforementioned Syllabi (II, III & IV Semesters) of M. Sc Plant Science with Specialization in Ethnobotany Programme to be implemented in the Dept. of Botany, Mananthavady Campus w.e.f.2023 admission.

6. The Vice Chancellor, after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11(1), Chapter III of Kannur University Act 1996, ***approved the Syllabi (II, III & IV Semesters) of M. Sc Plant Science with Specialization in Ethnobotany Programme and accorded sanction to implement the same in the Dept. of Botany, Mananthavady Campus w. e. f 2023 admissions, subject to report to the Academic Council .***

7. The Syllabi (II, III & IV Semesters) of M. Sc Plant Science with Specialization in Ethnobotany Programme under CBCSS implemented in the Dept of Botany, Mananthavady Campus with effect from 2023 admission, is appended and uploaded in the University website *(www.kannuruniversity.ac.in).*

8. Orders are issued accordingly.

Sd/-
Narayanadas K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: 1. Course Coordinator, Dept of Botany, Mananthavady Campus
2. Convenor, Curriculum Committee

Copy To: 1.PS to VC/ PA to R
2. PA to CE (to circulate among the sections concerned under Examination Branch)
3. EP IV/ EXC I
4. Computer Programmer
5. Web manager (to publish in the website)
6. SF/DF/FC

Forwarded / By Order
SECTION OFFICER

KANNUR UNIVERSITY

M.Sc. PLANT SCIENCE

SCHEME & SYLLABUS

(Under Choice Based Credit & Semester System)

2023 admission onwards

DEPARTMENT OF BOTANY

Kannur University

Mananthavady campus

Post Graduate Programme in Plant Science

The M.Sc. Plant Science course is a comprehensive two-year program designed to provide students with an advanced understanding of plant science divided into four semesters, each focusing on different areas of Plant Science.

KANNUR UNIVERSITY

DEPARTMENT OF BOTANY

VISION

To be a world class department with excellence in teaching and research by providing scientific and technological contributions

MISSION

Promote quality education and innovative research in Plant Science.

PROGRAMME OUTCOMES

PO 1 : Demonstrate and apply the fundamental knowledge of the basic principles of major fields of biology. Take informed actions after identifying the assumptions that frame our thinking and actions, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2 : Identify, formulate, conduct investigations, and find solutions to scientific problems based on in-depth knowledge of relevant domains.

PO 3 : Speak, read, write and listen clearly in person and through electronic media in English/language of the discipline, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 4 : Demonstrate empathetic social concern, and the ability to act with an informed awareness of environmental issues. Communicate scientific information in a clear and concise manner both orally and in writing

PO 5 : Apply knowledge to solve the issues related to plant sciences with the help of computer technology. Recognize different value systems including your own, understand the moral dimensions of issues, and accept responsibility for them.

PO 6 : Acquire the ability to engage in independent and life-long learning in the broadest context socio- technological changes.

PO 7 : Apply the knowledge to develop the sustainable and eco-friendly technology in Industrial Botany.

PROGRAMME SPECIFIC OUTCOMES

PSO 1 : A student completing the course can understand different specializations of Botany such as systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, Genetics and molecular biology of various life-forms.

PSO 2 : The students gets trained in various analytical techniques of plant biology, use of plants as industrial resources or as a human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.

PSO 3 : The student completing the course can identify various life forms of plants, design and execute experiments related to basic studies on evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, proteomics and transgenic technology.

PSO 4 : The students will get hands-on training in the field of ethnobotany and conservation biology and unique subjects like wetland ecology, landscape ecology etc. Students are also familiarized with the use of bioinformatics tools and databases for the identification of lead molecules for drugs and also to apply statistical tools on biological data.

PSO 5 : The student completing the course will be capable to execute short research projects incorporating various tools and techniques in any of the basic specializations of Plant Sciences, in addition to being specialised in ethnobotany and conservation biology

PSO 6 : The program will equip students with research skills required for independent study and original research in plant science. They will learn to conduct literature reviews, identify research gaps, formulate research questions, and develop research plans to explore and contribute to the field.

DURATION: 2 Years (4 semesters)

INTAKE: 13 Nos.

PROGRAMME OUTCOMES

1. To provide students with a comprehensive understanding of advanced biological concepts, acquire skills in experimental design, data analysis, and interpretation relevant to plant science research
2. To enhance student's abilities through coursework, assignments, and projects, students are challenged to think critically.
3. Enhance the ability to: communicate scientific concepts effectively and present research findings to both scientific and non-scientific audiences
4. Explore the interactions between plants and their environment, including ecosystems, climate change, and conservation and ethical implications and environmental impacts of plant science research and applications
5. Encourage interdisciplinary learning by integrating knowledge from different fields.
6. The programme can serve as a stepping stone to further study, such as pursuing a Ph.D. in Plant science or a related field.

ELIGIBILITIES:

- B.Sc. Degree in Plant Science/Botany with 50% marks.

ADMISSION:

- The selection of the candidate is based on Admission test. The admission test will cover Plant Science at the undergraduate level.

COURSE DETAILS:

A student must register for the required number of courses at the beginning of each semester. No students shall register for more than 24 credits and less than 16 credits per semester.

A total of 80 credits shall be the minimum for successful completion of the course in which a minimum of 56 credits for core course and electives and 8 credit s from outside are mandatory. Those who secure only minimum credit for core/ elective subjects has to supplement the deficiency for obtaining the minimum total credits required for successful completion of the program from the other divisions.

EVALUATION:

The faculty member who teaches the course shall do evaluation of the students for each course on the basis of Continuous Evaluation and End Semester Examination shall be evaluated by External Examiners. The proportion of the distribution of marks among the continuous evaluation and end semester examination shall be **40:60**.

Continuous Evaluation includes assignments, seminars, and written examination for each course. Weightage to the components of continuous evaluation shall be given for all theory papers of the course as follows:

Theory			Practical	
Components of CE	Minimum Number	Percentage	Components	Percentage
Test paper	2	40 %	Practical Test	80 %
Assignments	1	20 %	Record	20 %
Seminar, Viva, Presentation, Discussion and Debate	1	40 %	-	-

SCHEME

Total Credits: 21, Discipline Specific Core Courses (DSC): **18**, Discipline Specific Elective Course (DSE): **3**

FIRST SEMESTER							
Course Code	**Title of Paper**	**Contact hrs./Week**			**Marks**		**Credits**
		L	**T/S**	**P**	**ESE**	**CE**	
Discipline Specific Core Courses (DSC)							
MSPSC 01DSC01	Biology of Archegoniate	3	1	-	60	40	3
MSPSC 01DSC02	Anatomy and Microtechnique	3	1	-	60	40	3
MSPSC 01DSC03	Genetics and Evolution	3	1	-	60	40	3
MSPSC 01DSC04	Mycology and Plant Pathology	3	1	-	60	40	3
MSPSC 01DSC05	**PRACTICAL 1** Biology of Archegoniate, Anatomy of Angiosperms and Microtechnique	-	-	5	60	40	3
MSPSC 01DSC06	**PRACTICAL 2** Genetics, Mycology and Plant Pathology	-	-	5	60	40	3
	Total	**12**	**4**	**10**	**60**	**40**	**18**
Discipline Specific Elective Courses (DSE)							
MSPSC 01DSE01	Methodology and Philosophy of Science	3	1	-	60	40	3
	Total	**30**			60	40	**21**

Total Credits: 27, Discipline Specific Core Courses (DSC): **15**, Discipline Specific Elective Course (DSE): **6**, Multidisciplinary Elective (MDC) to be obtained from other departments: **2**, Ability Enhancement Course (AEC) to be obtained from other departments: **2**, Skill Enhancement Course to be obtained from other departments (SEC): **2(**. Any two)

SECOND SEMESTER							
Course Code	**Title of Paper**	**Contact hrs./Week**			**Marks**		**Credits**
		L	**T/S**	**P**	**ESE**	**CE**	
Discipline Specific Core Courses (DSC)							
MSPSC 02DSC07	Taxonomy and Advanced Plant Systematics.	3	1	-	60	40	3
MSPSC 02DSC08	Cell and Molecular Biology	3	1	-	60	40	3
MSPSC 02DSC09	Plant Physiology and Biochemistry	3	1	-	60	40	3
MSPSC 02DSC10	**Practical III** Taxonomy and Advanced Plant Systematics.	-	-	5	60	40	3
MSPSC 02DSC11	**Practical IV** Cell and Molecular Biology and Plant Physiology and Biochemistry	-	-	5	60	40	3
	Total	**9**	**3**	**10**	**60**	**40**	**15**
Discipline Specific Elective Courses (DSE) (Any 2 courses to be chosen)							
MSPSC 02DSE02	Developmental Biology of Plants	3	1	-	60	40	3
MSPSC 02DSE03	Environmental Science	3	1	-	60	40	3
MSPSC 02DSE04	Seed Technology	3	1	-	60	40	3
	Total	**6**	**2**		**60**	**40**	**6**
Multidisciplinary Elective (MDC) offered for other departments							
MSPSC 02MDC01	Ecology and Environment	2	1	-	60	40	2
MSPSC 02MDC02	Philosophy of Science						
Multidisciplinary Elective (MDC) To be obtained from other departments							
------		2	1	-	60	40	2#

Ability Enhancement Course (AEC) offered for other departments							
MSPSC 02AEC01	Organic Farming	2	1	-	60	40	2
MSPSC 02AEC02	Floriculture						
Ability Enhancement Course (AEC) To be obtained from other departments							
-----		2	1	-	60	40	2#
Skill Enhancement Course (SEC) offered for other departments							
MSPSC 02SEC01	Mushroom Technology	2	1	-	60	40	2
Skill Enhancement Course (SEC) To be obtained from other departments							
--------		2	1	-	60	40	2#
Total		**44**			**60**	**40**	**25**
*** Value Added Course (VAC)**							
MSPSC 02VAC01	Biology-Ethics and Philosophy	1	1	-	60	40	2

* Not to be added to the total credit of the program
#Any two course to be obtained from other departments

Total Credits: 23. Discipline Specific Core Courses (DSC): **15**, Discipline Specific Elective Courses (DSE): **6**, Multidisciplinary Elective (MDC) to be obtained from other departments: **2**

THIRD SEMESTER							
Course Code	**Title of Paper**	**Contact hrs./Week**			**Marks**		**Credits**
		L	**T/S**	**P**	**ESE**	**CE**	
Discipline Specific Core Courses (DSC)							
MSPSC 03DSC12	Biotechnology and Nano Biology	3	1	-	60	40	3
MSPSC 03DSC13	Bioinformatics	3	1	-	60	40	3
MSPSC 03DSC14	Ethnobotany and Ethnopharmacology	3	1	-	60	40	3
MSPSC 03DSC15	**Practical V** Plant Biotechnology, Tissue Culture and Bioinformatics	-	-	5	60	40	3
MSPSC 03DSC16	**Practical VI** Ethnobotany and Ethnopharmacology	-	-	5	60	40	3
	Total	**9**	**3**	**10**	**60**	**40**	**15**

Discipline Specific Elective Courses (DSE) (Any 2 course to be chosen)							
MSPSC 03DSE05	Methods in Plant Biology	3	1	-	60	40	3
MSPSC 03DSE06	Tissue culture and Plant Breeding	3	1	-	60	40	3
MSPSC 03DSE07	Microbiology						
	Total	**6**	**2**		**60**	**40**	**6**
Multidisciplinary Elective (MDC) offered for other departments							
MSPSC03 MDC03	Agri-business	3	1	-	60	40	4
MSPSC 03MDC04	Environmental Auditing and Impact Assessment	3	1	-	60	40	4
MSPSC 03MDC05	Plant Tissue Culture and Conservation	3	1	-	60	40	4
MSPSC 03MDC06	Ethnobotany and Conservation	2	1	-	60	40	4
Multidisciplinary Elective (MDC) to be obtained from other departments							
-----		3	1	-	60	40	4
	Total	**39**			**60**	**40**	**25**

Total credits: 16, Discipline Specific Core Courses (DSC): **3**, Discipline Specific Elective Courses (DSE): **3**, Project (P): **10**

Fourth Semester							
Course Code	**Title of Paper**	**Contact hrs./ Week**			**Marks**		**Credits**
		L	**T/S**	**P**	**ESE**	**CE**	
Discipline Specific Core Courses (DSC)							
MSPSC04 DSC17	Conservation Biology	3	1	-	60	40	3
Discipline Specific Elective Courses (DSE) (Any 1 course to be chosen)							
MSPSC04 DSE08	Forest Botany	3	1	-	60	40	3
MSPSC04 DSE09	Land Scape Ecology	3	1	-	60	40	3
MSPSC04 DSE10	Wetland Ecology	3	1	-	60	40	3
Project (P)							
MSPSC04 DSC18	Project Work	-	-	24	60	40	10
Total		**32**			**60**	**40**	**16**
Grand Total		**145**			**60**	**40**	**87**

FIRST SEMESTER M.Sc. PLANT SCIENCE PROGRAMME

Course Code& Title:	MSPSC01DSC01 BIOLOGY OF ARCHEGONIATAE	Module Outcome
Course Objectives:	1. To study the various groups of Algae, Bryophytes, Pteridophytes, Gymnosperms 2. To compare the similarities and differences in these groups	
Module1 **16 hours**	**Algae:** Introduction-History of Phycology-General characteristics. 1. Classification of Algae according to van den Hoek et al. 1995. A brief account of the recent development in molecular phylogenetics and DNA barcoding of algae. 2. Diversity of algae and cyanobacteria. 3. Morphology: Range of thallus structure. 4. Reproduction and life history. 5. Collection, identification, preservation (including herbarium techniques) of algae. 6. General account of the structure, reproduction and relationships in the following group Chlorophyta; Xanthophyta; Phaeophyta, Bacillariophyta, Euglenophyta and Rhodophyta. Cyanophyta: structure of cell, akinete and heterocyst, pigments, chromatic adaptation, thallus organization and reproduction. 7. Applied aspects of algae and cyanobacteria: biodiesel, hydrogen, methane and ethanol production, carbon dioxide sequestration, industrial applications, food supplements, pharmaceutical industries, biofertilizers, bioremediation, biodegradation, algal blooms, commercial cultivation of algae, mass production and field application of cyanobacteria.	1. The students will be able to collect, preserve, study and describe the general characteristics, classification and diversity of algae and cyanobacteria, their morphology, anatomy, reproduction and life history. 2. The students will also be able to evaluate the applied aspects of algae and cyanobacteria, such as biofuel production, carbon sequestration, industrial applications, food supplements, biofertilizers, bioremediation, algal blooms and commercial cultivation.

	8. Fossil algae and cyanobacteria. **References** Chapman, V. J. 1941. An Introduction to the Study of Algae. Cambridge University Press. Chapman, V. J. & Chapman, D. J. 1973. The Algae. Macmillan. Desikachary, T. V. 1959. Cyanophyta. Indian Council of Agricultural Research. Fritsch, F. E. 1961. The Structure and Reproduction of Algae. Vol. 2. Cambridge University Press. Irvine, D. E. & D. M. John. 1984. Systematics of the Green Algae. Academic Press. Stevensen, J. et al. 1996. Algal Ecology. Freshwater benthic ecosystems. Academic Press. Krishnamurthy, V. 1998. Algae of India and Neighboring Countries. 1. Chlorophycota. Oxford & IBH publishing Co. Pvt. Ltd. Kumar, H. D. 1990. Introductory phycology. East West Press Pvt. Ltd. Prescott, G. W.1969. The Algae. A Review. Thomas Nelson and Sons Ltd Round, F. E. 1975. The Biology of Algae. Edward Arnold. Smith, G. M. 1978. Manual of Phycology. The Ronald Press Company. Trainor, F. R. 1978. Introductory Phycology. John Wiley and Sons. Van Den Hock, Mann, D.G. and Jahns, H.M. 1995. Algae: An Introduction to Phycology. Cambridge University Press. Venkataraman, G. S. 1972. Algal Biofertilizers and Rice Cultivation. Today and Tomorrow's publishers. Venkataraman, G. S., Goyal, S. K., Kaushik B. D., and Roychaudhary, P. 1974. Algae form and function. Today and Tomorrow's printers. Vijayaraghavan, M. R. & Bhatia, B. 1997. Red Algae: Structure, Ultrastructure and Reproduction. APH Publishing Corporation.	

Module2 **12 hours**	**Bryophytes:** 1. General habit, habitat, distribution, biogeography, growth forms and systems of classification of bryophytes. A brief account of the recent developments in molecular phylogenetics and DNA barcoding of bryophytes. 2.Origin of bryophytes 3. General account of the anatomy, reproduction and life history of Marchantiales, Jungermanniales, Polytrichales and Anthocerotales. 4. Applied bryology: Ecological uses, household uses, medicinal uses (herbal medicines, transgenic products), decorative bryophytes, aquarium bryophytes, heavy metal detection and clean up, erosion control, horticultural uses (soil conditioning, air layering, pot culture, container gardens and hanging baskets), bioindicators of pollution. 5.Fossil bryophytes: a general account.	1. The students will be able to explain the general habit, habitat, distribution, anatomy, reproduction and classification of bryophytes. 2. The students will be also able to assess the applied bryology of bryophytes, such as their ecological, household, medicinal, decorative, horticultural and bioindicator uses.
	References Smith, A. J. E. (ed.). 1982. Bryophyte Ecology. Chapman & Hall. Shaw, A. J. & Goffinet, B. (eds.). 2000. Bryophyte Biology, Cambridge University Press. Glime, J. M. & Saxena, D.1991. Uses of Bryophytes. Today and Tomorrows Printers & Publishers. Schofield, W. B. 2001. Introduction to Bryology. The Blackburn Press. Nair, M. C. et al. 2005. Bryophytes of Wayanad, Western Ghats. MNHS, Calicut	
Module 3 **14 hours**	**Pteridophytes:** 1. Introduction to pteridophytes: general characteristics, life cycle, classification. Brief account of the recent developments in molecular phylogenetics and DNA barcoding of pteridophytes. 2. Diversity of forms among pteridophytes: general morphology with special reference to South Indian species of Lycopodiales, Isoetales, Marattiales, Filicales (Gleicheniaceae, Adiantaceae, Cyatheaceae). 3. Fossil pteridophytes: Psilophytales, Lepidodendrales,	1. The students will be able to understand the general characteristics, morphology, anatomy, life cycle and classification of pteridophytes, 2. The students will be able to understand the stelar evolution, heterospory and seed habit in pteridophytes.

	4. Habitat diversity of pteridophytes: epiphytes, lithophytes, climbers, halophytes, saprophytes, sciophytes, xerophytes, mesophytes, hydrophytes. 5. Stelar evolution: protostele, siphonostele, solenostele, dictyostele and special stellar types; vessels in pteridophytes. 6. The fern gametophytes: pattern of development, the morphology of mature gametophytes. 7. Heterospory and evolution of seed habit. 8. Cytology: chromosome number and morphology; polyploidy, the origin of polyploids, apospory, apogamy, agamospory. 9. Applied pteridology: bio-fertilizer production from Azolla: Azolla - Anabaena symbiosis; Pteridophytes as weeds: Salvinia (aquatic) and Pteridium (terrestrial); ornamental and medicinal pteridophytes. **References** Bierhost, D. W. 1971. Morphology of Vascular Plants. Macmillan Co. Dyer, A. C. 1979. The experimental Biology of Ferns. Academic Press. Hameed, C. A., Rajesh, K. P. and Madhusoodanan, P. V. 2003. Filmy Ferns of South India. Penta Book Publishers & Distributors. Jermy, A. C. 1973 (Ed.). The Phylogeny and Classification of Ferns. Academic Press. Kramer, K. U. & Green, P. S. 1991. The families and genera of Vascular Plants, Narosa. Nampy, S. and Madhusoodanan, P. V. 1998. Fern Flora of South India-Taxonomic Revision of Polypodioid Ferns. Daya Publishing House.	
Module 4 **14 hours**	Gymnosperms: 1. General characters, classification. A brief account of the recent developments in molecular phylogenetics and DNA barcoding of gymnosperms. 2. Geological horizon, distribution, general account including morphology, anatomy, phylogeny and interrelationship of the following orders a) Pteridospermales:. b) Glossopteridales: c) Caytoniales : d) Cycadeoidales: e) Pentoxylales: f)	The students will be able to outline the general characters, classification, morphology, anatomy, interrelationships, phylogeny and evolution of gymnosperms and

	Cycadales: g) Ginkgoales: h)Cordaitalesi) Coniferales: j) Taxales: k) Ephedrales: l) Welwitschiales: m) Gnetales: 3. Evolution of gymnosperms 4. Distribution of living and fossil gymnosperms in India. 5. Economic importance of gymnosperm **References** Andrews Jr., H. N. 1961. Studies in Paleobotany. John Wiley, New York Arnold, C. A. 1953. Origin and relationships of the cycads. Phytomorphology 3: 51-65 Beck, C. B. 1985. Gymnosperm phylogeny: A commentary on the views of S.V. Meyen. Bot. Rev. 51: 273-294 Chamberlain, C. J. 1919. The Living Cycads. Chicago University Press, Chicago. Chemberlain, C. J. 1935. Gymnosperms: Structure and Evolution. Chicago University Press. Crepet, W. L. 1972. Investigations of North American cycadeoids: Pollination mechanisms in Cycadeoidea. Amer. J. Bot. 59: 1048-1056 Dallimore, W. & Jackson, A. B. 1966. A Handbook of Conifera. 4th edn, E. Arnold. Delevoryas, T. 1962. Morphology and evolution of fossil plants. New York. Favre-Duchartre, M. 1958. Ginkgo, an oviparous plant. Phytomorphology 8: 377-390 Freedman, W.E. 1992a. Double fertilization in non-flowering seed plants and its relevance to the origin of flowering plants. Intl. Rev. Cytol. 140: 319-355. Freedman, W. E. 992b. Evidence of a pre-angiosperm origin of endosperm: Implications for the evolution of flowering plants. Science 235: 336-339. Greguss, P. 1955. Identification of Living Gymnosperms based on Xylotomy. AkadKiado. Harris, T. M. 1951. The relationships of the Caytoniales. Phytomorphology 1: 29-39. Mehra, P. N. 1988. Indian Conifers: Gnetophytes and Phylogeny of Gymnosperms. Pramodh P. Kapur, Raj Bandhu Ind. Complex, New Delhi	their transition to angiosperms.

	Meyen, S. V. 1984. Basic features of gymnosperm: Systematics and phylogeny as evidenced by the fossil record. Bot. Rev. 50: 1-111 Meyen, S. V. 1986. Gymnosperm systematics and phylogeny: A reply to commentaries by CB Beck, CN Miller, and GW Rothwell. Bot. Rev. 52: 300-320 Millay, M. A., & Taylor, T. N. 1976. Evolutionary trends in fossil gymnosperm pollen. Rev. Palaeobot. Palynol. 21: 65-91. Miller Jr., C.N. 1977. Mesozoic confers. Bot. Rev. 43: 217-280 Pant, D. D. 1975. The classification of gymnospermous plants. Palaebot. 6: 65-70 Pearson HHW (1929) Gnetales, Cambridge Univ. Press, London Madhulata, Sanwal. 1962. Morphology and embryology of Gnetumgnemon L. Phytomorphology 12: 243-264 Scott, D. H. 1909. Studies in Fossil Botany, 2nd edn. Vol 1 A and C Black, London Scott, D. H. 1923. Studies in Fossil Botany, Vol 2. A and C Black, London. Sharma, B. D. 1994. Gymnosperms: Morphology, Systematics, Reproductive Biology, In: Johri, B.M. (ed.), Botany in India: History and Progress. Vol. 2. Oxford & IBH, New Delhi. pp 1-23. Singh, H. 1978. Embryology of Gymnosperms. Geb Borntrager, Berlin. Stewart, W.N. 1981. The Progymnospermospsida: The construction of a concept. Can. J. Bot. 59: 1539-1542. Stewart, W. N. 1983. Palaeobotany and the evolution of plants. Cambridge University Press	

Course Code& Title:	MSPSC01DSC02 ANATOMY AND MICROTECHNIQUE	Module Outcome
Course Objectives:	To study the internal organisation of plants and the techniques associated with the study.	
Module I **16 hrs**	**Anatomy:** Introduction -Internal organisation of plant body -Methods of studying the Anatomy of the plant. Meristems: Shoot apical meristem and functional zones, axillary floral and inflorescence meristems – structural diversity of the vegetative meristems. Cell differentiation: tracheary element differentiation, secondary wall formation, vascular differentiation, development of aerenchyma, development of laticifers. Origin and structure of secondary plant body: vascular cambium formation-structure and formation of vascular cambium, anomalous secondary growth-classification, origin and function, primary thickening meristem in monocots, secondary growth in arborescent Liliaceae. **References** Beck, C. B. (2005) An Introduction to Plant Structure and Development. Cambridge University Press. Esau, K. (1977) Anatomy of Seed Plants. 2nd edition. John Wiley & Sons. Fahn, A. (1990) Plant Anatomy. 4th edition. ButterworthHeinemann Ltd. Mauseth, J. D. (1988) Plant Anatomy. The Benjamin Cummings Publishing Co. Raghavan V. (1999) Developmental Biology of Flowering Plants. Springer.	The module aims to provide students with a thorough understanding of the anatomy of the plant body, the development and differentiation of plant cells and tissues, the differentiation, structure and function of vascular systems and the origin and structure of secondary plant body with various types anatomical adaptations during secondary growth
Module II **14 hrs**	Structure and function of vascular tissues: xylem - structure and water movement. Phloem - structure and metabolite translocation, transfer cells, phloem loading and unloading. Secondary cambium: classification, origin and constitution of cambium, cambial activity, cambium in wound healing and grafting, cork-cambium, origin and function. Root: development, structural organization of root apical meristem, developmental activities, developmental zones, longitudinal files of cells, Q. C. concept and	Students will get interrelated concept of the structure and function of vascular tissues, such as xylem and phloem, and their role in water and nutrient transport in plants. To comprehend development and

	pro-meristem concept. T- division. Leaf: development, structural diversity, anatomy of C3 and C4 plants. Ecological leaf anatomy, sun and shade leaves, xeromorphic leaves, succulent leaves, halophytic leaves and hydromorphic leaves. Stress anatomy: anatomy and pollution, anatomical response to water stress and mineral deficiency, effects of pollution, insecticides and herbicides. **References** Beck, C. B. (2005) An Introduction to Plant Structure and Development. Cambridge University Press. Esau, K. (1977) Anatomy of Seed Plants. 2nd edition. John Wiley & Sons. Fahn, A. (1990) Plant Anatomy. 4th edition. Butter worth Heinemann Ltd. Mauseth, J. D. (1988) Plant Anatomy. The Benjamin Cummings Publishing Co. Raghavan V. (1999) Developmental Biology of Flowering Plants. Springer.	diversity of root and leaf anatomy, and their adaptations to different ecological conditions. The course also examines the effects of stress factors, such as pollution, water deficiency, and mineral deficiency, on plant anatomy.
Module III 14hrs	**Microtechnique:** 1. Microscope-Construction and Use-Light microscope, Phase contrast and electron microscope, Micrometric measurements and camera lucida. 2. Microtomes: Rotary, Sledge, and Cryostat. 3. Processing procedure for micro preparation: (i) Fixation and Storage-Killing and fixing: Principle and purpose, Common chemical fixatives, their preparation and specific uses; FAA, Carnoy's fluid, acetic alcohol, CRAF, Nawashins fluid, and Zircle's fluid. (ii) Dehydration: Principle and procedure, Dehydrating agents – Ethyl alcohol, n-Butyl alcohol, Tertiary butyl alcohol, Isopropyl alcohol and Chloroform. Different dehydrating series: Alcohol-Xylene method, Alcohol-TBA method & Alcohol Chloroform method. (iii) Paraffin infiltration – use of embedding oven (iv) Embedding: Preparation of blocks. 'L' block and paper boat. (v) Sectioning of paraffin blocks using rotary microtome: Trimming individual blocks and section cutting. **References** Miksche, J. P. (1976). Botanical Microtechnique and Cytochemistry. Iowa State University Press.	Students will be familiarised with various types of microscopes, microtomes, and staining techniques to prepare and observe plant specimens. They will be exposed to the principles and procedures of fixation, dehydration, embedding, sectioning, mounting, and clearing of plant tissues

	Gahan, P. B. (1984) Plant Histochemistry. Academic Press. Jensen, W. A. (1962) Botanical Histochemistry. WH Freeman & Company. Johansen, D. A. (1940) Plant Microtechnique. McGraw Hill. Khasim, S. M. (2002) Botanical Microtechnique: Principles and Practice. Capital Publishing Company. Pearse, A. G. E. (1980) Histochemistry, Theoretical and Applied. 4th Edition, Vol. 1 & 2. Churchill Livingstone. Sanderson, J. B. (1994). Biological Microtechnique. Bios Scientific Publishers.	
Module IV **10 hrs**	Adhesives and their preparations. Mounting and spreading of paraffin ribbons on micro slides. Staining: Stains used in microtechnique; Classification – Natural – Hematoxylene, Carmine, Orcein.Synthetic (coal tar) – Basic: Safranin, Crystal violet, Basic fuchsin, Cotton blue - Acidic: Fast green, Orange G, Erythrosine, Eosin, and Toluidine blue.Staining procedure: Single, double and triple staining. Staining combination: safranin and fast green /cotton blue crystal violet and orange-G/erythrosine, Hematoxyline, and safranin. Techniques of clearing, mounting, labelling and storing of permanent slides.Whole mounts, Vein clearing, and tissue maceration. Histochemical staining: Localization of proteins, nucleic acids, insoluble carbohydrates & lipids. Enzyme histochemistry – General account. Vital staining: Principle, procedure, and applications. **References** Miksche, J. P. (1976). Botanical Microtechnique and Cytochemistry. Iowa State University Press. Pearse, A. G. E. (1980) Histochemistry, Theoretical and Applied. 4th Edition, Vol. 1 & 2. Churchill Livingstone. Sanderson, J. B. (1994). Biological Microtechnique. Bios Scientific Publishers. Krishnamoorthy K. V. (1999) Methods in Cell Wall Cytochemistry. C.R.C. Press.	The module enables students to acquire the knowledge and skills of using various adhesives, mounting techniques, and staining procedures to prepare and observe plant specimens. Train students to perform single, double, and triple staining, and to use various staining combinations to enhance the contrast and visibility of plant tissues Introduce students to the methods and applications of histochemistry, whole mounts, vein clearing, and tissue maceration techniques

Course Code & Title	MSPSC01DSC03 GENETICS AND EVOLUTION	Module Outcome
Course Objectives:	Understand the basic principles of genetics and heredity like Mendelian laws of inheritance, chromosome theory of inheritance, sex determination, linkage and mapping, extrachromosomal inheritance, prokaryotic genetics and population genetics.	
Module 1 **12 hours**	**Science of Genetics :** An overview of modern history of the science of Heredity-Classical, Molecular and Evolutionary Genetics-The discovery and re discovery of Genes. Probability factor in Mendelian genetics- A critical analysis. Chi- square analysis, pedigree analysis and probability. **Allelic interactions**- Incomplete Dominance and Codominance, Lethal Alleles, Hierarchy of Dominance, Multiple Alleles, Pleiotropy, **Non allelic interactions**-Epistasis Polygenic inheritance, Quantitative trait loci (QTL), Statistics of quantitative genetics- Heritability. Genetic analysis pathways-Complementation test for alleles, Penetrance and Expressivity, Genes and Environment-Genetics and society. **Chromosomal Basis of Inheritance**: Chromosomal theory of inheritance, Sex-linked traits, Pedigree analysis of sex-linked traits, Activation and inactivation of X-chromosome, Sex-influenced traits, Sex-limited traits, Sex Determination.	The students will be able to solve the problems related to allelic interactions and understand the chromosomal basis of inheritance
References Module I	1. Snustad PD, Simmons MJ. 2015. Principles of Genetics, 7th edition. Wiley. 2. Klug WS, Cummings MR, Spencer CA, Palladino MA, Darrell Killian. 2018. Concepts of Genetics, 12th edition. Pearson. 3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. 2015. Introduction to Genetic Analysis, 11th edition. W.H. Freeman & Worth Publishers. 4. Pierce BA. 2016. Genetics: A Conceptual Approach 6th edition. W. H. Freeman. Strickberger MW. 2015. Genetics, 3rd edition. Pearson. 5. Samuels ML, Witmer JA, Schaffner A. 2015. Statistics for the Life Sciences, 5th edition. Pearson. 6. Brooker R. 2017. Genetics: Analysis and Principles, 5th edition. McGraw-Hill Higher Education 7. Tamarin R, 7th edition. 2017. Principles of Genetics. McGraw Hill Education.	

	8. Elrod S, Stansfield W. 2010. Schaum's Outline of Genetics, 5th edition. McGraw-Hill	
Module 2 **12 hours**	**Linkage and Gene Mapping:** Linkage, Crossing over, Evolutionary significance ofrecombination, Two-point test cross, Three-point test cross, Genetic Mapping, Genetic mapping in Drosophila, Linkage and mapping using tetrads, Physical mapping, Application of mapping. **Eukaryotic chromosomes-structure, classification and organization**, Banding, karyotyping,Chromosomal aberrations. Extra chromosomal inheritance: Cytoplasmic inheritance, Mitochondrial DNA, interplay between mitochondria and nuclear gene products, Chloroplast DNA, chloroplast biogenesis, Origin and evolution of mitochondria and chloroplast, Maternal effect. Introduction to Epigenetic inheritance: Epigenetic inheritance, Genomic Imprinting and Anticipation	Students will be able to describe about the molecular, quantitative and evolutionary genetics.
References **Module 2**	1. Snustad PD, Simmons MJ. 2015. Principles of Genetics, 7th edition. Wiley. 2. Klug WS, Cummings MR, Spencer CA, Palladino MA, Darrell Killian. 2018. Concepts of Genetics, 12th edition. Pearson. 3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. 2015. Introduction to Genetic Analysis, 11th edition. W.H. Freeman & Worth Publishers. 4. Pierce BA. 2016. Genetics: A Conceptual Approach 6th edition. W. H. Freeman.	

Module 3 **12 hours**	**Methods of gene transfer in prokaryotes-** Transformation, Conjugation and Transduction mapping.Phage genetics and mapping. Developmental genetics- genetic control of development in plants- genetic control of cell lineages. Behavioural genetics- general account Applied genetics- Eugenics, euphenics and euthenics. Immunogenetics. **Evolutionary Genetics-Population genetics** Genetic variation in populations and measuring - changes in genetic structure, causes and consequences – speciation and evolution. Hardy - Weinberg Equilibrium, Sewall Wright effect, Inbreeding, Natural selection, inbreeding and co-ancestry.**Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.	Describe major evolutionary lineages of plants and their defining characteristics
References **Module 3**	1. Snustad PD, Simmons MJ. 2015. Principles of Genetics, 7th edition. Wiley. 2. Klug WS, Cummings MR, Spencer CA, Palladino MA, Darrell Killian. 2018. Concepts of Genetics, 12th edition. Pearson. 3. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. 2015. Introduction to Genetic Analysis, 11th edition. W.H. Freeman & Worth Publishers. 4. Pierce BA. 2016. Genetics: A Conceptual Approach 6th edition. W. H. Freeman. 5. Hartl DL, Clark AG. 2006. Principles of Population Genetics 4th edition. Sinauer Associates is an imprint of Oxford University Press. 6. Crow JF, Kimura M. 2009. An Introduction to Population Genetics Theory. The Blackburn Press. 7. Hedrick PW. 2010. Genetics of Populations, 4th edition. Jones & Bartlett Learning 8 Brooker R. J. Genetics: Analysis and Principles. Addison Wesley Longman Inc. 9 Hedrick P. W. Genetics of Populations. Jones and Bartlett Publishers.	
Module 4 **12 hours**	**Evolution** **History of development of early evolutionary principles-** Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.Neo Darwinism	The students will be able to explain the mechanisms which underlie

	The Origin and Early history of life: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. **Palaeontology and Evolutionary History**: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo sapiens. **Origin of species-**Species are the basic unit of evolution-Species maintain their genetic distinctiveness through the barriers to reproduction-clustures of species reflect rapid evolution. Adaptive radiation; Isolating mechanisms; Evolution and Speciation; -Allopatric and Sympatric; Convergent evolution; Sexual selection; Co-evolution. **Evolution and Plant diversification-**The universal tree of life-an overview-cladistics-From single cell organisms to Kingdoms-Early plant life-The algal ancestry-Bryophytes—Early vascular plants-origin of land plants-Angiosperms—The culmination of plant Evolution-The main line of plant evolution-Retrospect and prospect.	evolution at the molecular level.
References Module 4	1.Futuyma, Douglas J Evolution - Sunderland, Sinauer Associates, 2013 - 656p. 2.Guttman, Burton S. Evolution : a beginner's guide - Oxford Oneworld 2005. - 203p. 3.Young, David, The discovery of evolution - 2 - Cambridge ; New York : Cambridge University Press, in association with Natural History Museum, London, 2007. - viii, 281 p 4.Hall, Brian Keith, Strickberger's evolution - 5 - Burlington, Mass. Jones & Bartlett Learning, c2014. - xxvi, 644 p. ill. 5.Lull, Richard Swann Organic evolution - New York, The Macmillan Company, 2009 - 744p.ISBN:9788181160447 6.Ingrouille, Martin Plants : Diversity and Evolution - Cambridge : Cambridge University Press, 2006. - 440p. 7.Charles Darwin Origin of Species - New Delhi Goyl Saab - 479p. 8.Benton, M. J.Introduction to paleobiology and the fossil record - Chichester, UK Hoboken, NJ Wiley Blackwell, 2009. - xii, 592 p. 9. Delevoryas, Theodore Plant Diversification (2ndEdn),Halt,rinehart and winston 10. Dobzhansky, B (1961) Genetics and the origin of species Columbia University press,New york. 11. Simmonds N.W.(Ed)(1976) Evolution of crop plants. Longman London and NewYork	

	12.Stebins G.L(1950)Variation and Evolution in plants.Columbia University press, Newyork 13. StebinsG.L(1970) The process of organic evolution. prenticehall, new Delhi 14. Strwart W.N (1983) paleobotany and Evolution of plants-Cambridge University press. 15.Harlan.P.Banks(1972) Evolution and plants of the past,Macmillan 16. Jay.M.Savage (1977) Evolution .Halt,rinehart and winston,New York 17. Joan Eiger Gottlieb (1971) Plants Adaptation through evolution. 18.Delevoryas,Theodore-PlantDiversification(2nd Edn),Halt, Rinehart and winston 19. Dobzhansky,B(1961) Genetics and the origin of species Columbia University press,Newyork.	

Course Code:	MSPSC01DSC04 MYCOLOGY AND PLANT PATHOLOGY	Module Outcome
Course objectives:	1. To learn about major pathogen groups that infect plants 2. The impact of plant diseases on food security and ecosystems 3. To learn about how plant defend against the pathogens and how to manipulate plant pathogen interaction in favour of plants.	
Module I 12hrs	**Introduction:** Need to study plant diseases- important plant diseases that shaped the history of human civilization. 10 most important plant diseases of the world & India. Plant- Virus-Vector Interactions: Plant viral diseases, symptoms, major viral pathogens. Viral genomes, size and nature of proteins, viral replication within the host cell and viral movement from cell to cell within the host. Viral movement from plant to plant. Insect vectors involved in transmission, persistent and non-persistent transmission. Plant response to viral pathogens and resistance mechanisms. **References** Agrios, G. N. 2006. Plant Pathology, Academic Press. Dickinson,M. Molecular Plant Pathology. 2003. BIOS Scientific Publishers. J.S. Huang. 2001. Plant pathogenesis and resistance: biochemistry and physiology of plant-microbe interactions. Kluwer Academic.	The students will be able to acquire knowledge on diverse groups of viruses that affect plants
Module 12hrs	**Plant- Bacterial Interactions:** Plant bacterial diseases, classes of plant pathogenic bacterium, general symptoms. Alpha and beta proteobacterial phytopathogens (Agrobacterium and Ralstonia), gamma proteobacterial phytopathogens (Erwinia, Xanthomonas). Gram-positive and fastidious phytopathogenic bacteria: Clavibacter and Xylella. Plant pathogenic mycoplasmas. Quorum sensing, Virulence factors- Toxins, EPS, Cell wall degrading enzymes, type I, II, III and IV	The students will be able to Recognize the host and pathogen interaction

	secretion system. Regulation of Hrp genes, hairpins and type III effectors. Modes of transmission. Plant response to pathogenic bacteria. **References** Clarence I. Kado Plant Bacteriology, Published by American Psychopathological Society. Agrios, G. N. 2006. Plant Pathology, Academic Press. Dickinson,M. Molecular Plant Pathology. 2003. BIOS Scientific Publishers. J.S. Huang. 2001. Plant pathogenesis and resistance: biochemistry and physiology of plant-microbe interactions. Kluwer Academic.	
Module III **12 hrs**	**Plant –Fungal interactions:** Necrotrophic phytopathogenic fungi –Diseases, symptoms, mode of pathogenesis, Host selective toxins, non-host selective toxins, Genetics of toxin biosynthesis and toxin resistance, Plant susceptibility to toxins. Biotrophic phytopathogenic fungi – Diseases, symptoms, mode of pathogenesis, Specialized structures for nutrition, Effectors - apoplastic and cytoplasmic., Plant response to fungal infection and resistance. Quelling Importance of the plant diseases; the concept of plant disease; causes of plant diseases; classification of plant diseases; parasitism and pathogenesis; Koch's postulates; effect of the pathogen on the plants; symptoms of plant diseases; development of epidemics; plant disease management; major crop diseases of Kerala. **References** H.H. Prell and P. Day, Plant–Fungal Pathogen Interaction: A Classical and Molecular View; Published by Springer-Verla Agrios, G. N. 2006. Plant Pathology, Academic Press. Dickinson, M. Molecular Plant Pathology. 2003. BIOS Scientific Publishers.	Students will be able for handling disease free varieties and Implement the disease management techniques in the fields.

Module IV **12 hrs**	**Plant – Nematode interactions:** Classes of plant parasitic nematodes, feeding organs, Ecto and Endo parasitic nematodes, Nematode dissemination, important plant diseases caused by nematodes, Nematode effectors and host targets, Plant response to nematodes and resistance mechanisms. Plant interaction with parasitic plants. Plant Resistance and Susceptibility factors: Preformed defence, Host resistance and non-host resistance, Induced resistance and Systemic Acquired Resistance, PAMPS and PAMP Triggered Immunity (PTI), Effector Triggered Immunity (ETI), Effector Triggered Susceptibility (ETS). Theories and models on Plant Resistance to pathogens. Applied Plant Pathology: Methods of Plant pathogen diagnostics. Evolution of Plant-Pathogen interactions- its significance on breeding disease-resistant plants, Genetic engineering of Plants for resistance. **References** Roland N. Perry and Maurice Moens. Plant Nematology, Published by CABI	Students will be able to understand how plant defend against the pathogens and how to manipulate plant pathogen interaction in favour of plants.

Course Code and Title	MSPSC01DSE01 METHODOLOGY AND PHILOSOPHY OF SCIENCE	Module Outcome
Course Objectives	i) Understand what science is and in what ways science differs from non-science and pseudoscience subjects ii) Understand the different methods of reasoning in Science. iii) Get an idea about the modes of scientific explanations. iv)Understand the role of paradigm shifts in various branches of scientific research; also get an idea about the scientific revolutions in various branches of science v) Understand the value, its acceptance and the criticism to Science. vi)Understand the historical milestones in the evolution of scientific thoughts and research. vii)Distinguish between different centuries concerning the growth of science and scientific thoughts.	
Module I **12hrs**	**1.What is science?** Scientific knowledge-Streams of Science-Basic and applied science- A summary of the History of science - Science and society – Science as a human activity - Origin of modern science. Philosophy of Science- A brief Historical introduction-definition, scope and the evolution of concepts - Science and pseudo-science. **2. Scientific Method and Reasoning** Scientific method - Observations, pieces of evidence and proofs- Hypothetico-deductive model, Inductive model home's problem of induction-Significance of verification (proving) - corroboration and falsification (disproving)- Positivism. Karl popper and the concept of falsification. Realism and Antirealism- Observable and unobservable distinctions. **3. Explanation in science** Hempel's covering law model of explanation - The problem of symmetry Explanation and causality -	To understand what science is and in what ways science differs from non-science and pseudoscience subjects and Students will be able to understand the different methods of reasoning in Science.

	Can science explain everything? -Explanation and Reduction.	
Module II **10hrs**	**4. Scientific Change and Scientific Revolutions** Logical positivist philosophy of science – Empiricism-New Paradigms and Scientific Change -The structure of scientific revolutions - Incommensurability and theory-ladenness of data - Thomas Kuhn and the rationality of science **5. Scientific temper and its fostering.** Critical thinking and logical reasoning in science. Science and its critics- Science as just one narrative -scientism- Science and religion debates, Science and values. Is Science value-free?	Understand the historical milestones in the evolution of scientific thoughts and research.
Module III **14hrs**	**Experimentation in science** Introduction-Selecting a problem-Hypothesis-auxiliary hypothesis and ad-hoc hypothesis. Experimental Design-Variables-Correlation and causality-sampling—control in experiments.-Experimental bias-performing experiments-Measurement error. **Philosophy of Biology.** What is biology? -The nature and logic of biological sciences -Logic of life. -Molecular logic of life-Problems of Biological classification — biological species concept- Evolution and Natural selection- Function and adaptation-The gene-centric view of evolution- Philosophical issues in Genetics - Classical and Molecular -Genes and information -Genetic determinism. Reductionism in Biology – argument from molecular biology-Ecological concepts- Anthropocentric and Ecocentric- Deep and Shallow - Biological determinism. Biology and Ethics. -Early history and development of methods in Biology.	Get an idea about the modes of scientific explanations based on experiments

Module IV **12hrs**	**History of Biology in the Seventeenth century:** Anatomists, Microscopists History of Biology in the Eighteenth century: Carolus Linnaeus-The founder of biological Taxonomy; Precursors to modern evolutionary theory- Lamarck and Cuvier **History of Biology in the Nineteenth century:** Birth of associations and societies to promote science; Charles Darwin; Pre-Darwinian evolution; Origin of species-Gregor Mendel's Experiments - The emergence of biological disciplines; Experimental Physiology; Cell theory, cell pathology and germ theory. **History of Biology in the Twentieth century:** The first half of 20thcentury: Growth of microbiology and Biochemistry; Genetics and heredity Second half of 20thcentury: The architects of life - proteins, DNA and RNA; The origins and borderlines of life; Growth of genetic engineering; Growth of Biotechnology; Growth of Genomics; Growth of Recombinant DNA.	The students will have an understanding of the ups and downs in the history of science, the pace of scientific research during the 17th to 20th Centuries, contributions made by scientists in the past centuries and the methods and philosophy behind scientific experimenting.
REFERENCES	**Philosophy of Science** 1. Alan Chalmers. What is this thing called science? University of Queensland Press, Open University Press, 3rd revised edition, Hackett,1999 2. Elliott Sober. Philosophy of Biology, West view press2000 3. Richard Dewitt. Worldviews: an introduction to history and philosophy of science. Blackwell publishing 2004. 4. Boyd, R., Gasper, P., and Trout, J.D. (eds., 1991), The Philosophy of Science, Blackwell Publishers, Cambridge, MA. 5. Glaze brook, Trish (2000), Heidegger's Philosophy of Science, Fordham University Press. 6. Gutting, Gary (2004), Continental Philosophy of Science, Blackwell Publishers, Cambridge, MA. **History and Philosophy of Biology** 1. Allen, Garland E. Thomas Hunt Morgan: The Man and His Science. Princeton University Press: Princeton, 12 1978. ISBN 0-691-08200-6 2. Allen,	

Garland E. Life Science in the Twentieth Century. Cambridge University Press,1975.
3. Annas, Julia Classical Greek Philosophy. In Boardman, John; Griffin, Jasper; Murray, Oswyn (ed.) The Oxford History of the Classical World. Oxford University Press: New York, 1986. ISBN0-19-872112-9
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8. Coleman, William Biology in the Nineteenth Century: Problems of Form, Function, and Transformation. Cambridge University Press: New York, 1977. ISBN0-521-29293-X
9. de Chadarevian, Soraya. Designs for Life: Molecular Biology after World War II. Cambridge University Press: Cambridge, 2002. ISBN0521570786
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12. Kay, Lily E. The Molecular Vision of Life: Caltech, The Rockefeller Foundation, and the Rise of the New Biology. Oxford University Press: New York, 1993. ISBN0-19-511143-5
13. Larson, Edward J. Evolution: The Remarkable History of a Scientific Theory. The Modern Library: New York, 2004. ISBN0-679-64288-9
14. Lennox, James (2006-02-15). "Aristotle's Biology". Stanford Encyclopedia of Philosophy.

	15. Lovejoy, Arthur O. The Great Chain of Being: A Study of the History of an Idea. Harvard University Press, 1936. Reprinted by Harper & Row, ISBN 0-674-36150-4, 2005 paperback: ISBN0-674-36153-9. 16. Magner, Lois N. A History of the Life Sciences, third edition. Marcel Dekker, Inc.: New York, 2002. ISBN 0-8247-0824-5 17. Mason, Stephen F. A History of the Sciences. Collier Books: New York,1956. 18. Mayr, Ernst. The Growth of Biological Thought: Diversity, Evolution, and Inheritance. The Belknap Press of Harvard University Press: Cambridge, Massachusetts, 1982. ISBN0- 674-36445-7 19. Mayr, Ernst and William B. Provine, eds. The Evolutionary Synthesis: Perspectives on the Unification of Biology. Harvard University Press: Cambridge, 1998. ISBN0-674-27226-9 20. Morange, Michel. A History of Molecular Biology, translated by Matthew Cobb. Harvard University Press: Cambridge, 1998. ISBN0-674-39855-6 21. Secord, James A. Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of Vestiges of the Natural History of Creation. University of Chicago Press: Chicago, 2000. ISBN0-226-74410-8 22. Serafini, Anthony The Epic History of Biology, Perseus Publishing, 1993. Sulston, John. The Common Thread: A Story of Science, Politics, Ethics and the Human Genome. National Academy Press, 2002. ISBN 0309084091 23. Smocovitis, Vassiliki Betty. Unifying Biology: The Evolutionary Synthesis and Evolutionary Biology. Princeton University Press: Princeton, 1996. ISBN0-691-03343-9 24. Spangenburg R and D K Moser. History of Science from the Ancient Greeks to the Scientific Revolution. 2000. Universities Press. 25. Spangenburg R and D K Moser. History of Science in the 18thCentury. 2000. Universities Press.	

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Course Code& Title	MSPSC01DSC05 PRACTICAL 1 BIOLOGY OF ARCHEGONIATE, ANATOMY OF ANGIOSPERM AND MICROTECHNIQUE	Module Outcome
Course Objectives	To gain knowledge on the diversity, structural organization and reproduction of algae, Bryophytes, Pteridophytes and Gymnosperms To compare the similarities and differences in these groups To acquire knowledge about the anatomical features of Plants	
Module I **24hrs**	**Module I. Algae and Bryophytes** **Algae** 1. Collection, preparation and presentation of algal herbarium (minimum 5 herbarium sheets). 2. Field collection and study of the types mentioned below and their classification up to generic level. Cyanobacteria: Nostoc, Anabaena Chlorophyta: Cosmarium, Cladophora, Pithophora, Bryopsis, Codium, Xanthophyta: Botrydium, Vaucheria. Bacillariophyta: Pinnularia, Navicula Phaeophyta: Padina, Sargassum, Rhodophyta: Gracilaria, Batrachospermum, Bryophytes: Field collection, Morphological and structural study of the following genera: Asterella, Cyathodium, Anthoceros, Bryum, Pogonatum, Porella, Marchantia.	**Module I. Algae and Bryophytes** The module aims to teach students how to collect, prepare, and present algal and bryophyte specimens for taxonomic and morphological study. The course also covers the identification and classification of various genera of algae and bryophytes, based on their external and internal features. The course also introduces students to the diversity and distribution of algae and bryophytes in different habitats.
Module II **20 hrs**	**Pteridophytes** 1. Morphological, anatomical and reproductive features of Lycopodium, Isoetes, Angiopteris, Osmunda, Lygodium, Salvinia. 2. Fossils: Rhynia, Lepidodendron, 3. Habitat study of Lycopodium, Selaginella, Actiniopteris, Drynaria and Salvinia. 4. Spore germination and development of prothallus in Knop's Agar medium. 5. Submission of a field study report and 5 herbarium specimens of common, local pteridophytes.	**Module II. Pteridophytes** The module aims equip students to observe and analyze the morphological, anatomical, and reproductive features of various pteridophytes. It also covers the identification and classification of different orders and genera of pteridophytes, based on

		their external and internal characteristics. The course also trains students to perform spore germination and prothallus development experiments in laboratory conditions.
Module III **20 hrs**	**Module III. Gymnosperms:** 1. Identification of petrifactions, compressions, impressions, slides of fossil types included in gymnosperm groups mentioned above 2. Comparative study of vegetative and reproductive structures of Zamia, Araucaria, Cupressus, Podocarpus and Ephedra (living gymnosperms) 3. Morphological and anatomical studies of the above-mentioned taxa	**Module III. Gymnosperms:** After completing this modulestudents will be able to identify mentioned gymnosperms using morphological and anatomical characters of vegetative and reproductive structures
Module IV **30 hrs**	**Anatomy of Angiosperms and Microtechnique** Anomalous secondary growth: Dracaena, Bignonia, Amaranthus, Nyctanthes, Mirabilis, Bougainvillea and beetroot. **Leaf anatomy**: C3 and C4 plants, succulents, xeromorphic leaves, halophytes and hydrophytes. Stomata: types, stomatal index. **Microtechnique:** Preparation of stained permanent slides of the following: Whole mounts, freehand sections, maceration and serial microtome sections using double, triple, and histochemical staining procedures. At least twenty permanent micro preparations representing whole mounts, freehand sections and serial sections should be submitted for evaluation	**Module IV. Anatomy of Angiosperms and Microtechnique** The course aims to train students to prepare and identify sections of plant tissues that show anomalous secondary growth. The course also covers the microtechnique skills of preparing stained permanent slides of various plant tissues, using whole mounts, freehand sections, maceration, and serial microtome sections. The course also trains students to use different types of staining procedures, such as double, triple, and histochemical staining.
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Scott, D. H. 1923. Studies in Fossil Botany, Vol 2. A and C Black, London.
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Anatomy and Microtechnique

Beck, C. B. (2005). An Introduction to Plant structure and Development. Cambridge University Press.
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Course Code& Title	MSPSC01DSC06 PRACTICAL 2: GENETICS, MYCOLOGY AND PLANT PATHOLOGY	Module Outcome
Course Objectives	To learn about major pathogen groups that infect plants To analyse the impact of plant diseases on food security and ecosystems Apply quantitative problem-solving skills to genetics problems and issues.	
Module 1 **36 hrs**	**Genetics**: **Independent assortment**-Systems for solving dihybrid crosses. **Genetic Interactions-**Two factor interactions-Epistatic interactions-Non Epistatic Interactions-Multiple allelism and Quantitative genetics. **Linkage and chromosome Mapping**,Tetrad analysis in Ascomycetes-Recombination Mapping with Tetrads **The Binomial and Chi square distributions-**Testing genetic ratios. **Genetics of Microorganisms**-Problems on prokaryotic chromosome mapping **Population genetics-** Calculating gene frequencies	The students will be able to apply the basic principles of genetics for genetic improvement of plants.
Module 2 **20 hrs**	**Mycology** 1. Plant disease symptoms: recognition and identification 2. Isolation of pure culture of a fungal plant pathogen from a diseased plant. 3. Application of Koch's postulate 4. Preparation of culture media 5. Isolation of fungi from soil by dilution-plate method. 6. Isolation of fungi from dung.	The students will be able to recognize the host and pathogen interaction
Module 3 **20 hrs**	**Study of morphology and anatomy of the reproductive structures of the following genera of fungi**: *Phytophthora, Pythium, Albugo, Pilobolus, Glomus, Mucor, Rhizopus, Saccharomyces, Taphrina, Ascobolus, Xylaria, Trichoglossum, Phomopsis, Drechslera, Aspergillus, Penicillium,*	The students will get a knowledge on disease forecasting and management.

	Alternaria, Cercospora, Fusarium, Tremella, Auricularia, Puccinia.	
Module 4 **14 hrs**	**Plant pathology** 1. Study of the symptoms and signs of the following plant diseases in the laboratory and in the field and identification of the pathogens: abnormal leaf fall of rubber, coffee rust, plumeria rust, blister-blight of tea, quick wilt of pepper, white rust of amaranth, Cercospora leaf-spot of okra, powdery mildew of any locally available crop, rice blast, brown spot of rice, whip-smut of sugar cane, soft rot of carrot, sesamum phyllody, cassava mosaic. 2. Molecular diagnostics of plant-pathogen using PCR 3. Detection of plant virus using ELISA	The students will be able to analyze the plant-pathogenic interaction and implement the disease management techniques in the fields.
REFERENCES	**References** Kowles R. Solving Problems in Genetics. Springer. Sambamurthy A. V. S. S. Genetics. Narosa Publishing House. Brooker R. J. Genetics: Analysis and Principles. Addison Wesley Longman Inc. Hedrick P. W- Genetics of Populations. Jones and Bartlett Publishers. Griffiths A. J. F., Gelbbart W. M., Lewontin R. C., Miller J. H.- Modern Genetic Analysis. W.H. Freeman & Company. Dabholkar A. R. Elements of Biometrical Genetics. Concept Publishing Company. Frankel O. H. and Bennet E. Genetic Resources in Plants. Blackwell. Hotter P. Textbook of Genetics. Ivy Publishing House. Satpathy G. C. Genetics. Kalpaz Publications. Joshi R. M. Biosafety and Bioethics. Isha Books. Pagano M. and Gauvreau K. Principles of Biostatistics. Duxbury. Panse V. G. and Sukhatme, P. V. Statistical Methods for Agricultural Workers. ICAR. Rangaswamy R. A Text Book of Agricultural Statistics. New Age International Publishers. Jasra P. K. Biostatistics. Krishna Prakashan Media (P) Ltd	

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SECOND SEMESTER

DISCIPLINE SPECIFIC CORE COURSES (DSC)		
Course Code and Title	**MSPSC02DSC07** **TAXONOMY AND ADVANCED PLANT SYSTEMATICS** **Credits – 3 (45 hrs)**	**Module Outcome**
Course Objectives:	▪ To make students familiar with the foundations of plant systematics, methods used and the research goals of a systematic study. ▪ To make students familiar with the concepts and the terminology used in plant systematics including modern molecular systematics. ▪ To present the most recent knowledge of evolutionary relationships of plants as well as practical information vital to the field.	
Module I 12 hrs	Taxonomy: Definitions, Objectives, Importance, Scope. Conceptual bases of the classifications of the following: Bentham & Hooker, Engler & Prantl, Hutchinson & Overview of APG System of classification. Taxonomic structure, taxonomic hierarchy, taxonomic categories - supra specific and infraspecific categories; Concept of species, genus and family. Taxonomic characters: Concept of character, character variations and their taxonomic implications. Plant description terminologies; method of describing a plant species using morphological characters. **References** 1. Cronquist, A. (1988). The evolution and classification of flowering plants. New York Botanical Garden Press. 2. Dahlgren, R. M. T., Clifford, H. T., & Yeo, P. F. (1985). The families of monocotyledons. Springer-Verlag. 3. Davis, P. H., & Heywood, V. H. (1973). Principles of angiosperm taxonomy. Robert Krieger Publishing Co. 4. Harris, J. G., & Harris, M. W. (2007). Plant identification terminology. Spring Lake Publishing. 5. Hutchinson, J. (1959). The families of flowering plants. Oxford. 6. Webster, J. E. (2002). Describing plant species. Bishen Singh Mahendrapal Singh.	• Students will be able to describe the key similarities, differences, benefits, and limitations of classification systems of Bentham & Hooker, Engler & Prantl, Hutchinson, and the APG system. • Students will be able to describe plants using standard description terminologies/technical terms.
Module II 12 hrs	Plant Nomenclature: Brief History on the origin and development of nomenclature; detailed study of the major provisions of the International Code of Nomenclature for Algae, Fungi and	• Students will be able to explain the origin and development of plant nomenclature,

	Plants (ICN) Major changes from the preceding Code- Effective and Valid Publication, Rule of Priority and its limitations, Typification, Different kinds of types, Author citation, Rejection and retention of names, Conserved names; Nomenclature of hybrids; Nomenclature of cultivated plants. Common technical terms used in Plant nomenclature. **References** 1. Simpson, M. G. (2006). Plant systematics. Elsevier Academic Press. 2. Sivarajan, V. V. (1991). Introduction to the principles of plant taxonomy (2nd ed.). Oxford & IBH Publishing Co. 3. Sivarajan, V. V., & Robson, N. S. K. (Eds.). (1991). Introduction to the principles of plant taxonomy (2nd ed.). Oxford & IBH Publishing Co. 4. Naqshi, A. R. (1993). An introduction to botanical nomenclature. Scientific Publishers. 5. Radford, A. E. (1986). Fundamentals of plant systematics. Harper & Row. 6. Lawrence, G. H. M. (1951). Taxonomy of vascular plants. Oxford and IBH Publishing Co. 7. McNeill, J., et al. (2006). International code of botanical nomenclature (ICBN) (Vienna code). A.R.G. Gautner Verlag K.G. 8. Janick, J., et al. (2002). International code of nomenclature of cultivated plants. International Society for Horticultural Science. 9. Turland, N. J., Wiersema, J. H., Barrie, F. R., Greuter, W., Hawksworth, D. L., Herendeen, P. S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T. W., McNeill, J., Monro, A. M., Prado, J., Price, M. J. & Smith, G. F. (eds.) 2018: International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile 159. Glashütten: Koeltz Botanical Books. DOI https://doi.org/10.12705/Code.2018	summarize the major provisions of the code (ICN) and to identify the major changes from the preceding codes. • Students will be able to explain the concepts of effective and valid publication, the rule of priority, typification, the process of rejection and retention of names.
Module III **11 hrs**	Practical identification of plants: Different kinds of Identification keys, Construction of dichotomous keys- Indented and bracketed keys. Various kinds of Taxonomic literature:	• Students will be able to construct and use dichotomous keys.

	Floras, Revisions, Manuals, Monographs, Periodicals and Journals. Methods of plant exploration; Management of Herbaria; Major Herbaria in India and the World; Role of Herbaria in taxonomy. Floristic studies in India; Major centres of taxonomic and floristic studies in India; Organization and functions of the Botanical Survey of India. Botanical Gardens: Role of taxonomy in biodiversity conservation. **References** 1. Harris, J. G., & Harris, M. W. (2007). Plant Identification Terminology. Spring Lake Publishing. 2. Radford, E. A. (1986). Fundamentals of Plant Systematics. Harper & Row Publishers. 3. Simpson, M. G. (2006). Plant Systematics. Elsevier. 4. Sivarajan, V. V. (1991). Introduction to the Principles of Plant Taxonomy. Oxford & IBH Publishing Co. Pvt. Ltd. 5. Stace, C. A. (1989). Plant Taxonomy and Biosystematics. Edward Arnold. 6. Mc Neill, J., Barrie, F. R., Buck, W. R., Demoulin, V., Greuter, W., Hawksworth, D. L., & Redhead, S. A. (2006). International Code of Botanical Nomenclature (Vienna Code). A.R.G. Gautner Verlag K.G. 7. Janick, J., Bailey, W. R., Whipkey, A., Simon, P. W., & Booth, K. O. (2002). International Code of Nomenclature of Cultivated Plants. International Society for Horticulture Science. 8. Naqshi, A. R. (1993). An introduction to Botanical Nomenclature. Scientific Publishers. 9. Stuessy, T. F. (2009). Plant taxonomy: the systematic evaluation of comparative data (2nd ed.). Columbia University Press.	• To name the major herbaria in India and the world and explain their role in taxonomy. • They will be able to describe important floristic studies in India and identify the major centers of taxonomic and floristic studies.
Module IV **10 hrs**	Modern trends in Plant Taxonomy: Biosystematics, Numerical Taxonomy: Phenetics and Cladistics; Cladistic methodology; Molecular Taxonomy; Phylogenetic systematics-basic principles. A brief account of DNA barcoding in plants. Sources of taxonomic characters: Morphology, Anatomy, Embryology, Cytology, Palynology and Phytochemistry.	• Students will be able to define and explain the concepts of taxonomy, biosystematics, numerical taxonomy, cladistics, molecular taxonomy, and phylogenetic systematics.

	References 1. Kitching, I. J. et al. (1998). Cladistics – the theory and practice of Parsimony Analysis. Oxford University Press. 2. Douglas, E., & Soltis et al. (2005). Phylogeny and Evolution of Angiosperms. Sinauer Associates Inc. 3. Smeath, P. H. A., & Sokal, R. R. (1973). Numerical Taxonomy. WH Freeman & Co. 4. Hollingsworth, P. M., Bateman, R. M., & Gornall, R. J. (1999). Molecular systematics and Plant Evolution. Taylor and Francis, London. 5. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. A., & Donoghue, M. J. (2002). Plant Systematics: A Phylogenetic Approach. Sinauer Associates, Inc. 6. Salemi, M., & Vandamme, A.-M. (Eds.) (2003). The Phylogenetic Handbook. A Practical Approach to DNA and Protein Phylogeny. Cambridge University Press. 7. Simpson, M. G. (2006). Plant Systematics. Elsevier. 8. Stace, C. A. (1989). Plant Taxonomy and Biosystematics. Edward Arnold. 9. Radford, E. A. (1986). Fundamentals of Plant Systematics. Harper & Row Publishers. 10. Lawrence, G. H. M. (1951). Taxonomy of Vascular Plants. Oxford and IBH Publishing Co. 11. Sivarajan, V. V. (1991). Introduction to the Principles of Plant Taxonomy. Oxford & IBH Publishing Co. Pvt. Ltd.	• Students will be able to identify the importance of different sources of taxonomic characters, including morphology, anatomy, embryology, cytology, palynology, phytochemistry and molecular biology. • Students will be able to list and explain the important steps in DNA barcoding of plants

Course Code:	MSPSC02DSC08 CELL AND MOLECULAR BIOLOGY Credits – 3 (45 hrs)	Module Outcome
Course objectives:	To study the organization of the cell and the molecules of heredity. To study cell and their components To understand the structure, organisation and functions of Nucleic acids To understand gene expression and regulation To study the basic techniques involved in cell and molecular biology	
Module I **11 hrs**	**Introduction:** Cell Biology: Introduction to the study of cell biology-The Discovery of cells, cellular properties and organization- the size of cells- visualizing cells- History of the Progress of cell Biology-the Development of the cell theory- pre cellular evolution-Modern cell Biology. Cell structure in eukaryotes and prokaryotes, cell organelles and their ultra-structure, functions, cytoskeleton, cytoplasmic streaming and cell adhesion, Cell communication: junctions between cells and cell signalling, Cell membranes: membrane dynamics and solute transport across membranes. Structural organization of chromosomes: Structural organization of chromosomes in Prokaryotes and Eukaryotes. Structural hierarchy of chromosomes. packaging the DNA - Chromatin reticulum- Heterochromatin and Euchromatin- Chromosome morphology- fine structure -Organisation of Centromeres and telomeres. Cell Division: Interphase: preparing for mitosis (G1, S and G2) and M phases- Significance of G0 - Cell cycle and Regulation. Mitosis, Meiosis. **References** 1. Gerald Karp 2013. Cell and Molecular Biology: Concepts and Experiments. 7th Edition, Wiley, NJ, USA. 2. Geoffrey M. Cooper & Robert E. Hausman 2013. The Cell: Molecular Approach, 6th	The students will be able to acquire knowledge on cell signalling and the regulation of cell division.

	Edition, Sinauer Associates, Inc., Sunderland, USA. 3. Harvey Lodish, Arnold Berk, Chris A. Kaiser & Monty Krieger 2012 Molecular 4. Cell Biology. 7th Edition, W. H. Freeman, NY, USA. 5. Jeff Hardin, Gregory Paul Bertoni& Lewis J. Kleinsmith 2011. Becker's World of the Cell. 8th Edition, Benjamin Cummings, San Francisco, California, USA. 6. Stephen R. Bolsover, Elizabeth A. Shephard, Hugh A. White & Jeremy S. Hyams 2011. Cell Biology: A Short Course Wiley-Blackwell, NJ, USA. 7. Bruce Alberts, Dennis Bray, Karen Hopkin & Alexander D Johnson 2009. Essential Cell Biology.3rd Edition, Garland Science, NY, USA.	
Module II **11 hrs**	**Nucleic acids:** Structural organization of genetic material in Prokaryotes and Eukaryotes. Structure, composition and function of DNA and RNA. Different types of RNA, mRNA, tRNA, rRNA, snRNA, snoRNA, miRNA, Xist RNA, siRNA, Mechanism of DNA replication: DNA polymerase I, Il, Ill, DNA gyrases, topoisomerases, ligases, initiation of replication, roles of RNA polymerase (primase) and replisome complex, the current concept of DNA replication in prokaryotes and eukaryotes. **DNA Mutation and Repair**. Types of DNA mutations-DNA alterations that lead to mutations-- DNA damaging agents-Molecular basis of mutation- tautomeric shift, alkylating agents, base analogues. **Mechanism of DNA Repair**-Direct repair-Base Excision repair -Nucleotide excision repair-Mismatch repair-Recombinational DNA repair and Homologous recombination **Transposons** - Characteristics-Transposons (Tn) and insertion sequences (Is) - Basic components of bacterial Transposons, Mechanism of transposition, Retrotransposons, LINES and SINES.	The students will be able to study the structure, alteration and repair mechanisms of Nucleic acids

	References 1. James D. Watson, Tania A. Baker, Stephen P. Bell & Alexander Gam 2013. Molecular Biology of the Gene. 7th Edition, Benjamin Cummings, San Francisco, California, USA. 2. Burton E. Tropp 2012. Molecular Biology: Genes to Proteins. 4th Edition, Jones & Bartlett, Burlington, USA. 3. Jocelyn E. Krebs, Elliott S. Goldstein & Stephen T. Kilpatrick 2012. Lewin's GENES Xl. Jones & Bartlett, Burlington, USA. 4. Robert F. Weaver 2011. Molecular Biology 5th Edition, McGraw-Hill, NY, USA. I I. 5. Michael M. Cox, Jennifer Doudna & Michael O'Donnell 2011. Molecular Biology: Principles and Practice. W. H. Freeman, NY, USA.	
Module III **11 hrs**	**Gene expression**: The genetic code, one gene-one polypeptide- Experiments conducted to decipher the genetic code, salient features, exceptions. Transcription - General features of transcription, transcription unit, Current concepts of transcription in prokaryotes and eukaryotes, Regulatory sequences and transcription factors involved, Post-transcriptional modifications. Translation - Basic structure of proteins, ribosomes, tRNA. Wobble hypothesis, Mechanism of translation and factors involved in prokaryotes and eukaryotes, factors affecting translation accuracy, non-ribosomal peptide synthesis. **References** 1. James D. Watson, Tania A. Baker, Stephen P. Bell & Alexander Gam 2013. Molecular Biology of the Gene. 7th Edition, Benjamin Cummings, San Francisco, California, USA. 2. Burton E. Tropp 2012. Molecular Biology: Genes to Proteins. 4th Edition, Jones & 3. Bartlett, Burlington, USA. 4. Jocelyn E. Krebs, Elliott S. Goldstein & Stephen T. Kilpatrick 2012. Lewin's 5. GENES Xl. Jones & Bartlett, Burlington, USA.	Students will be able for handling disease free varieties and Implement the disease management techniques in the fields.

	6. Robert F. Weaver 2011. Molecular Biology 5th Edition, McGraw-Hill, NY, USA. I I. Michael M. Cox, Jennifer Doudna& Michael O'Donnell 2011. Molecular Biology: Principles and Practice. W. H. Freeman, NY, USA. 7. Nancy Craig, Orna Cohen-Fix, Rachel Green and Carol Greider 2010. Molecular 8. Biology: Principles of Genome Function. Oxford University Press, USA.	
Module IV **12 hrs**	**Regulation of gene expression**: Regulation in prokaryotes- Constitutive, Inducible and Repressible expression, positive and negative control. Induction and catabolite repression in Lac operon, repression and attenuation in trp operon, Translational and post-translational regulation. Lysogenic and lytic switches in lambda phage. Regulation in Eukaryotes - Regulation at the chromatin level, Epigenetic changes at the chromosome level, genome imprinting, transcriptional gene regulation, epigenetic mechanisms of transcriptional gene regulation, regulation by cis acting control elements, alternative promoters, trans-acting factors, transcriptional activator proteins, enhancers, silencers, post-transcriptional gene regulation including alternative splicing, RNA editing, RNA interference, Riboswitches, RNA stability, the role of RNA-decaying factors in gene regulation, translational regulation, post translational control, protein processing, proteasome complex and protein degradation. **References** 1. James D. Watson, Tania A. Baker, Stephen P. Bell & Alexander Gam 2013. Molecular Biology of the Gene. 7th Edition, Benjamin Cummings, San Francisco, California, USA. 2. Burton E. Tropp 2012. Molecular Biology: Genes to Proteins. 4th Edition, Jones & Bartlett, Burlington, USA. 3. Jocelyn E. Krebs, Elliott S. Goldstein & Stephen T. Kilpatrick 2012. Lewin's GENES Xl. Jones & Bartlett, Burlington, USA. 4. Robert F. Weaver 2011. Molecular Biology 5th Edition, McGraw-Hill, NY, USA. II.	Students will be able to understand how plant defend against the pathogens and how to manipulate plant pathogen interaction in favour of plants.

	5. Michael M. Cox, Jennifer Doudna& Michael O'Donnell 2011. Molecular Biology: Principles and Practice. W. H. Freeman, NY, USA. 6. Nancy Craig, Orna Cohen-Fix, Rachel Green and Carol Greider 2010. Molecular **7.** Biology: Principles of Genome Function. Oxford University Press, USA.	

Course Code & Title:	MSPSC02DSC09 **PLANT PHYSIOLOGY AND BIOCHEMISTRY** **Credits – 3 (54 hrs)**	**Module Outcome**
Course Objectives:	▪ Upon completion of this course, students will be able to explain and demonstrate the structure and function of the basic building blocks of life - the chemical components of living organisms especially plants. ▪ This course aims to provide students with an understanding of the core topics and advanced integrated knowledge in plant biochemistry and physiology.	
Module I **16 hrs**	**Introduction to Biochemistry** Biochemistry and organization of cells - Molecular logic of life - Chemical unity and biological diversity - Hierarchy of Molecular Organisation -Bioenergetics and Laws of thermodynamics-Energy transformations and coupled reactions-chemi osmotic synthesis of ATP. **Nucleotides and Nucleic acids**: Functions of nucleotides, nucleotide biosynthesis by de novo pathways and salvage pathways; Purine and Pyrimidine metabolism **Lipids**: Classification of lipids; Occurrence and properties of fatty acids, Fatty acid metabolism-Oxidation of fatty acids- Biosynthesis of fatty acids. Glycolipid, Lipid biosynthesis: Membrane phospholipids, Triacylglycerols, Cholesterol, Steroids and Isoprenoids. **Carbohydrate and Glycobiology-** Structure and classification- Monosaccharides, Oligosaccharides and Polysaccharides; Biological functions, Glycoproteins, Proteoglycans; **Metabolism**: Glycolysis, TCA cycle, Pentose phosphate pathway, oxidative phosphorylation; Gluconeogenesis; Cyanide insensitive respiration; Anaerobic respiration. Sucrose synthesis and breakdown, starch structure and metabolism **Plant cell wall polymers**: structure elucidation, degradation, Cellulose, Hemicellulose, Pectin, Lignin. **References** 1. Beck, C. B. (2005) An Introduction to Plant Structure and Development. Cambridge University Press.	• To learn the structure and function of essential biomolecules and their key chemical and physical properties. • To understand the biochemical mechanisms underlying the metabolism of plants.

	2. Stumpf, P. K. and Conn, E. E (1980). The Biochemistry of Plants: A Comprehensive Treatise. Academic Press. 3. Taiz, L. and Zeiger, E. (2002). Plant Physiology. The Benjamin Cummings Publishing Corporation Inc. 4. Wilkins, M. B. (1984). Advances in Plant Physiology. Longman Scientific & Technical. 5. Nelson, David L and cox Michael M Cox (2021)-Lehlinger Principles of Biochemistry(7th edn) W.H. Freeman. 6. Lehninger L.Albert (1970) Principles of Biochemistry 7. Voet D and Voet J.G (2010)-Principles of biochemistry	
Module II **14 hrs**	**Amino acids- Peptides and Proteins**: Amino acids - Nomenclature, Structure, Classification, properties and biological functions. Proteins: Conformation-Tertiary and Quaternary; Protein: Hierarchy of protein structure, motifs and domains, torsion angle and Ramachandran plot, Forces stabilizing protein structure. Protein synthesis; Protein folding; post-translational modifications; molecular chaperones; Proteolysis; Protein isolation from plant tissues, Purification, quantification protein-ligand interaction; Metabolism: Biosynthesis of amino acids reductive amination, transamination. GDH and GOGAT pathway. **Enzymes:** Classification, principles of catalysis, Mechanism of enzyme activity, Factors affecting enzyme activity, regulation, Michaelis-Menten equation & Kinetics Derivation of Michaelis-Menten equation — Michaelis-Menten plot and Lineweaver Burke plot. Enzyme inhibition; Cofactors and Coenzymes. **References** 1. Nelson, David L and cox Michael M cox (2021)-Lehlinger principles of Biochemistry(7th edn) W.H. Freeman. 2. Lehninger L.Albert (1970) Principles of Biochemistry 3. Voet D and Voet J.G (2010)-Principles of biochemistry 4. Stumpf, P. K. and Conn, E. E (1980). The Biochemistry of Plants: A Comprehensive Treatise. Academic Press.	• To learn the structure and function of Amino acids and their key chemical and physical properties. • To understand the biochemical mechanisms underlying the function of enzymes

	5. Taiz, L. and Zeiger, E. (2002). Plant Physiology. The Benjamin Cummings Publishing Corporation Inc. **6.** Wilkins, M. B. (1984). Advances in Plant Physiology. Longman Scientific & Technical.	
Module III **14 hrs**	**Plant cells and water-** Ionization of water- weak acids and weak bases; pH scale, Buffers; properties of water, hydrogen bonding, polarity, Cohesion and adhesion. The concept of water potential. Water movement in cells and tissues -Soil-plant-atmosphere continuum. Bulk movement of water and substances across the membrane, The ascent of xylem water and the uptake of water by the roots, Aquaporins, stomatal regulation of transpiration, anti transpirants; Nutrition in plants; Absorption of mineral ions - absorption of solutes. Translocation in the phloem. Sources and sinks. Mechanism of translocation. **Photosynthesis- Light reaction**: pigments, photosynthetic apparatus, photosynthetic electron transport, water oxidation and its molecular mechanism, photophosphorylation, pseudo cyclic electron transport, Mehler reaction. Genetics of photosynthesis **Dark reaction**: Carbon dioxide fixation in C_3, C_4 and CAM plants regulation of Photosynthetic Carbon Reduction cycle; photorespiration and its regulation, environmental factors affecting photosynthesis. **Nitrogen metabolism**: Nitrogen nutrition, organic nitrogen, nitrogen fixation in legumes, nitrate and ammonia assimilation- Sulfur metabolism, Interrelationship between photosynthesis, respiration and nitrogen metabolism. Export of fixed nitrogen from nodules. Nitrogen nutrition - agricultural and ecological aspects. Genetics of N_2 fixation. **References** 1. Taiz, L. and Zeiger, E. (2002). Plant Physiology. The Benjamin Cummings Publishing Corporation Inc 2. Anderson, J. W. and Boardall, J. (1991) Molecular Activation of Plant cells- An Introduction to Plant Biochemistry. Blackwell Scientific Publishers.	• Students will understand the basic concepts of plant water relation. • Students will understand the process of conduction of water and translocation of solutes. • To comprehend the photo physiological process in plants and the inter relationship between photosynthesis respiration and nitrogen metabolism.

	3. Beck, C. B. (2005). An Introduction to Plant Structure and Development. Cambridge University Press. 4. Bewley, J. D. and Black E. (1994) Seeds: Physiology of Development and Germination. 2nd Edn. Plenum Publishing Corporation. 5. Bidwell, R.G. S. (1979) Plant Physiology. 2nd Edn. Macmillan Publishing Corporation. 6. Buchanan, B. B, Gruissem, W. and Jones, R. L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists. 7. Devlin, R. M. and Witham, F. H. (1986). Plant Physiology. IVth Edn. CBS Publishers & Distributors.	
Module IV **10 hrs**	**Growth and development:** Growth differentiation and development. Genetic control and hormonal regulation. Seed germination. Physiology of hormones in plant development - auxins, gibberellins, cytokinin, abscisic acid and ethylene. Role of vitamins and nutrients in development. Plant growth regulators- **Phytohormones**- Auxin; cytokinin; Gibberellins; ethylene; ABA. polyamines; Brassinosteroids, Jasmonate; Phytochromes and light control; Mechanism of phytochrome and gene action. Cryptochromes and blue light effect. physiology of flowering and fruiting; Seed dormancy and germination, senescence. Plant movements. Seed physiology. **Photomorphogenesis:** Phytochrome—chemistry and physiological effects. **Stress physiology**: Abiotic and biotic stresses, morphological and cellular adaptation; molecular mechanism of stress tolerance and protection **Plant secondary metabolites:** Classification; Isolation, Characterization, Biosynthetic pathways, Applications (Alkaloids, Phenols, Terpenoids, Flavonoids); Allelopathic substances. **References** 1. Hopkins, W. G. (2004). Introduction to Plant Physiology. John Wiley & Sons Inc. 2. Karp G. (1996). Cell and Molecular Biology — Concepts and Experiments. John Wiley & Sons, Inc. 3. Mayer and Poljakoff- Mayber. (1989). The Germination of Seeds. IVth Edn. Pergmon Press.	• Students will learn the basic concepts of growth in plants and the role of phyto hormones in the development. Students will understand the photo physiological process in plants. • To understand the biochemistry of secondary metabolites in plants.

	4. Moore. T. C. (1981) Research Experience in Plant Physiology. A Laboratory Manual. Springer Verlag, 5. Noggle, G. R. and Fritz G. J. (1992). Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd. 6. Salisbury, F. B. and Ross C. W. (1992) Plant Physiology. 4th Edn. Wordsworth Publishing Corporation. 7. Steward, F. C. Plant Physiology - A Treatise. Vol. I to X. Academic. Press. 8. Taiz, L. and Zeiger, E. (2002). Plant Physiology. The Benjamin Cummings Publishing Corporation Inc	

Course Code and Title	**PRACTICAL III:** **MSPSC02DSC10** **TAXONOMY AND ADVANCED PLANT SYSTEMATICS** **Credits – 3 (90 hrs)**	**Module Outcome**
Course Objectives	▪ To make students familiar with the foundations of plant systematics, methods used and the research goals of a systematic study. ▪ To make students familiar with the concepts and the terminology used in plant systematics including modern molecular systematics. ▪ To present the most recent knowledge of evolutionary relationships of plants as well as practical information vital to the field	
Module I **30 hrs**	During this study, the student shall get familiar with the local flora. The students should get familiar with the method of dissecting and studying plants in the laboratory, describing them in technical terms, preparing scientific illustrations, constructing artificial keys and identify them based on Bentham and Hooker's system of classification. For this purpose, each student shall work out at least 2 members of each of the following families of angiosperms available in the area: Ranunculaceae, Menispermaceae, Polygalaceae, Caryophyllaceae, Myrtaceae, Clusiaceae, Sterculiaceae, Meliaceae, Sapindaceae, Rosaceae, Rhizophoraceae, Melastomataceae, Aizoaceae, Oleaceae, Gentianaceae, Boraginaceae, Verbenaceae, Scrophulariaceae **References** 1. Harris J. G. & M. W. Harris. 2007. Plant Identification Terminology. Spring Lake Publishing. 2. Judith, E. W. 2002. Describing Plant Species. Bishen Singh Mahendrapal Singh. 3. Sivarajan, V. V. 1991. Introduction to the Principles of Plant Taxonomy. Oxford & IBM Publishing co. Pvt. Ltd. 4. Radford, E. A. 1986. Fundamentals of Plant Systematics. Harper & Row Publishers.	• Students will be able to dissect the flowers and describe the plants in technical terms. • Students will be able to prepare scientific illustrations of plants. • Students will be able to construct artificial keys to identify plants. • Students will be able to identify and classify local plants using the Bentham and Hooker's system of classification.

Module II **30 hrs**	The students should get familiar with the method of dissecting and studying plants in the laboratory, describing them in technical terms, preparing scientific illustrations, constructing artificial keys and identify them based on Bentham and Hooker's system of classification. For this purpose, each student shall work out at least 2 members of each of the following families of angiosperms available in the area: Lentibulariaceae, Convolvulaceae, Pedaliaceae, Lauraceae, Loranthaceae, Nyctaginaceae, Casuarinaceae, Amaryllidaceae, Commelinaceae, Zingiberaceae, Cyperaceae **References** 1. Harris J. G. & M. W. Harris. 2007. Plant Identification Terminology. Spring Lake Publishing. 2. Judith, E. W. 2002. Describing Plant Species. Bishen Singh Mahendrapal Singh. 3. Sivarajan, V. V. 1991. Introduction to the Principles of Plant Taxonomy. Oxford & IBM Publishing co. Pvt. Ltd.	• Students will be able to dissect the flowers and describe the plants in technical terms. • Students will be able to prepare scientific illustrations of plants. • Students will be able to construct artificial keys to identify plants. • Students will be able to identify and classify local plants using the Bentham and Hooker's system of classification.
Module III **15 hrs**	During this study, each student shall undertake a field study tour for at least 3 days, under the guidance and supervision of a teacher, at a place ecologically and floristically different from their place of regular study. Each one shall also collect plant specimens for herbarium preparation and shall submit at least forty, well preserved, correctly identified and labelled herbarium specimens along with the field book and report for evaluation during their practical examination. **References** 1. Harris J. G. & M. W. Harris. 2007. Plant Identification Terminology. Spring Lake Publishing. 2. Judith, E. W. 2002. Describing Plant Species. Bishen Singh Mahendrapal Singh. 3. Sivarajan, V. V. 1991. Introduction to the Principles of Plant Taxonomy. Oxford & IBM Publishing co. Pvt. Ltd.	• Students will be able to apply their knowledge of plant identification and classification to a new environment. • Students will be able to observe and record field and relevant ecological data. • Students will be able to write a field report. • Students will gain an appreciation for the diversity of plant life.
Module IV **15 hrs**	Exercises in nomenclatural citations and solving nomenclatural problems in synonymy, homonymy, priority, typification etc. **References**	• Students will be able to correctly cite plant names in accordance with the International Code of Nomenclature for algae, fungi, and plants

	1. Harris J. G. & M. W. Harris. 2007. Plant Identification Terminology. Spring Lake Publishing. 2. Judith, E. W. 2002. Describing Plant Species. Bishen Singh Mahendrapal Singh. 3. Sivarajan, V. V. 1991. Introduction to the Principles of Plant Taxonomy. Oxford & IBM Publishing Co. Pvt. Ltd.	• Students will be able to identify and solve common nomenclatural problems, such as homonymy, synonymy, and changes in taxonomic rank etc

Course Code and Title	**PRACTICAL IV:** **MSPSC02DSC11** **CELL AND MOLECULAR BIOLOGY AND PLANT PHYSIOLOGY AND BIOCHEMISTRY** **Credits – 3 (90 hrs)**	Module Outcome
Course Objectives	▪ To study the organization of the cell and the molecules of heredity. ▪ To study cell and their components ▪ To understand the features of various nucleic acids ▪ To learn the structure and function of essential biomolecules and their key chemical and physical properties. ▪ To understand the biochemical mechanisms underlying the metabolism of plants	
Module I **30 hrs**	Reagent preparation for Plasmid isolation. Raising *E. coli* with a plasmid, by streaking on antibiotic-containing media. Raising *E. coli* liquid culture for plasmid isolation. Plasmid DNA isolation using the alkaline lysis method. Gel electrophoresis to see the isolated plasmid, study the DNA staining procedure and alternative forms of plasmid obtained after extraction. Preparation of Reagents and Buffers for plant DNA isolation **References** 1. Bonifacino, J. S. 2003. Short Protocols in Cell Biology. John Wiley & Sons Inc. 2. Rickwood, D. & Harris, J. R. 1996. Essential Techniques: Cell Biology. Promega	
Module II **30 hrs**	Plant genomic DNA isolation from plant tissues by C TAB method. Gel electrophoresis to see the isolated plant DNA. Plant RNA isolation Gel electrophoresis to see the isolated plant RNA. Quantification of DNA/RNA Exercises relevant to topics such as lac operon, trp operon, etc. Mitosis and Meiosis-Cell division stages. **References** 1. Gerald Karp 2013. Cell and Molecular Biology: Concepts and Experiments. 7th 2. Edition, Wiley, NJ, USA 3. Bonifacino, J. S. 2003. Short Protocols in Cell Biology. John Wiley & Sons Inc. 4. Rickwood, D. & Harris, J. R. 1996. Essential Techniques: Cell Biology. Promega	
Module III	Quantitative estimation of reducing sugar Quantitative estimation of protein.	

15 hrs	Isolation of enzyme (amylase/ xylanase) from germinating finger millet seeds and estimating crude enzyme activity. Isolation of enzyme (amylase/ xylanase) from germinating finger millet seeds and estimating crude enzyme activity. Cell wall profiling (hemicellulose composition/hydroxycinnamate) by HPLC 6 Enzyme kinetics- Determination of pH and temperature optimum, Michaelis constant (Km) and Vmax **References** 1. Buchanan BB, Gruissem W, Jones RL 2000. Biochemistry and molecular biology of plants. L K International Pvt. Ltd. 2. Nelson DL, Michael M Coxe: 2008. Lehninger Principles of Biochemistry fifth edition, W. H. Freeman and Company 3. Nelson DL, Michael M Coxe 2016. Lehninger Principles of Biochemistry: 4. seventh edition, W. H. Freeman and Company 5. Taiz L and Zeiger E. 2010 Plant Physiology. (5th Edition). Sinauer Associates, Inc., Sunderland, Massachusetts. ISBN: 978-0-87893-866-7. 6. Dey PM and Harborne J B. 1997. Plant Biochemistry. first edition, AcademicPress 7. Bonner J and Warner JE. 1976. Plant Biochemistry: Third edition, Academic press 8. Hopkins, W. G. (2004). Introduction to Plant Physiology. John Wiley & Sons Inc. 9. Karp G. (1996). Cell and Molecular Biology Concepts and Experiments. John Wiley & Sons, Inc. 10. Mayer and Poljakoff- Mayber. (1989). The Germination of Seeds. IVthEdn. Pergmon Press. 11. Moore. T. C. (1981) Research Experience in Plant Physiology. A Laboratory Manual. Springer Verlag, 12. Noggle, G. R. and Fritz G. J. (1992). Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd. 13. Salisbury, F. B. and Ross C. W. (1992) Plant Physiology. 4th Edn. Wordsworth Publishing Corporation	
Module IV **15 hrs**	Estimation of total phenolics Estimation of cell wall polysaccharide, cellulose, in selected grass species. Isolation of intact organelles: chloroplasts and mitochondria. Separation of pigments and metabolites Chlorophyll estimation -	

	Assay of photosynthetic electron transport activity from isolated chloroplast using oxygraph Determination of ascorbic acid content of the tissue. **References** 1. Wink M 1999. Biochemistry of Plant Secondary Metabolism: Sheffield Academic Press, Volume 2 2. Dey PM and Harborne JB. 1997. Plant Biochemistry. Academic Press 3. Anderson, J. W. and Boardall, J. (1991) Molecular Activation of Plant cells An Introduction to Plant Biochemistry. Blackwell Scientific Publishers. 4. Beck, C. B. (2005) An Introduction to Plant Structure and Development. Cambridge University Press. 5. Bewley, J. D. and Black E. (1994) Seeds: Physiology of Development and Germination.2nd Edn. Plenum Publishing Corporation. 6. Heldt HW and Piechulla B 2011. Plant Biochemistry: fourth edition, Academic Press 7. Nobel PS and Henry RJ 1996. Practical application of Plant molecular biology. Chapman and Hall, London 8. Bidwell, R.G. S. (1979) Plant Physiology. 2nd Edn. Macmillan Publishing Corporation. 9. Buchanan, B. B, Gruissem, W. and Jones, R. L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists. 10. Devlin, R. M. and Witham, F. H. (1986). Plant Physiology. IVthEdn. CBS Publishers & Distributors.	

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)		
Course Code and Title	**MSPSC02DSE02** **DEVELOPMENTAL BIOLOGY OF PLANTS** **Credits – 3 (45 hours)**	
Course Objectives	• Make students familiar with the molecular and cellular basis of the processes that govern plant development. • Expose students to the most recent scientific advances in plant development. • Make students familiar with tools and methodologies commonly used in plant cell and developmental biology research.	
Module I **12 hrs**	**Introduction to development of plants:** Introduction to model plants used for developmental studies in plant system, advantages of each system with special emphasis on the model plant Arabidopsis Basics: Cell division and cell cycle, planes of cell division, cell autonomy, cell polarity, radial a/symmetry, pattern formation, abaxial/ adaxial identity, cell lineage vs. cell position, meristem, determinant vs. indeterminant meristem. Reproduction: Male and female gametophyte development, genetic and hormonal regulation of reproduction, pollination, and fertilization **References** 1. Bhojwani SS & Bhatnagar SP. 2009. Embryology of angiosperms. Vikas Publication House. 2. Buchanan BB, Grussem W and Jones RL. 2015. Biochemistry and Molecular Biology of plants. John Wiley & Sons Inc.	• Explain the importance and characteristics of model plants used for developmental studies in plant system, such as *Arabidopsis* • Outline the steps and events of plant reproduction, from pollination to fertilization, and the genetic and hormonal regulation involved in each stage.
Module II **12 hrs**	**Seed Development and germination:** Seed formation, cotyledon, endosperm and seed coat development. Seed dormancy and germination, hormonal regulation of seed dormancy, seedling development, Concept of vernalization and genetic regulation of vernalization. **Embryogenesis**: Basic layout of dicot and monocot embryos, stages of embryo development, embryonic axis, cell division and pattern formation in embryo, genetic and hormonal regulation of embryo development, cell polarity in embryo. Shoot development: Structure and function of shoot apical meristem (SAM), initiation and maintenance of SAM, regulation of meristem size, antagonism between SAM and lateral organs, genetic regulations, axial bud formation, shoot branching. **References**	• To describe the processes and factors involved in seed development and germination, and how they affect plant growth and adaptation. • To Compare and contrast the embryogenesis and shoot development of dicot and monocot plants, and the molecular and cellular mechanisms that regulate them

	1. Davis PJ. 2004. Plant hormones: Biosynthesis, Signal Transduction, Action. Kluwer Academic Publishers. 2. Raghavan V. 1997. Molecular Embryology of Angiosperms. Cambridge University Press. 3. Raghavan V. 2000. Developmental Biology of the Plants. Springer-Verlag, New York. 4. Raghavan V. 2006. Double Fertilization: Embryo and Endosperm	
Module III **11 hrs**	**Leaf development:** Emergence of leaf primordium from SAM, the abaxial and adaxial identity of leaf cells, leaf margin, trichrome, epidermis and stomatal development, theories of stomatal development, vascular differentiation. **Floral development:** Transition from vegetative to reproductive stage, inflorescence meristem, floral whorls specification, ABC model and beyond, whorl boundary specification, asymmetric flower development, structure, and development of monocot flowers. **References** 1. Development in Flowering Plants. Springer-Verlag Berlin Heidelberg. 2. Seymour GB, Tucker GA, Poole M &Giovannoni J. 2013. The Molecular Biology and Biochemistry of Fruit Ripening. A John Wiley & Sons, Inc. Publication. 3. Srivastava LM. 2002. Plant growth and Development: Hormones and Environment. Academic Press.	• Discuss the morphological and molecular aspects of leaf development, and how they affect the structure and function of leaves. • Describe the floral development of dicot and monocot plants, and the genetic and environmental factors that regulate it.
Module IV **10 hrs**	**Fruit Development and ripening:** Genetics and epigenetics of the ovary to fruit transition, the role of hormones in the regulation of ovary to fruit transition, fruit size genes and the control of fruit size in model crops such as Arabidopsis, Tomato, ripening of climacteric and non-climacteric fruits; Various factors controlling fruit ripening, the role of hormones in fruit ripening. Manipulation of fruit ripening by altering various parameters. Endoreduplication and fruit development. **References** 1. Taiz L and Zeiger E, Moller, I.M & Murhy A. 2015. Plant Physiology & Development. Sinauer Associate Inc. Publishers. 2. Taiz L and Zeiger E. 2013. Plant Physiology. Sinauer Associate Inc. Publishers.	• Describe the genetic and epigenetic mechanisms of fruit development and ripening, and how they are influenced by hormones and environmental factors. • Discuss the diversity and regulation of fruit size and ripening in different plant species, and the potential applications of manipulating fruit

	3. The Arabidopsis Book, ASPB publication (available freely at www.aspb.org)	quality and shelf life.

Course Code and Title	MSPSC02DSE03 ENVIRONMENTAL SCIENCE (Credits – 3) 45 hrs	Module Outcome
Course Objectives	• This course will introduce students to the major concepts and issues related to the ecology of plants. • In this course, we will emphasize the factors affecting the distribution and abundance of plant species, interactions between plants and their biotic as well as the abiotic environment. Will also consider the issues related to large-scale ecology and global climate change.	
Module I 11 hrs	**Basic concept in Ecosystem:** Structure of ecosystem- concept, structure, function and services; Ecological Niche: concept of niche, biotic and abiotic resources Air, Water and Soil (Mineral) resources, nature and types of biotic and energy resources (freshwater, marine and estuary); Habitat- Interaction between biotic and abiotic factors; Function of ecosystem- Biogeochemical cycles; Concept of ecosystem equilibrium and nature balance. Law of Thermodynamics, Ecological energetics, and productivity; ecological pyramid, Homeostasis and feedback mechanisms. Ecological succession- types and mechanism. **References** 1. Misra, R. 1968. Ecology workbook, Oxford & IBH Publishing Co. 2. Nayar, M.P. and Sastry, A.R.K. 1987, 1989,1990. Red Data Book of Indian Plants. 3 vols. 3. Odum, E.P. 1976. Fundamentals of Ecology, W.B. Sanders Co. 4. Peter stiling Ecology- global insights and investigations McGraw Hill. 2012. 5. Mackenzie, A. ball, A.S. and Virdee, S.R. 2002. Ecology (2nd Edition). Viva Books Ltd.	Students learn the concepts on ecosystem and environment.
Module II 12 hrs	**Population Ecology:** Definition and concept of population, Population growth curves; population regulation; life history strategies (r and K selection); density, frequency, dominance, IVI, natality, mortality, age distribution, biotic potential, carrying capacity, aggregation, dispersion, ecotypes and ecophene; concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. **References** 1. Smith, R.I. and Smith, T.M. 1998. Elements of Ecology (4th Edition). The Benjamin Cummings Publishing Co.	Students are able to understand the population concept from an ecological perspective and how various factors affect the growth of various populations.

	2. Cunningham, W.P. and Saigo, B.W. 1999. Environmental Science (5th Edition) McGraw Hill. 3. Chapman, J.L. and Reiss, M.J. 1992. Ecology- Principle and Application, Cambridge University Press.	
Module III **12 hrs**	**Community Ecology:** Definition and concept of community, community diversity, structure, dominance, stratification and periodicity; Community interdependence, Ecotone, Edge effect and Ecological Niche. Species interactions- Types of interactions, interspecific competition, herbivory, Pollination Biodiversity: concepts, types of diversity, centres of diversity, endemism, threats to biodiversity. Hotspots, Red Data Book and Red list Categories, IUCN account of biodiversity. Conservation ecology of threatened plants and animals of India (Project Tiger) and Kerala. **References** 1. Peter stiling, Ecology- global insights and investigations McGraw Hill. 2012. 2. Park, C. 1997. The Environment-Principles and Applications, Routledge. 3. Smil, V. 1997. Cycles of Life. Civilization and Biosphere W.H. Freeman and Co. N.Y. 4. Smith, R.L. and Smith, T.M. 1998. Elements of Ecology (4th Edition). The Benjamin Cummings Publishing Co. 5. IUCN Plant Red Data book. IUCN, London.	The study of community ecology is essential because it assists in understanding how communities are organised and developed over time.
Module IV **10 hrs**	**Applied Ecology:** The Ecological crisis - Industrialization- The human transformation of the earth- Human activity is placing the biosphere under increasing stress. Growth of the world economy Urbanization. - The vulnerable planet. World Earth summits and protocols. The failure of the ecological reforms-Environmental revolution. Conservation programmes: UNEP, MAB, Ramsar convention, Convention on Biodiversity. Conservation and Ecological movements in India and Kerala. Environmental pollution: causes of air, water, and land; pesticides, radiation, noise and automobile pollution; effect of greenhouse gases, case studies; effect on plants and animals; control with emphasis on biological methods like bioaugmentation, Bioremediation, phytoremediation and Bio sequestration.	It is understanding, analyzing, communicating and managing ecosystems in a scientific and sustainable way to benefit the coexisting relationships that humans have with the natural environment.

	References 1. Misra, R. 1968. Ecology workbook, Oxford & IBH Publishing Co. 2. Odum, E.P. 1976. Fundamentals of Ecology, W.B. Sanders Co. 3. APHA, AWWA, WEF, 2012. Standard methods for the examination of water and wastewater.	

Course Code and Title	MSPSC02DSE04 SEED TECHNOLOGY Credits 3– (45 hrs)	Module Outcome
Course Objectives	• To understand the basics of seed formation and its structure. • To Comprehend the concept of seed dormancy and germination. • Understand the types and characteristics of seed storage products and conditions, including carbohydrates, proteins, lipids and secondary metabolites	
Module I 12 hrs	**Seed Formation and its Structure** Introduction to seed technology: definition, scope, importance and history of seed technology **Seed formation**: sexual and asexual reproduction, pollination and fertilization, embryogenesis and endosperm development. Apomixis – identification, classification, significance and its utilization in different crops for hybrid seed production; Polyembryony - types and significance **Seed structure**: morphology and anatomy of seeds, types of seeds, seed coat and its functions Seed classification: botanical, agronomic, morphological and physiological classification of seeds **References** 1. Agrawal, R. L. (2018). Seed technology. Oxford & IBH Publishing Company Pvt. Limited 2. Bewley, J. D., Bradford, K. J., Hilhorst, H. W., & Nonogaki, H. (2013). Seeds: physiology of development, germination and dormancy. Springer Science & Business Media 3. Baskin, C. C., & Baskin, J. M. (2014). Seeds: ecology, biogeography, and evolution of dormancy and germination. Academic Press 4. Copeland, L. O., & McDonald, M. B. (2001). Principles of seed science and technology. Springer Science & Business Media	• Identify the major morphological and anatomical features of seeds and their functions. • Classify seeds based on their botanical, morphological and physiological characteristics
Module II 12 hrs	**Seed dormancy:** definition, types, causes and significance of seed dormancy. Orthodox. Recalcitrant and Intermediate seeds. Endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy. Physical, chemical, biological, and environmental methods of breaking seed dormancy, advantages and disadvantages of each method Seed viability: definition, methods of testing seed viability, factors affecting seed viability, seed vigour and its measurement.	• Define seed dormancy and germination and explain their biological roles in plant survival and reproduction. • Identify the types and causes of seed dormancy and how they affect the germination

	Seed viability: definition, methods of testing seed viability, factors affecting seed viability, seed vigour and its measurement. **Seed germination**; factors affecting germination; role of embryonic axis; growth hormones and enzyme activities Physiological processes during seed germination; methods of measuring seed germination. seed respiration, breakdown of stored reserves in seeds, mobilization and interconversion pathways. **References** 1. Baskin, C. C., & Baskin, J. M. (2014). Seeds: ecology, biogeography, and evolution of dormancy and germination. Academic Press 2. Bewley, J. D., & Black, M. (1994). Seeds: Physiology of Development and Germination. Springer New York, NY 3. Finch-Savage, W. E., & Leubner-Metzger, G. (2006). Seed dormancy and the control of germination. New Phytologist, 171(3), 501-523. 4. Kucera, B., Cohn, M. A., & Leubner-Metzger, G. (2005). Plant hormone interactions during seed dormancy release and germination. Seed Science Research, 15(4), 281-307. 5. McDonald, M. B., & Copeland, L. O. (1997). Seed production: principles and practices. Springer Science & Business Media.	potential and behaviour of seeds
Module III **10 hrs**	**Seed Storage Products:** Types, such as carbohydrates, proteins, lipids and secondary metabolites Seed storage conditions: effects of temperature, moisture, oxygen, light and pests on seed storage, methods of controlling these factors. Seed storage warehouse - Seed borne pathogen. Reserve mobilization during germination: enzymatic degradation of seed storage products, transport and utilization of reserve products, role of hormones and gene expression in reserve mobilization. **References** 1. Bewley, J. D., Bradford, K. J., Hilhorst, H. W., & Nonogaki, H. (2013). Seeds: physiology of development, germination and dormancy. Springer Science & Business Media 2. Dickie, J. B., & Pritchard, H. W. (2002). Systematic and evolutionary aspects of desiccation tolerance in seeds. In Desiccation and survival in plants: drying without dying (pp. 239-259). CABI Publishing. 3. Ellis, R. H., Hong, T. D., & Roberts, E. H. (1985). Handbook of seed technology for gene banks. Volume II. Compendium of specific germination information	• Explain different storage product types in seeds. • Describe the process of reserve mobilization during germination, including the enzymatic degradation of seed storage products, and the transport and utilization of these reserve products.

	and test recommendations. Handbook of seed technology for gene banks. Volume II. Compendium of specific germination information and test recommendations. 4. Penfield, S. (2017, September). Seed dormancy and germination. Current Biology, 27(17), R874–R878. 5. Bewley, J. D., & Black, M. (1994). Seeds: Physiology of Development and Germination. Springer New York, NY	
Module IV **11 hrs**	**Role of Seed Technology:** Goals and Objectives of Seed Technology, Seed Quality, Classes of Seed, Factors Influencing the Life Span of Seeds. Seed industry and its components, seed production and distribution systems, seed policies and regulations Seed quality: definition, components and determinants of seed quality, seed quality standards and certification **Classes of seed**: breeder, foundation, registered and certified seeds, criteria and procedures for each class of seed **Seed testing**: definition, objectives and principles of seed testing, National and International Organisations and seed Testing linkages seed sampling, purity analysis, germination test, seed health test, seed vigour test, seed moisture test, seed weight test, seed viability test, seed dormancy test, seed certification test. Seed Bank, Indian Seed Act, seed rule and seed order. Seed Inspector Qualifications, duties and responsibilities. Intellectual Property Law of Plant and Farmers' Rights in India **References** 1. Agrawal, R. L. (2018). Seed technology. Oxford & IBH Publishing Company Pvt. Limited 2. Copeland, L.O., McDonald, M.B. (2001). Seed Testing. In: Principles of Seed Science and Technology. Springer, Boston, MA. 3. McDonald, M. B., & Copeland, L. O. (1997). Seed production: principles and practices. Springer Science & Business Media. 4. Singh, P. (2012). Objective seed technology. Kalyani Publishers. 5. ISTA 2006. Seed Testing Manual. ISTA, Switzerland. 6. Misra, M.K., Harries, A., Dadlani, M. (2023). Role of Seed Certification in Quality Assurance. In: Dadlani, M., Yadava, D.K. (eds) Seed Science and Technology. Springer, Singapore. 7. Kumar, S., Sripathy, K.V., Udaya Bhaskar, K., Vinesh, B. (2023). Principles of Quality Seed Production. In: Dadlani, M., Yadava, D.K. (eds) Seed Science and Technology. Springer, Singapore	• Define and discuss seed quality, including its components and determinants, as well as standards for seed quality and certification processes. • Identify and differentiate between the classes of seeds: breeder, foundation, registered, and certified seeds.

<table>
<tr><th colspan="3">Multidisciplinary Elective Courses (MDC) offered for other Departments</th></tr>
<tr><td>Course Code and Title</td><td>MSPSC02MDC01
ECOLOGY & ENVIRONMENT
Credits – 2 (30 hrs)</td><td>Module Outcome</td></tr>
<tr><td>Course Objectives</td><td colspan="2">Course Objectives:
This course will introduce students to the major concepts and issues related to the ecology of plants. In this course, we will emphasize the factors affecting the distribution and abundance of plant species, interactions between plants and their biotic as well as the abiotic environment. We will also consider the issues related to large-scale ecology and global climate change.
Course Outcome:
At the end of this course, students will be able to explain the processes that are responsible for species distribution and abundance. Understand how these processes shape populations and communities. Comprehend interactions between species and the environment that determine community composition and structure. Apply ecological principles to current conservation issues.</td></tr>
<tr><td>Module I
10 hrs</td><td>Ecosystem Ecology: Ecosystem structure; ecosystem function; ecosystem services; Energy flow and mineral cycling (C, N, P). Food chain and food web - Producers, consumers and decomposers. Ecological Pyramids. Primary production and decomposition. Structure and function of some Indian ecosystems: Terrestrial (forest, grassland, Desert) and Aquatic (fresh water, marine, estuarine). Habitat and Niche: Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.

References
1. Barry R. G. (2003), Atmosphere, weather and climate, Rutledge Press, UK
2. Chapman, J.L. and Reiss, M.J. (1992). Ecology-Principle and Application, Cambridge University Press
3. Cunningham, W.P. and Saigo, B.W. (1999). Environmental Science (5th Edition) McGraw Hill.
4. Odum, E.P. (1976). Fundamentals of Ecology, W.B. Sanders Co.</td><td>Students will be able to:
• Describe the structure and function of ecosystems.
• Explain the relationships between different ecosystem components and how they interact to maintain ecosystem function.
• Analyze the impact of human activities on ecosystems, and develop strategies for the conservation and management of ecosystems.</td></tr>
</table>

	5. Smith, R.L. and Smith, T.M. 1998. Elements of Ecology (4th Edition). The Benjamin Cummings Publishing Co. 6. Misra, R. (1968). Ecology workbook, Oxford & IBH Publishing Co.	
Module II **10 hrs**	**Biodiversity**- species, genetic and ecosystem diversity- global, national and local levels. Value of biodiversity- Consumptive and productive use, social, ethical, aesthetic and option values- Hot spots and warm spots- Endangered and Endemic species of India. Concept of reserve and resources; Problems with the exploitation of resources. Natural Resources Conservation, Role of individuals in Sustainable Environmental Management. Biodiversity conservation strategies; in situ and ex situ conservation-Protected areas of India, ANTS, NP and Biosphere Reserves, Gene bank, seed bank, IBPGR, Cryopreservation; IUCN categories, red data book. **References** 1. IUCN Red list of threatened species - a global species assessment, IUCN, Gland, Switzerland 2. Loreau M., and P. lnchausti (2002), Biodiversity and Ecosystem functioning: Synthesis and Perspectives, Oxford University Press, Oxford 3. Nayar, M.P. and Sastry, A.R.K. 1987, 1989, 1990. Red Data Book of Indian Plants. 3 vols. 4. Primack R.B. (2002), Essentials of Conservation Biology (3rd Edition), Sinauer Associates, Sunderland, SA 5. Wilson E. O. (1993), Diversity of Life, Harvard University Press, Cambridge, MA 6. Stilling, P. (2012). Ecology: Global insights and investigation. McGraw Hill Companies.	Students will be able to: • Define and explain the key concepts of biodiversity. • Identify and describe the major biodiversity hotspots and warm spots in India and around the world. • Discuss the role of individuals in sustainable environmental management and biodiversity conservation.
Module III **10 hrs**	**The Ecological crisis** - Industrialization- The human transformation of the earth- Human activity is placing the biosphere under increasing stress. Growth of the world economy Urbanization. - The vulnerable planet. World Earth summits and protocols. Conservation programmes: UNEP, MAB, Ramsar convention, Convention on Biodiversity. Conservation and Ecological movements in India and Kerala Environmental pollution- Nuclear (Radioactive) pollution; Case studies; Minamata, Love Canal, Bhopal	Students will be able to: • Describe the major international and national conservation programmes that are in place to address the ecological crisis. • Explain the concepts of environmental pollution, nuclear

	tragedy, Chernobyl, Tsunami. Solid waste management-urban and industrial wastes; Role of individual-prevention of pollution, Bioremediation technologies. **References** 1. Barry R. G. (2003), Atmosphere, weather, and climate 2. Cunningham, W.P. and Saigo, B.W. (1999). Environmental Science (5th Edition) McGraw Hill. 3. Smith, R.L. and Smith, T.M. 1998. Elements of Ecology (4th Edition). The Benjamin Cummings Publishing Co. 4. Stilling, P. (2012). Ecology: Global insights and Investigation. McGraw Hill Companies.	pollution, and solid waste management. • Discuss the role of individuals in preventing pollution and managing solid waste.

Course Code and Title	MSPSC02MDC02 PHILOSOPHY OF SCIENCE Credits – 2 (30 hrs)	Module Outcome
Course Objectives	• Understand what science is and in what ways science differs from non-science and pseudoscience subjects • Understand the different methods of reasoning in Science. • Get an idea about the modes of scientific explanations. • Understand the value, its acceptance and the criticism to Science. • Understand the historical milestones in the evolution of scientific thoughts	
Module I 8 hrs	**1.What is science?** Scientific knowledge-Streams of Science-Basic and applied science- Science and society – Science as a human activity - Origin of modern science. Philosophy of Science- A brief Historical introduction-definition, scope - **2. Method and Reasoning** Scientific method - Observations, pieces of evidence and proofs- Hypothetico-deductive model, Inductive model-Hume's problem of induction-Significance of verification (proving) - corroboration and falsification (disproving)- Positivism. Karl Popper and the concept of falsification.	To understand what science is and in what ways science differs from non-science and pseudoscience subjects and Students will be able to understand the different methods of reasoning in Science.
Module II 8 hrs	**3. Explanation in science** Hempel's covering law model of explanation - The problem of symmetry Explanation and causality - Can science explain everything? -Explanation and Reduction. **4. Scientific Change and Scientific Revolutions** Logical positivist philosophy of science – Empiricism-New Paradigms and Scientific Change - The structure of scientific revolutions - Incommensurability and theory-ladenness of data - Thomas Kuhn and the rationality of science	Understand the historical markers in the evolution of scientific thought.
Module III 7 hrs	**5. Scientific temper and its fostering.** Critical thinking and logical reasoning in science. Realism and Antirealism- Observable and unobservable distinctions **6. Science and its critics**- Science as just one narrative -scientism- Science and religion debates, Science and values. Is Science value-free?	To appreciate what is critical thinking and to realize streams of knowledge other than science.

Module IV **7 hrs**	**7. Experimentation in science** Introduction-Selecting a problem-Hypothesis-auxiliary hypothesis and ad-hoc hypothesis. Variables-Correlation and causality-sampling—control in experiments.- Experimental bias-performing experiments-Measurement error. **8. History of science**- A brief outline	To understand about the methods of scientific experimentation.
	References 1. Alan Chalmers. What is this thing called science? University of Queensland Press, Open University Press, 3rd revised edition, Hackett,1999 3. Richard Dewitt. Worldviews: an introduction to history and philosophy of science. Blackwell publishing 2004. 4. Boyd, R., Gasper, P., and Trout, J.D. (eds., 1991), The Philosophy of Science, Blackwell Publishers, Cambridge, MA. 5. Glaze brook, Trish (2000), Heidegger's Philosophy of Science, Fordham University Press. 6. Gutting, Gary (2004), Continental Philosophy of Science, Blackwell Publishers, Cambridge, MA. 7. Allen, Garland E. Thomas Hunt Morgan: The Man and His Science. Princeton University Press: Princeton, 12 1978. ISBN 0-691-08200-6 2. 8. Annas, Julia Classical Greek Philosophy. In Boardman, John; Griffin, Jasper; Murray, Oswyn (ed.) The Oxford History of the Classical World. Oxford University Press: New York, 1986. ISBN0-19-872112-9 9 Mason, Stephen F. A History of the Sciences. Collier Books: New York,1956. 10 Okasha, S (2002) Philosophy of science-A very short introduction- Oxford Academic 11Popper K.R (1963)-Conjectures and refutations. The growth of scientific knowledge 12. Spangenburg R and D K Moser. History of Science from the Ancient Greeks to the Scientific Revolution. 2000. Universities Press. 25. 13 Spangenburg R and D K Moser. History of Science in the 18thCentury. 2000. Universities Press. 14. Spangenburg R and D K Moser. History of Science in the 19thCentury. 2000. Universities Press.	

	15. Spangenburg R and D K Moser. History of Science from 1895 to 1945. 2000. Universities Press. 16 Spangenburg R and D K Moser. History of Science from 1946 to 1990s. 2000. Universities Press. 17 Thomas, S. Kuhn-(1962). The Structure of scientific revolutions -University of Chicago press: Chicago	

ABILITY ENHANCEMENT COURSES (AEC) OFFERED FOR OTHER DEPARTMENTS		
Course Code & Title:	**MSPSC02AEC01:** **ORGANIC FARMING** **Credits – 2 (30 hrs)**	**Module Outcome**
Course Objectives	• The objective is to raise awareness about organic farming and promote the use of sustainable agricultural practices for the production of nutritious and organic food. • To introduce the concept of organic ecosystem and learn about biological magnification and its relevance in today's world.	
Module I **10 hrs**	**Organic farming** – History and development - definition – need – scope – principles – characteristics - relevance to modern agriculture. Different eco-friendly farming systems- biological farming, natural farming, regenerative agriculture – permaculture - biodynamic farming **References** 1. Arun K. Sharma. 2002. A Handbook of organic farming. Agrobios, India. 627p. 2. Palaniappan, S.P and Annadurai, K.1999. Organic farming-Theory and Practice. Scientific publishers, Jodhpur,India. 257p. 3. Mukund Joshi and Prabhakarasetty, T.K. 2006. Sustainability through organic farming. Kalyani publishers, New Delhi. 349p.	The students will possess the knowledge and understanding necessary to implement organic farming principles.
Module II **10 hrs**	Nutrient use in organic farming-scope and limitations. Pesticide- Green manures- bio fertilisers – type – benefits and limitations. Relevance of organic farming Kerala model and global agriculture and future prospects advantages - barriers. **References** 1. Balasubramanian, R., Balakishnan, K and Siva Subramanian, K. 2013. Principles and practices of organic farming. Satish Serial Publishing House. 453p 2. Tarafdar, J.C., Tripathi, K.P and Mahesh Kumar, 2009. Organic agriculture. Scientific Publishers, India. 369p.	Students can acquire knowledge on the use of manures and pesticides in organic farms and can identify advantage and limitations.

Module III **10 hrs**	Initiatives taken by the central and state governments, NGOs and other organizations for promotion of organic agriculture in India. Operational structure of NPOP – other agencies for organic production. Marketing and export potential of organic products – national economy **References** 1. Tiwari, V.N., Gupta, D.K., Maloo, S.R and Somani, L.L. 2010. Natural, organic, biological, ecological and biodynamic farming. Agrotech Publishing Academy, Udaipur. 420p. 2. Dushyent Gehlot. 2005. Organic farming-standards, accreditation, certification and inspection. Agrobios, India. 357p 3. Maliwal P. L. principles of organic farming: textbook: (as per syllabus of v dean's committee, ICAR) 4. Somasundaram, E., D. Udhaya Nandhini, M. Meyyappan., Principles of organic farming. 412 Pages, 2021 by CRC Press	Students able to establish and manage a variety of farming systems, ventures, and commercial enterprises, and ultimately become organic farming entrepreneurs.

Course Code and Title	MSPSC02AEC02 FLORICULTURE Credits – 2 (30 hrs)	Module Outcome
Course Objectives	• Develop professional skill and employability skill related to floriculture • To understand importance of commercial varieties of the flowering crop • To Identify Commercial Flowers and their packaging.	
Module I **10 hrs**	**Fundamentals of floriculture:** Introduction and scope of floriculture, Status and prospects of commercial cultivation of flowers. Pot plant and cut foliage production - species and varieties, propagation, media, shade and water requirement, nutrition, pruning, plant protection, harvesting, postharvest handling and marketing of major traditional and cut flowers- jasmine, rose, chrysanthemum, lotus, tuberose. Commercial cultivation of orchids and anthurium. Study of quality parameters for cut flowers for domestic markets and export. **References** • Bose, T.K. and Yadav, L.P. 1989 Ed. Commercial Flowers. Naya Prakash, Calcutta, India. • Bose, T.K., Maiti, R.G., Dhua, R.S. and Das, P. 1999 Ed. Floriculture and Landscaping Naya Prakash, 206, Bidhan Sarani, Calcutta. • Hardenbug, R.E. Watadar. A.E and Wong C.Y. 1986. The Commercial storage of Fruits. Vegetables, Florist and Nursery stock. U.S. Department of Agriculture. New York. • Chadha, K.L., 2001 (Ed). Handbook of Horticulture. ICAR, New Delhi. • Choudhary, M.L. and Prasad, K.V. 2003. The value addition in Horticulture. Division of Floriculture and Landscaping, Indian Agricultural Research Institute, New Delhi. p. 100-104. • Larson, R.A. 1980. Introduction to Floriculture Academic Press, London Laurie, A., Kiplinger	Thorough understanding the fundamentals commercially cultivated flowering plants
Module II **10 hrs**	**Nursery management:** Common Garden tools- watercan, digging fork, shovel, garden rake, hand trowel, secateurs, budding/grafting knife. Methods of Vegetative propagation: Cutting, grafting, budding, layering; rooting medium, potting mixture and planting of cuttings, purpose of nursery bed, planting material production, methods of planting, media components and management, Fertilizers and shade regulation – Green house, irrigation, nutrition, plant protection.	Identify and apply Can expertise in method of plant propagation and its management of commercially cultivating flowering plants

	References • D.C. and Nelson, K.S. 1979. Commercial Flower Forcing. McGraw Hill Book Company, New York. • Pal B.P. 1972. The Rose in India. Indian Council of Agricultural Research, New Delhi. • Prakahs, J. and Bhandary, K.R. Floriculture Technology, Trades and Trends 1994. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. • Rajeevan, P.K. Singh, K.P. and Valsalakumari P.K. 2003 ed. Bulbous Flowers. Indian Society of Ornamental Horticulture Division of Floriculture & Landscaping, IARI, New Delhi. • Rajeevan, P.K., Sobhana, A., Bhaskar, J., Swapna, S and Bhattacharjee, S.K 2002. Orchids. Technical Bulletin. AICRP on Floriculture ,ICAR, New Delhi. • Baily., 1971. Perpetual flowering carnation. Faber and Faber, London. Biswas, T.D. 1984. Rose growing. Principles and practices. Assoc. Pub.Co., New Delhi.	
Module III **10 hrs**	**Landscaping and plant propagation:** Elements of landscaping - plants, water, stone, wood, metal, glass, lighting, Principles of landscaping, Sexual and asexual methods– advantages and disadvantages. Propagation through seeds – seed formation, maturation, dormancy, treatments for breaking dormancy, germination, viability. Vegetative propagation – cuttings, layering, budding and grafting - different methods. Other plant parts used for propagation - bulbs, tubers, runners, stolons etc. **References** • Bose, T.K.and S.K. Bhattacharjee., 1980. Orchids of India. Naya Prakash, Calcutta. • Bose, T.K. and P.Yadav. 1989. Commercial flowers. Naya Prakash, Calcutta. FAO Manual on Export packaging of Cut flowers. 1993. • Foja Singh., 1997. Advances in Floriculture. Media Today Pvt. Ltd., New Delhi-17. • Prasad, S. and U.Kumar. 1998. Commercial floriculture. Agro Botanica. Bikaner – 334 004. • Roy. A. Larson., 1992. Introduction of Floriculture. International Book Distributing Co., Lucknow.	Acquire experience in preparation and execution of landscape plants maintenance of gardens and lawns

SKILL ENHANCEMENT COURSES (SEC) OFFERED FOR OTHER DEPARTMENTS		
Course Code and Title	**MSPSC02SEC01** **MUSHROOM TECHNOLOGY** **Credits – 2 (30 hrs)**	**Module Outcome**
Course Objectives	• To impart skills in cultivation and marketing in mushrooms. • To provide basic knowledge in cultivation of mushrooms • To provide awareness in marketing trends of mushrooms	
Module I **10 hrs**	**History and introduction:** Mushroom, morphology, distribution, structure and life cycle of *Agaricus* and *Pleurotus*, Edible Mushroom, Medicinal Mushroom and Poisonous mushrooms, nutraceuticals and dietary supplements. Keys for identification of edible mushrooms. **References** • Pandey B P 1996. A textbook of fungi. Chand and company N Delhi. • Kaul T N 2001. Biology and conservation of mushrooms. Oxford and IBH publishing company N.Delhi. Gupta P.K. Elements of Biotechnology. 51 • Harander Singh. 1991. Mushrooms- The Art of Cultivation-Sterling Publishers. • Indian Journal of Mushrooms. Published by I.M.G.A. Mushroom Research Laboratory. College Agriculture, Solan	Gain the knowledge of Identification of different types of edible mushrooms and toxic mushroom.
Module II **10 hrs**	**Cultivation and maintenance:** 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., Cultivation of white button mushroom – Spawn, composting, spawning, harvesting, factors effecting button mushroom production. **References** • Marimuthu, T. et al. (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore. • Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi • Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications. • Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.	Understand hands on training for the preparation of bed for mushroom cultivation and spawn production.
Module III **10 hrs**	**Post-Harvest and management**: Quality assurance of mushrooms. Pest management, Common pests, disease prevention and control measures, Processing - Blanching, steeping, sun drying, canning, pickling, freeze drying, Storage – short term and long-term storage, Production level, economic return. Developing small scale industry	Understand how to identify and sustainably manage pest and diseases and weed mushrooms.

	and Government schemes. Mushroom Research Centres in India. **References** 1. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi. 2. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi. 3. V.N. Pathak, Nagendra Yadav and Maneesha Gaur (2000). Mushroom Production and Processing Technology/ Vedams E books Pvt Ltd., New Delhi. 4. Tiwari, S.C., Pandey, K (2018) Mushroom cultivation. Mittal publisher, New Delhi. 5. Philips, G., Miles, Chang, ST (2004). Mushrooms: Cultivation, nutritional value, medicinal effect and environmental effect. 2nd ed. CRC Press. 6. Gimenez, A. (2017). Edible and medicinal mushrooms: Technology and Application. Wiley-Blackwell publishers. 7. Nita Bahl. (2002). Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. 8. Suman. (2005). Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi	

VALUE ADDED COURSE (VAC)		
Course Code and Title	**MSPSC02VAC01** **BIOLOGY – ETHICS AND PHILOSOPHY** **Credits – 2 (30 hrs)**	**Module Outcome**
Course Objectives	• To understand the philosophical and ethical issues in biological applications and research	
Module I **14 hours**	**Biology -The nature and logic of biological sciences** - Logic of life. -Molecular logic of life. Problems of Biological classification — biological species concept- Evolution and Natural selection- Function and adaptation-The gene-centric view of evolution. Philosophical issues in Genetics - Classical and Molecular genetics -Genes and information -Genetic determinism-genetics and society-Eugenics and Euphenics- Reductionism in Biology	• To describe logic of life especially on molecular basis.
Module II **8 hours**	**Philosophical and political issues in Ecology-** Sustainable development -conservation and waste management - Anthropocentric and Ecocentric views- Biological determinism. Pandemics and Covid-19- Issues and Analysis.	• The students will be able to comprehend the political and philosophical concepts in ecology.
Module III **8 hours**	**Bio Ethics-** -Ethical dimensions of scientific practice- Contemporary issues in Bio ethics Ethical Issues in Biotechnology -Medical ethics- Ethics of clinical practices- Methodology and Ethics in Biological research-Bio ethics and Social justice. **References** 1. Bowler, Peter J. The Earth Encompassed: A History of the Environmental Sciences. W. W. Norton & Company: New York, 1992. ISBN0-393-32080-4 2. Bud, Robert. The Uses of Life: A History of Biotechnology. Cambridge University Press: London, 1993. ISBN 0521382408 3. De Chadarevian, Soraya. Designs for Life: Molecular Biology after World War II. Cambridge University Press: Cambridge, 2002. ISBN0521570786 4. Davies, Kevin. Cracking the Genome: Inside the Race to Unlock Human DNA. The Free Press: New York, 2001. ISBN 0-7432-0479-4 11.	• The students will be able to understand the ethical in biological research and medicine.

5. Holmes, Frederic Lawrence. Meselson, Stahl, and the Replication of DNA: A History of "The Most Beautiful Experiment in Biology". Yale University Press: New Haven, 2001. ISBN0300085400
6. Kay, Lily E. The Molecular Vision of Life: Caltech, The Rockefeller Foundation, and the Rise of the New Biology. Oxford University Press: New York, 1993. ISBN0-19-511143-5
7. Lennox, James (2006-02-15). "Aristotle's Biology". Stanford Encyclopaedia of Philosophy.
8. Mayr, Ernst and William B. Provine, eds. The Evolutionary Synthesis: Perspectives on the Unification of Biology. Harvard University Press: Cambridge, 1998. ISBN0-674-27226-9
9. Morange, Michel. A History of Molecular Biology, translated by Matthew Cobb. Harvard University Press: Cambridge, 1998. ISBN0-674-39855-6
10. Serafini, Anthony -The Epic History of Biology, Perseus Publishing, 1993.
11. Sulston, John. The Common Thread: A Story of Science, Politics, Ethics and the Human Genome. National Academy Press, 2002. ISBN 0309084091
12. Smocovitis, Vassiliki Betty. Unifying Biology: The Evolutionary Synthesis and Evolutionary Biology. Princeton University Press: Princeton, 1996. ISBN0-691-03343-9
13. Brian Garvey (2007) Philosophy Biology-McGill Queens University Press
14. Elliott sober (1993)-Philosophy of Biology Boulder, Colo Westview press.
15. Marjorie Grene and David Depew (2004) The philosophy of biology -An Episodic History
16. David L. Hull and Michael Ruse-(2008) The Cambridge companion to the philosophy of Biology.

THIRD SEMESTER

<table>
<tr><th colspan="3">DISCIPLINE SPECIFIC CORE COURSES (DSC)</th></tr>
<tr><td>Course Code & Title</td><td>MSPSC03DSC12
BIOTECHNOLOGY AND NANOBIOLOGY
Credits -3 (52 hrs)</td><td>Module Outcome</td></tr>
<tr><td>Course Objectives</td><td colspan="2">▪ This course aims to provide students with an understanding of the core topics and advanced integrated knowledge in plant biotechnology and Nano Biology
▪ After completion of the course, the students will get in-depth knowledge both theoretically and practically about plant biotechnology and manipulation techniques.</td></tr>
<tr><td>Module I
14 hrs</td><td>Recombinant DNA Technology: Tools in genetic engineering; prokaryotic and eukaryotic vectors; shuttle-, expression, Broad host range vectors; enzymes involved; gene cloning- shotgun cloning, comparison of cloning vectors. gene library; Plant Transformation Technology- Agrobacterium-mediated gene transfer- Agrobacterium based vectors - viral vectors and their application. Direct gene transfer methods- chemical methods, electroporation, microinjection, particle bombardment.
Molecular Techniques: DNA markers & DNA probes, DNA Sequencing methods (Maxam & Gilbert, Sanger et al., capillary), RNA Sequencing. In situ hybridisation-colony hybridisation, dot & slot blotting (Southern, Northern, Western, South-Western & North-Western), RFLP, RAPD, STS & PCR (Variants in PCR), Real-time quantitative PCR, LCR), DNA- & RNA finger printing, genomic library, cDNA library & gene bank; chromosome walking; protein sequencing-MALDI.

References
1. Lewin B (2009). Genes IX. Humana Press.
2. Flynne WG (2008). Biotechnology and Bioengineering. Nova Science Publishers
3. Lipps, G. (2008). Plasmids: Current Research and Future Trends. Caister Academic Press.
4. Torr, J. D. (2006). Genetic Engineering-Current Controversies. Greenhaven Press.
5. Torr, J. D. (2001). Genetic Engineering opposing viewpoints- Greenhaven Press
6. Robert Bud (1993) The uses of life-A history of Biotechnology-Cambridge university press</td><td>To understand the mechanisms of gene Manipulation</td></tr>
</table>

	7. Colin J Anderson (2007) Understanding Genes and GMOs world scientific publishing company. 8. Engdahl, S. (2006). Genetic Engineering-Contemporary Issues. Greenhaven Press, San Diego, USA. 9. Magnien, E. & De Nettancourt, D. (1985). Genetic Engineering of Plants and Micro-Organisms Important for Agriculture. Springer Verlag. 10. Keith Wilson and John Walker (Eds.) Principles and Techniques of Biochemistry and Molecular Biology (6th edn.), Cambridge University Press, USA (2005). 11. Keshav Trehan (1990) Biotechnology. Wiley Eastern,New Delhi. 12. Laura Livingston Mays (1981): Genetics A Molecular approach: Macmillan publishing company.	
Module II **14 hrs**	**Precision genome engineering:** sequence specific nucleases, ZFN, TALEN, CRISPR/cas9 and their use in chromatin modification and epigenetic regulation, transcriptional repression, transcriptional activation, gene editing and genome editing. Gene transfer technique for the improvement of agronomic characters - Pest Resistance-Herbicide Resistance-drought resistance-enrichment of storage protein (Mechanism of gene action)-Flower colour, Shape, fruit ripening, colour, and flavour- Improvement of the nutritional quality of seeds-post harvest preservation Biotechnology of Nitrogen Fixation Biotechnology of photosynthesis **References** 1. Fox, M. W. (2000). Beyond Evolution: The Genetically Altered Future of Plants, Animals, the Earth ... and Humans. Lyons Press. 2. Ho, R. J. Y. & Gibaldi, M. (2003) Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs. Wiley-VCH 3. David S. Goodsell 2004. bio nanotechnology: Lessons from Nature. Wiley Publishers. 4. Crispeels, M.J. and Sadava, D.E. 2003. Plants, Genes and Crop Biotechnology, Jones and Bartlett Publishers (2nd Edition). 5. Cunningham, C. and Porter, A.J.R. 1997. Recombinant Proteins from Plants: Production and Isolation of	• To understand the mechanism of precision genome engineering and the gene transfer techniques in plants • To familiarize with, plant transformation and genetic engineering applied in Agriculture

	Clinically Useful Compounds (Methods in Biotechnology), Humana Press. 6. Glick, B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology, CRC Press. 7. Keshav Trehan (1990) Biotechnology. Wiley Eastern, New Delhi. 8. Laura Livingston Mays (1981): Genetics A Molecular approach: Macmillan publishing company. 9. Sobti RC & Pachauri SS (2009) Essentials of Biotechnology; Ane Books, New Delhi. 10. Thomas, G. M. Schalkhammer (ed.) 2002, Analytical Biotechnology, Birkhäuser Verlag, Switzerland. 11. Twyman, R.M (1998), Advanced Molecular Biology Viva Books Private Ltd. 12. Gresshoff, P.M. 1994. Plant Genome Analysis: Current Topics in Plant Molecular Biology. CRC Press. 13. Potrykus I.and G. Spangenberg, G. 1997. Gene Transfer to Plants (Springer Lab Manual), Springer Verlag. 14. Slater, A., Scott, N.W. and Fowler, M. R. 2008. Plant biotechnology: the genetic manipulation of plants. Oxford University Press. 15. Miller Jr., C.N. 1977. Mesozoic confers. Bot. Rev. 43: 217-280	
Module III **10 hrs**	**Recombinant DNA technology and society** Biotechnology and Bio ethics – an overview of Genetic screening for any predisposition symptoms, Genetic screening and privacy -Gene therapy -Distortion of Biological processes-GMOs, Golden Rice- (with Vitamin-C) Terminator Genes. Food safety- Slow ripening fruits-controlled ripening. Cotton without insecticide - Environmental and Biosafety issues. Concerns. Role of Multinational companies in biotechnology-Agribusiness-. Economic, and Legal issues. Bio Ethics-Patenting Life forms- Biotechnology and the Patents. Biotechnology and the future of Agriculture-Stem cell research-Sociopolitical issues- HGP and ethical questions- Biological warfare and Bioweapons. **References** 1. Enzo Russo and David Cove(1998): Genetic Engineering , Dreams and Nightmares; Oxford university press.	• To realize the ethical issues associated with gene manipulation and to realize the social complications associated with Biotechnology.

	2. Vandana Shiva and Ingunn Moser (1996); Bio politics Feminist and ecological Reader on Biotechnology; Orient Longman. Torr, J. D. (2006). Genetic Engineering-Current Controversies. Greenhaven Press. 3. Engdahl, S. (2006). Genetic Engineering-Contemporary Issues. Greenhaven Press, SanDiego, USA. 4. Jan Vijg, 2007, Aging of the genome- The dual role of DNA in life and Death, Oxford University Press Inc., 5. John. E. Smith (2004) Biotechnology: Cambridge university press JamesD Torr (Ed)	
Module IV **14 hrs**	**Nano biology** History, scope and significance of Nanotechnology. - Synthesis of nanomaterials – Top down and bottom up. Nano-biotechnology: definition, concepts, and applications. Nano systems in nature. Cellular Nanostructures; Criteria for suitability of nanostructures for biological applications, Nanoscale Bio molecules (nucleic acids and proteins) Artificial bio nano structures. Nanoparticles. Colloidal nanostructures Nanopores; Biomolecular motors; Applications of nanotechnology in life sciences. – DNA micro array and biosensors. use of carbon nanotubes in biotechnology Disease diagnosis, drug delivery, drug targeting and tissue engineering Nanovesicles; Nanospheres; Nano capsules Nano biosensors, Nano pesticides and nano herbicides, Nano bio farming, Nano additives in food. Nanoparticles for diagnostics and imaging. **References** 1. Muralidharan VS & Subramania A (2009) Nanoscience and Technology; Ane Books, New Delhi 2. Jain.K.K (2016) Nanobiotechnology in molecular diagnosis- current technologies and applications. 3. Guozhong Cao (2004) Nanostructures and Nanomaterials -Synthesis, Properties and applications. Imperial college press 4. Bharat Bhushan (Ed.) (2004), Handbook of Nanotechnology Springer-Verlag, Berlin 5. David S. Goodsell (2004). bio nanotechnology: Lessons from Nature. Wiley Publishers. 6. Madhuri Sharon et.al(2013) Bio nano technology-Concepts and Applications, Ane Books Pvt Ltd.	• To understand the scope and significance of nano biotechnology and its applications in life sciences

Course Code and Title	MSPSC03DSC13 **BIOINFORMATICS** **Credits: 3 (45 hrs)**	**Module Outcome**
Course Objectives	▪ To create awareness about genomics and proteomics along with bioinformatics and biological databases. ▪ Get knowledge about biological databases and understand sequence alignment methods. ▪ Understand methods in genomics and proteomics. ▪ Understand the molecular level interactions and molecular modelling. ▪ Understand the method of structure-based drug design and gain basic knowledge of systems biology.	
Module I **12 hrs**	**DATABASES & TOOLS:** Introduction to Bioinformatics, Need for informatics tools and exercises, Significance of databases towards informatics projects. The nucleotide and protein sequence databases: GenBank, DDBJ. EMBL, PIR, Primary and Secondary Databases; Format of databases, Gene bank flat file. Protein Data Bank (PDB) flat file; FASTA Format, PIR Format; Structure file formats, PDBSUM, PDB Lite, MMDB, SCOP, Pfam; Database of structure viewers. Specialized databases: NCBI, Pubmed, OMIM, Medical databases, KEGC, EST databases; Overview of other popular tools for bioinformatics exercises **SEQUENCE ALIGNMENT AND DATABASE SEARCHES:** Introduction, the evolutionary basis of sequence alignment, the Modular Nature of proteins, Optional Alignment Methods, Substitution scores, substitution matrices, PAM, BLOSUM, Gap penalties, Statistical significance of Alignments, Database similarity searching, FASTA, BLAST, Low-Complexity Regions, Repetitive Elements. Practical Aspect of Multiple Sequence Alignment, Progressive Alignment Methods, CLUSTALW. **PHYLOGENETIC ANALYSIS:** Introduction to Phylogenetic analysis, rooted and un rooted trees, Elements of phylogenetic Models, Phylogenetic Data Analysis: Alignment, Substitution Model Building, Tree Building, and Tree Evaluation, Building the Data Model (Alignment), Determining the Substitution Model, Tree - Building Methods, Searching for Trees, Rooting Trees,	The students will access different biological databases, retrieve protein and nucleic acid sequences and perform sequence alignment.

	Evaluating Trees and Data, Phylogenetic software (CLUSTALW, PHYLIP etc), Conceptual numericals. **References** 1. Bioinformatics - Andreas D Baxevanis. Wiley Interscience, 1998. 2. Bioinformatics -David W Mount, Cold spring harbor, 2001. 3. Introduction to Bioinformatics - Arthur Lesk, Oxford, 2006. 4. Bioinformatics - Stuart M Brown, NYU Medical Centre, NY USA. 2000.	
Module II **12 hrs**	**PREDICTIVE METHODS:** Predictive Methods using Nucleotide sequences: Framework, Masking repetitive DNA, Database searches, Codon Bias Detection. Detecting Functional Sites in the DNA (promoters, transcription factor binding sites, translation initiation sites), Integrated Gene Parsing, biding RNA Genes, Web-based tools. (GENSCAN, GRAIL, GENEFINDER). Predictive Methods using Protein sequences: Protein Identity based on composition, Physical properties Based on sequence, secondary structure and folding classes, specialized structures or features, tertiary structure. Related web-based software (JPRED, PROSEC, NNPREDICT, and SOPMA) **PLASMID MAPPING AND PRIMER DESIGN:** Restriction mapping, Utilities, DNA strider, Mac Vector and OMIGA, gene construction KIT, Vector NTI, Web based tools (MAP, REBASE); Primer design - the need for tools, Primer design programs and software (PRIMER3). **References** 1. Fundamental Concepts of Bioinformatics- DEKrane & ML Raymer, Pearson, 2006. 2. Structural Bioinformatics PE Boume and H Weissig, Wiley - Liss, 2003. 3. Computational methods for macromolecular sequence analysis - R F Doolittle. Academic Press, 1996. 4. Computational Methods in Molecular Biology - S. L. Salzberg, D B Searls, S Kasif, Elsevier, 1998.	Explain different methods used in genome and proteome analysis.
Module III **11 hrs**	**GENOME BIOINFORMATICS:** Sequencing methods (qualitative), Bioinformatics tools and automation in Genome Sequencing, analysis of Raw genome sequence	The students able to prepare

	data, Utility of EST database in sequencing, Bioinformatics in the detection of Polymorphisms, SNPs and their relevance, Bioinformatics tools in microarray data analysis, tools for comparative genomics. **MOLECULAR VISUALIZATION:** Generation or Retrieval, Structure Visualization, Conformation Generation. Graphical representation of molecular structures: small molecules (low molecular weight - peptides, nucleotides, disaccharides, simple drugs molecules) and macromolecules (high molecular weight molecules- proteins, DNA, RNA, membranes). Usages of visualization software available in the public domain like VMD, Rasmol, Pymol, Spdb Viewer, Chime, Cn3D. Rotameric Structures of Proteins (Conformational Flexibility), Canonical DNA Forms (DNA Sequence Effects). **References** 1. Bioinformatics, Methods And Applications - Genomics, Proteomics And Drug Discovery - S C Rastogi, N Mendiratta & P Rastogi, PHI, 2006. 2. The Molecular Modeling Perspective in Drug Design - N Claude Cohen – Academic Press, 1996. 3. Analytical Tools for DNA, Genes & Genomes: - Arseni Markoff New Age, 2007. 4. Introduction to Bioinformatics - Anna Trarnontano Taylor & Francis. 2007. 5. Bioinformatics - Des Higgins & Willie Taylor - Oxford. (2005) 6. Discovering Genomics, Proteomics and Bioinformatics - A M Campbell and L J Heyer, Pearson education, 2007.	different molecular interactions, techniques of molecular modelling, protein structure prediction.

Module IV **10 hrs**	**IN SILICO MODELING & DRUG DESIGN:** Scope and applications of in silico modelling in modern biology. Comparative modelling, constructing an initial model, refining the model, manipulating the model, molecule superposition and structural alignment, concept of energy minimization, different types of interactions and formulation of force fields. Basic MD algorithm, its limitations, treatment of long-range forces. Molecular modelling in drug discovery, deriving bioactive conformations, molecular docking, quantitative structure activity relationship (QSAR), deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Ligand - Receptor Interactions: Docking, Calculation of Molecular Properties using Energy Calculations (no derivation). **References** 1. N Claude Cohen. 1996. The Molecular Modeling Perspective in Drug Design, Academic Press. 2. Arseni Markoff. 2007. Analltical Tools for DNA, Genes & Genomes, New Age. 3. Anna Trarnontano. 2007. Introduction to Bioinformatics, Taylor & Francis. 4. Des Higgins & Willie Taylor. 2005. Bioinformatics, Oxford. 5. A M Campbell and L J Heyer. 2007. Discovering Genomics, Proteomics and Bioinformatics, Pearson education.	Explain the method of structure-based drug design and basic concept of systems biology

Course Code and Title	MSPSC03DSC14 **ETHNO BOTANY AND ETHNO PHARMACOLOGY** **Credits: 3 (45 hrs)**	**Module Outcome**
Course Objectives	▪ To study the interrelationship between people and plants, historically and cross-culturally. Explore the role of plants in human culture and practices, how humans have used and modified plants, and how they represent them in their systems of knowledge. ▪ The course aims to introduce students to the science of how people use plants in different cultures and societies (ethnobotany), with emphasis on current research and issues. The objectives of this course are to: Introduce students to the basic concepts of ethnobotany with emphasis on plant-human interactions.	
Module I **12 hrs**	**Introduction** - relevance, scope and status. Classification, International, National and Regional (Kerala State) Contributions (J.W. Harshberger, R.E. Schultes, E.K. Janakiammal, M.S. Swaminathan S.K. Jain, K.S. Manilal, V.V Sivarajan & P. Pushpangadan). Centres of Ethnobotanical studies in India, AICRPE-All India Coordinated Research Project on Ethnobiology, FRLHT- Foundation for the Revitalisation of Local Health Traditions. Study in brief about Tribal/Folk communities of Kerala State focusing on Anthropology, Customs and Beliefs & Archaeological Ethnobotany. (Koraga, Kurichiya, Adiyan, Paniya, Cholanaikan, Kadar, Kurumba, Kuruman, Kani, Ulladan, Kattunayakan, Muthuvar, Irular). Role of ethno-medicine and its scope in modern times. Role of Ethnobotany in conservation and sustainable development. **References**	• Student will able to study the eminent personalities contributed in the field of ethnobotany. • To acquire knowledge about different tribal communities residing in Kerala

	1. Chaudhuri, Rai, H. N., Guha, A., Roychowdhury, E. & Pal, D. C. 1980. Ethnobotanical uses of Herbaria-II. J. Econ. Tax. Bot. 1:163-168. 2. Chaudhuri, Rai, H. N., Banerjee, D. K. & Guha, A. 1977. Ethnobotanical uses of herbaria. Bull. Bot. Surv. India19:256-261. 3. Faulks, P.J. 1958. An Introduction to Ethnobotany. Moredale Publications Ltd., London. 4. Ford, R. I. (Ed.). 1978. The Nature and Status of Ethnobotany. Anthropological Paper no.67. Museum of Anthrop., Univ. of Michigan. 5. Harshberger, J. W. 1896. The Purpose of Ethnobotany. Bot. Gazette 31: 146-154. 6. Jain, S. K. 1964. The role of a Botanist in folklore Research. Folklore 5:145-150 7. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 1, Eastern Ghats and Deccan. Apple Academic Press, Inc. Taylor & Francis Group 8. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 2 Western Ghats and West Coast of Peninsular India. Apple Academic Press, Inc. Taylor & Francis Group 9. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 5, The Indo-Gangetic Region and Central India. Apple Academic Press, Inc. Taylor & Francis Group 10. Singh K. S. 2002. People of India: Kerala (3 pts.) Volume 27, Issue 2, Anthropological Survey of India 11. Luiz A. A. D. 1986. Tribes of Kerala Bharatiya Adimjati Sevak Sangh	
Module II **12 hrs**	**Methods in the ethnobotanical study**: General ethnobotanical techniques-Anthropological field methods. Quantitative approach (Open-ended and semi-structured interviews, 'Hands on' learning of traditional techniques) and Qualitative approach (Structured interviews and questionnaires, Free-listing, Pile sorting and preference ranking: triadic and paired, Systematic surveys -e.g., of transects or hectare plots); Linguistic and other symbolic	• Students will be able to enumerate the key anthropological field methods used in ethnobotanical studies • Demonstrate the ability to design and conduct open-ended and semi-structured interviews.

	analyses - Symbolic and Empirical analysis of Myths and Folklore; Plant labels and cultural significance. Plant collection and taxonomy: Nature and uses of voucher specimens, Plant identification. The plant used in ethnomedicine- e.g.: *Trichopus zeylanicus, Aegle marmelos, Janakia arayalpatra, Rauwolfia serpentina, Justicia adhatoda, Tinospora cordifolia.* Preparation and their uses. National and Global interests in ethnobotany: Plant derived drugs used in orthodox medical practice; Traditional Plant management and Environmental conservation; Traditional germplasm management: in situ and ex-situ conservation; Local benefits: Cultural survival and community development: Ethnomedicine and Primary health care; Renewable plant products: Sustainable source of income; Protecting local resources. Commercialization and conservation: Sustainable development - Economic growth and resource conservation. **References** 1. Jain, S. K. & Rao, R. R. 1983. Ethnobotany in India-An Overview. Botanical Survey of India. 2. Jain, S. K. (Ed.). 1981. Glimpses of Indian Ethnobotany. Oxford & IBH Publishing Co. 3. Jain, S. K. 1967a. Ethnobotany – Its scope and study. Indian Museum Bull. 2:39-43. 4. Jain, S. K. 1995. A Manual of Ethnobotany. Scientific Publishers. 5. Jain, S. K., Mudgal, V., Banerjee, D. K., Guha, A., Pal, D. C. & Das, D.1984 6. Anthony B Cunningham Applied 2001. Ethnobotany People, Wild Plant Use and Conservation. Earthscan Publications Ltd 7. Russell Bernard H. 2006. Research Methods in Anthropology: Qualitative and Quantitative Approaches, AltaMira Press A division of Rowman & Littlefield Publishers, Inc.	• Design and conduct structured interviews using standard questionnaires.

8. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 1, Eastern Ghats and Deccan. Apple Academic Press, Inc. Taylor & Francis Group
9. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume, Volume 2 Western Ghats and West Coast of Peninsular India. Apple Academic Press, Inc. Taylor & Francis Group
10. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume, Volume 5, The Indo-Gangetic Region and Central India. Apple Academic Press, Inc. Taylor & Francis Group
11. Alan Bryman. 1988. Quantity and Quality in Social Research, Loughborough University. Routledge, Taylor & Francis Group. Unwin Hyman Ltd
12. Anita Jain and S.K. Jain. 2016. Indian Ethnobotany – Bibliography of 21st Century (2001-2015). Scientific Publishers (India).
13. Ashok K. Jain. 2016. Indian Ethnobotany: Emerging Trends (Dr. S.K. Jain Felicitation Volume). Scientific Publishers (India)
14. Jain, S. K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi
15. Jain, S. K. (1989). Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow 12
16. Jain, S. K. (1995). A manual of Ethnobotany. Scientific Publishers, Jodhpur
17. Jain, S. K., Mudgal, V., Banerjee, D. K., Guha, A., Pal, D. C. and Das, D. (1984). Bibliography of Ethnobotany. Botanical Survey of India, Howrah
18. Jain S.K. (1997). Contribution to Indian Ethnobotany, Sci. Publ. Jodhpur

Module III **11 hrs**	**Phytochemistry and pharmacology** Introduction, scope and relevance. A brief account of Phytochemistry, pharmacodynamics and pharmacokinetics. Difference between herbal/botanicals and pharmaceutical medicine. Quality, safety and efficacy of herbal medicines/ nutraceuticals. Role of ethnopharmacology in drug development. *In vivo* Screening methods used for herbal drugs: Screening for anti-inflammation and analgesic activity, Screening for antiulcer activity, Screening for antidiuretic activity, Screening for liver-related disorder. Database on pharmaceutical uses of plants. Basic definition and types of toxicology, Regulatory guidelines for conducting toxicity studies as per OECD, Alternative methods to animal toxicity testing. Biological screening of herbal drugs- introduction and need for phytopharmacological screening. *In vitro* Screening methods used for herbal drugs: Antimicrobial screening of herbal drugs, Screening for anticancer activity, Screening for antioxidant activity, Screening for antiurolythetic activity. **References** 1. Traditional plant medicines as sources of new drugs. P J Houghton in Pharmacognosy Trease and Evan's.16 Ed .2009 2. Cunningham, A. B. (2001). Applied Ethnobotany. Earthscan Publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996). 3. Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England 4. In vivo and in vitro assays Glimpses of ethnopharmacology 1994 Eds. P Pushpangadan, V George and U.Nyman 5. Faulks, P.J. (1958). An introduction to Ethnobotany, Moredale Publ. London 6. Jose Boban K. (1998). Tribal Ethnomedicine: Continuity and change. APH publishing corporation 5, Ansari Road, Darya Ganj, New Delhi	• Define and explain the key concepts in herbal medicine, including phytochemistry, pharmacodynamics, pharmacokinetics, and ethnopharmacology. • Describe the role of ethnopharmacology in drug development. • Define biopiracy and intellectual property rights (IPR) and explain the ethnopharmacology and IPR issues.

	7. Phytochemical Methods. Harborne JB. 1984.Chapman and Hall, London 8. Mathur, P. R. G. (1977). The tribal situation in Kerala. Kerala Historical Society, Trivandrum 9. Shashi, S. S. (1995). Tribes of Kerala (Encyclopedia of Indian tribes Series-8). Anmol Publication Pvt. Ltd. Ansari Road, Daryagang, New Delhi 10. Snehalatha and Jain, S. K. (1998). Historical Archive in Ethnobotany. Institute of Ethnobotany, NBRI, Lucknow 11. Padmaja Udaykumar. 2021. Medical Pharmacology, Sixth Edition, CBS Publishers & Distributors Pvt Ltd 12. John T. Romeo. 2003. Integrative Phytochemistry: from Ethnobotany to Molecular Ecology. Pergamon Elsevier Science Ltd Secondary Metabolism in Model Systems 13. John T. Romeo. 2004.Recent advances in phytochemistry. volume 38. Secondary Metabolism in Model Systems. Elscvicr Ltd. All rights reserved. 14. Jeliazkov (Zheljazkov) and Cantrell. 2016. Medicinal and Aromatic Crops: Production, Phytochemistry, and Utilization. American Chemical Society, Washington, DC. Distributed in print by Oxford University Press 15. Runeckles V. C. and E. Conn Metabolism and Regulation of secondary plant products. academic press New York San Francisco London. 16. Reinhard Jetter. Phytochemicals—Biosynthesis, Function and Application. Springer International Publishing Switzerland 2014 17. In vivo and in vitro assays Glimpses of ethnopharmacology 1994 Eds. P Pushpangadan, V George and U.Nyman	
Module IV **10 hrs**	Plants used by ethnic groups as food, medicines (Ethnomedicine), beverages, fodder, fibre, resins, oils, fragrances and other uses. NWFP (Non-Wood Forest Produces), animal products, minerals, artefacts, and rituals, used by Tribal and Folk Communities of Kerala. Traditional/indigenous knowledge and its importance. Ethnobotany and	• List and describe the different types of plants, animals, minerals, and artefacts used by tribal and folk communities of

	Ethnopharmacology as a tool to protect interests of ethnic groups and rural development. Biopiracy, Intellectual Property Rights (IPR). Ethnopharmacology and IPR issues. The integrated drug development programme, technology transfer and commercialization of Traditional medicine. **References** 1. C.P. Khare (Ed.). 2007. Indian Medicinal Plants: An Illustrated Dictionary. Springer Science 2. Sheona Shackleton, Charlie Shackleton and Patricia Shanley. 2011. Non-Timber Forest Products in the Global Context. Springer-Verlag Berlin Heidelberg. 3. Sarah A. Laird, Rebecca J. McLain and Rachel P. Wynberg 2010. Wild Product Governance: Finding Policies that Work for Non-timber Forest Products. Earthscan publication. 4. Azamal Husen, Rakesh Kumar Bachheti, Archana Bachheti. 2021. Non-Timber Forest Products Food, Healthcare and Industrial Applications. Springer 5. Traditional plant medicines as sources of new drugs. P J Houghton in Pharmacognosy Trease and Evan's.16 Ed .2009 6. Cunningham, A. B. (2001). Applied Ethnobotany. Earthscan publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996).	Kerala for food, medicine, beverages, fodder, fibre, resins, oils, fragrances, and other purposes. • Discuss the traditional/indigenous knowledge systems of tribal and folk communities of Kerala and their importance in conservation and sustainable use of natural resources.

Course Code and Title	MSPSC03DSC15 PRACTICAL V: PLANT BIOTECHNOLOGY, TISSUE CULTURE AND BIOINFORMATICS Credits – 3 (90 hrs)	Module Outcome
Course Objectives	▪ To study the techniques DNA isolation ▪ To study applicability of restriction enzymes in genetic engineering. ▪ To learn the plasmid isolation ▪ To understand methods in genomics and proteomics	
Module I 30 hrs	Genomic DNA isolation by CTAB method from plant tissues Isolation of bacterial genomic DNA. Molecular weight determination of DNA by Agarose gel electrophoresis Restriction fragment analysis of DNA. **References** 1. Ausubel, F. M. el al. (2002) Short protocols in Molecular Biology. Vol. l, 2 John Wiley & Sons. 2. Wilson, J. & Hunt, T. (2007) Molecular Biology of the Cell Problems Book: 5th Edition. Garland Science. 3. Lodish, H. (2007). Students Solutions Manual for Molecular Cell Biology. 4. W. H. Freeman Co. Innis, M. A., Gelfand, D. H. & Sninsky, J. J. (1999). PCR Applications: Protocols for functional Genomics. Academic Press.	Students will be able to understand advanced technique of genomic DNA isolation.
Module II 30 hrs	Plasmid DNA isolation. Estimation of DNA concentration by Spectrophotometric method. Lac induction by X-Gal method. **References** 5. Mitra, S. (1996) Genetic Engineering. Macmillan India Ltd. 6. Reed, R. et al. (2007) Practical Skills in Biomolecular Sciences.	Students will be able to understand plasmid DNA isolation quantification

Module III **15 hrs**	Exercises on Windows, Linux, Networking, Internet search & Graphics. Usage of Software for identification - Accessing existing databases on the Worldwide Web; Software for identification of species- BLAST Construction of phylogenetic tree- clustal W Secondary structure of protein sequence- SOPMA Nucleotide - BLAST **References** 1. Bioinformatics - Andreas D Baxevanis. Wiley Interscience, 1998. 2. Bioinformatics -David W Mount, Cold spring harbor, 2001. 3. Introduction to Bioinformatics - Arthw Lesk, Oxford, 2006. 4. Bioinformatics Stuart M Brown, NYU Medical Center, NY USA. 2000. 5. Fundamental Concepts of Bioinformatics - D E Krane & M L Raymer, Pearson, 2006. 6. Structural Bioinformatics PE Boume and H Weissig, Wiley - Liss, 2003. 7. Computational methods for macromolecular sequence analysis R F Doolittle. Academic Press, 1996.	Students will able to understand different biological databases, retrieve protein and nucleic acid sequences and can perform sequence alignment.
Module IV **15 hrs**	Usage of software to elucidate the structure of biomolecules, docking of molecules & molecular designing/modelling; Analytical software related to Genomics and proteomics. Usage of similarity, homology and alignment software; Software of Microarray analysis - design, processing and analysis. **References** 1. Computational Methods in Molecular Biology - S.L.Salzberg, D B Searls, S Kasi, Elsevier, 1998. 2. Bioinformatics, Methods And Applications Genomics, Proteomics And Drug Discovery - S C Rastogi, N Mendiratta& P Rastogi, PHI, 2006. 3. The Molecular Modeling Perspective in Drug Design - N Claude Cohen - Academic 4. Press, 1996. 5. Analytical Tools for DNA, Genes & Genomes: - Arseni Markoff, New Age, 2007. 6. Introduction to Bioinformatics - Anna Tramontano Taylor & Francis. (2007) 7. Bioinformatics - Des Higgins & Willie Taylor - Oxford. (2005) 8. Discovering Genomics, Proteomics and Bioinformatics - A M Campbel and L J Heyer, Pearson education, 2007.	Students will able to understand different methods used in genome and proteome analysis, techniques of molecular modelling, protein structure prediction.

Course Code and Title	MSPSC03DSC16 PRACTICAL VI ETHNOBOTANY AND ETHNOPHARMACOLOGY Credits – 3 (90 hrs)	
Module I **30 hrs**	**Ethnobotany** 1. Field trip to tribal settlement to survey, collection, documentation, processing and preservation of ethnobotanical specimens in the institutional repository. **Ethnopharmacology** 2. Preliminary phytochemical analysis **References** 1. Phytochemical Methods. Harborne JB. 1984.Chapman and Hall, London 2. Jose Boban K. (1998). Tribal Ethnomedicine: Continuity and change. APH publishing corporation 5, Ansari Road, Darya Ganj, New Delhi 3. Phytochemical Methods. Harborne JB. 1984.Chapman and Hall, London 4. Mathur, P. R. G. (1977). The tribal situation in Kerala. Kerala Historical Society, Trivandrum 5. Shashi, S. S. (1995). Tribes of Kerala (Encyclopedia of Indian tribes Series-8). Anmol Publication Pvt. Ltd. Ansari Road, Daryagang, New Delhi 6. Snehalatha and Jain, S. K. (1998). Historical Archive in Ethnobotany. Institute of Ethnobotany, NBRI, Lucknow 7. Padmaja Udaykumar. 2021. Medical Pharmacology, Sixth Edition, CBS Publishers & Distributors Pvt Ltd 8. John T. Romeo. 2003. Integrative Phytochemistry: from Ethnobotany to Molecular Ecology. Pergamon Elsevier Science Ltd Secondary Metabolism in Model Systems 9. John T. Romeo. 2004.Recent advances in phytochemistry. volume 38. Secondary Metabolism in Model Systems. Elscvicr Ltd. All rights reserved. 10. In vivo and in vitro assays Glimpses of ethnopharmacology 1994 Eds. P Pushpangadan, V George and U.Nyman	• To conduct ethnobotanical surveys in tribal settlements to document the traditional use of plants by ethnic groups. • To perform basic phytochemical tests, such as tests for alkaloids, flavonoids, tannins, terpenoids, and saponins, to identify the major classes of compounds present in herbal extracts.
Module II **30 hrs**	**Ethnobotany** 1. Review of a Peoples Biodiversity Register (PBR) in collaboration with BMC of a local self-government. Calculation of the Shannon/ Simpson's diversity index.	• Analyse the PBR to identify the most important plant species for the local community.

	Ethnopharmacology 2. Testing of Antimicrobial activity of herbal drug of by disc diffusion method **References** 1. Cunningham, A. B. (2001). Applied Ethnobotany. Earthscan Publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996). 2. Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England 3. Phytochemical Methods. Harborne JB. 1984.Chapman and Hall, London 4. Madhav Gadgil, P. R. Seshagiri Rao, Utkarsh Ghate, Ashwini Chhatre. 2000, New Meanings for Old Knowledge: Ecological Applications, Published by Wiley. 5. People's Biodiversity Register. Revised PBR Guidelines 2013, National Biodiversity Authority, India 6. In vivo and in vitro assays Glimpses of ethnopharmacology 1994 Eds. P Pushpangadan, V George and U.Nyman 7. John T. Romeo. 2003. Integrative Phytochemistry: from Ethnobotany to Molecular Ecology. Pergamon Elsevier Science Ltd Secondary Metabolism in Model Systems 8. John T. Romeo. 2004.Recent advances in phytochemistry. volume 38. Secondary Metabolism in Model Systems. Elscvicr Ltd. All rights reserved	• Identify any gaps in the PBR and suggest ways to improve it. • Calculate the Shannon and Simpson diversity indices for the plant species documented in the PBR. • Interpret the results of the diversity indices to draw conclusions about the plant diversity of the local area.
Module III **15 hrs**	**Ethnobotany** 1. Chemical test for Natural Products (honey) (Fiehe's test, Molisch's test, Reducing sugar test) **References** 1. Beverages, Sugar and Confectionery Product 2015, Manual of methods of analysis of foods, food safety and standards authority of India ministry of Health and Family Welfare Government of India New Delhi.	To perform test like Fiehe's test, Molisch's test, Reducing sugar test etc. for the determination of quality of natural products like honey.
Module IV **15 hrs**	**Ethnopharmacology** 1. Estimation of antioxidant activity of the herbal drug. 2. Determination of lipid (wax) profile by TLC method	• To perform test for the determination of antioxidant activity of the herbal drug.

	References 1. John T. Romeo. 2003. Integrative Phytochemistry: from Ethnobotany to Molecular Ecology. Pergamon Elsevier Science Ltd Secondary Metabolism in Model Systems 2. John T. Romeo. 2004.Recent advances in phytochemistry. volume 38. Secondary Metabolism in Model Systems. Elsevier Ltd. All rights reserved 3. Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England 4. Phytochemical Methods. Harborne JB. 1984.Chapman and Hall, London 5. Lipid analysis: Isolation, Separation, Identification and Lipidomic analysis 4th edition WW Christie and X Han, Wood head publishing, Oxford Cambridge UK, 2012.	• To determine the lipid profile of the natural wax products by TLC method.

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE) (Any 2 courses to be chosen)		
Course Code and Title	**MSPSC03DSE05** **METHODS IN PLANT BIOLOGY** **Credits 3 (48 hours)**	**Module Outcome**
Course Objectives	• This course aims to make the learners understand the important methods and innovative research used in plant biology and rules in scientific writing. This will help the master students in carrying out their dissertation work and preparing their thesis. • To study the important methods applied in different research areas and their technological advances. To expose students to scientific writing and make them understand how the research findings can be documented and communicated scientifically.	
Module I **10 hours**	**Basic concepts** – Mole, Atomic weight, Molecular weight. Concentration units- Normality- molarity, molality, ppm, percentage solutions. **Hazardous chemicals** – Rules for handling, Lab safety- Precautions. safety policy. labelling and Storage. **Scientific writing**: Review of literature; Content writing; preparing journal manuscripts. Use of reference software **References** 1. Chawla, H. S. (2009). Introduction to plant biotechnology (3rd ed.). Science Publishers. 2. Wilson, K. & Walker, J. (2018). Principles and techniques of biochemistry and molecular biology (8th ed.). Cambridge University Press. 3. APHA (American Public Health Association). (2003). Standard methods for examination of water and waste water.23th Ed.Washington DC, USA. 4. Benjamin R. Sveinbjornsson and Sveinbjorn Gizurarson Handbook for Laboratory Safety, 978-0-323-99320-3, Elsevier 5. Prof. Robert H. Hill Jr., David C. Finster, 2010, Laboratory Safety for Chemistry Students, Wiley, ISBN: 978-0-470-34428-6 6. C R Kothari., (2016) Research methodology : methods and techniques. New age international publishers	• Students will be able to describe and demonstrate basic concepts in research like atomic weight, molecular weight etc. and to perform basic scientific writing including journal manuscripts.
Module II **15 hrs**	**Microscopy:** Light microscopy- Bright-field, Dark-field, Phase-contrast, Differential interference contrast, Fluorescence, Laser	• Students will be able to describe the basic principles and applications of different

	dissection, confocal, Stereomicroscopy, Transmission and scanning electron microscopy. **Chromatography:** Principles and application: Paper chromatography, thin layer chromatography (TLC); HPTLC; Column chromatography: gel filtration, adsorption, partition, affinity, ion exchange; HPLC; Gas chromatography. LC-MS; GC-MS **Centrifugation**- Principles and application: types of centrifuges; Tracer techniques; Bioreactors, Fermenter. **Electrophoresis** – SDS PAGE **Spectroscopy:** Principles and application: Beer and Lambert law, Colorimetry and spectrophotometry, Flame photometry and atomic absorption spectrophotometry; Infrared spectroscopy- FTIR, NIR; Raman Spectroscopy; Nuclear Magnetic Resonance (NMR). Mass Spectrometry: Basic principle and application; ESI-MS; MALDI-TOF; MS-MS.LC-MS; GC-MS **References** 1. Ruzin, S. E. (1999). Plant microtechnique and microscopy. Oxford University Press. 2. Walter F. & Schmitt W. (1980). The microtome: Manual of the technique of preparation and of section cutting. Ernst Leitz Wetzlar GMBH. 3. Banwell C.N. (2016) Fundamentals of Molecular Spectroscopy. McGraw Hill Education 4. Snyder, L.R., Kirkland, J.J. & Dolan, J.W. (2009). Introduction to modern liquid chromatography (3rd ed.). Wiley.	types of microscopies, spectroscopy, and chromatography techniques used in plant biology research. • Students will be able to compare and contrast the applications, advantages disadvantages of different types of microscopies, spectroscopy, and chromatography techniques for different research purposes
Module III 11 hrs	**Flow cytometry Methods**: Principles of flow Cytometry, Nuclear DNA content measurement, Flow Cytometry and Ploidy: Applications in Systematics, Ecology and Evolutionary Biology, Genome Size Estimation, Analysis of endopolyploidy. **Structural biology and protein interactions**: Cryo-electron microscopy, X-ray crystallography, Protein NMR, and X-ray scattering; yeast two-hybrid assay, split protein assays, co-immunoprecipitation and affinity purification. Protein Localization: Reporter genes, florescent protein tagging, immunostaining.	• Students will be able to describe the basic principles and applications of flow cytometry and structural biology techniques. • Students will be able to compare and contrast the advantages and disadvantages of flow cytometry and structural biology techniques.

	References 1. Doležel, J., Greilhuber, J., & Suda, J. (2005). Flow cytometry with plant cells: Analysis of genes, chromosomes and genomes. Wiley-VCH Publishers. 2. Harris, R. K., Roderick, E. W., & Wasylishen, D. J. (2009). NMR crystallography. Wiley. 3. Bollag, D. M., Rozycki, M. D., & Edelstein, S. J. (2009). Protein methods (2nd ed.). Wiley. 4. Chawla, H. S. (2009). Introduction to plant biotechnology (3rd ed.). Science Publishers.	
Module IV **12 hrs**	**Biostatistics**: Quantitative methods in biology- introduction -Methods of data collection- primary and secondary data- census and sampling methods. Tabulation and presentation of numerical data- diagrammatic and graphical presentation. Measures of central tendencies- mean, median and mode. Skewness and kurtosis. Measures of variations- range, quartile deviation, mean deviation- variance and standard deviation. Standard error and Coefficient of variation. Tests of significance- z, t and $\chi 2$ tests. Analysis of variance. Analysis of variance - (ANOVA) - One way and two-way, Correlation and regression analysis. Experimental designs. Introduction to various statistical software. **References** 1. Bailey, N. T. J. (1969). Statistical methods in biology. The English Universities Press. 2. Osborn, John. Fundamentals of biostatistics. Bernard Rosner, PWS-Kent, Boston, 1990. 3. Sokal, Robert R., and F. James Rohlf. "Biostatistics." Francise & Co, New York 10 (1987). 4. Norman, Geoffrey R., and David L. Streiner. Biostatistics: the bare essentials. PMPH USA (BC Decker), 2008.	• Students will be able to explain the basic concepts and uses of biostatistics and scientific writing in plant biology research. • Students will be able to evaluate and contrast different ways of collecting, analysing, and presenting data in plant biology research

Course Code and Title	MSPSC03DSE06 **TISSUE CULTURE AND PLANT BREEDING** **Credits – 3 (45 hours)**	**Module Outcome**
Course Objectives	• Highlight the role played by Plant breeding and Biotechnology in modern society and its relevance to sustainable solutions for agriculture, environment and energy sectors. • Understand the principles and methods of both conventional and modem plant breeding. • To familiarize with plant tissue culture techniques.	
Module I **12 hours**	Introduction to cell and tissue culture-Tissue culture media (composition, preparation) - growth hormones- Pathways of regeneration- initiation and maintenance of callus and cell suspension culture- organogenesis- embryogenesis-Micropropagation: various stages of micropropagation, importance, subculture, hardening, vitrification, Germplasm conservation slow growth and Cryopreservation. Somatic embryogenesis- pathways–conditions importance. Callus pathway and Somaclonal variations. **References** 1. Flynne, W. G. (2008). Biotechnology and bioengineering. Nova Publishers. 2. Bhowjwani, S.S. (1990). Plant Tissue Culture: Application and Limitations. Amsterdam, Elsevier 3. Bhojwani, S. S., & Razdan, M. K. (1986). Plant tissue culture: theory and practice. Elsevier. 4. Chrispeels, M. J., & Sadava, D. E. (2003). Plants, genes, and crop biotechnology. Jones & Bartlett Learning. 5. Cunningham, C., & Porter, A. J. (Eds.). (2008). Recombinant proteins from plants (Vol. 3). Springer Science & Business Media. 6. Doods, J. H. & Roberts, L. W. (1985). Experiments in Plant Tissue culture, Cambridge University Press. 7. George, E. F. (1993). Plant propagation by tissue culture part 1. The technology.	• The students will get in-depth knowledge both theoretically and practically about plant cell culture and manipulation techniques.

Module II **12 hours**	Haploid plant production, Importance of haploid plants. Androgenesis: pre-treatment of anther/pollen grains, callus induction and shoot regeneration, androgenic embryos and development. Merits and demerits of anther culture. Microspore culture, Protocol, Advantages of microspore culture over anther culture- In vitro gynogenesis, Ovary/ovule/flower bud culture, embryo culture, Protoplast isolation culture and fusion- methods-somatic hybrids and cybrids. Production of haploids, triploids and endosperm culture. Selection methods of cybrids and its applications. **References** 1. Narayanaswamy, S. (1994). Plant cell and tissue culture. Tata McGraw-Hill Education. 2. Kumar, N. (Ed.). (2022). Biotechnology and Crop Improvement: Tissue Culture and Transgenic Approaches. CRC Press. 3. Hammond, J., McGarvey, P., & Yusibov, V. (Eds.). (2012). Plant biotechnology: new products and applications (Vol. 240). Springer Science & Business Media. 4. Razdan, M. K. (2002). An introduction to plant tissue culture. Oxford and IBH publishing. 5. Slater, A., Scott, N., & Fowler, M. (2008). Plant biotechnology: the genetic manipulation of plants. OUP Oxford. 6. Smith, R. H. (2012). Plant tissue culture: techniques and experiments. academic press. 7. Smith, R.2000. Plant Tissue Culture: Techniques and Experiments.2nd ed., Academic Press.	
Module III **10 hours**	Production of secondary metabolites from plant cell cultures - Processes for enhancing the production of secondary metabolites- Technology of plant cell culture for production of chemicals- Bioreactor systems and models for mass cultivation of plant cells. Molecular Farming & Industrial Products-Application of Plant biotechnology to produce quality oil- Industrial enzymes paper, biodegradable plastics-antigens (edible vaccine) and plantibodies. Metabolic engineering for plant secondary metabolites. **References** 1. Gupta, P. K. (1994). Elements of biotechnology. Rastogi Publications. 2. De, K. K. (1997). Plant tissue culture. New Central Book Agency.	• To understand the concepts of modern technology pertaining to large scale production of Plant secondary products

	3. Mascarenhas, A. F. (Ed.). (1991). Handbook of plant tissue culture. Publ. and Information Division, Indian Council of Agricultural Research. 4. Dubey, R. C. Publications of Prof. RC Dubey A. Books Published: 12. 5. Trivedi, P. C. (Ed.). (2001). Algal Biotechnology. Pointer Publishers. 6. Rashid, A. (2009). Molecular physiology and biotechnology of flowering plants. Alpha Science International. 7. Smith, R. H. (2012). Plant tissue culture: techniques and experiments. academic press. 8. Smith, R.2000. Plant Tissue Culture: Techniques and Experiments.2nd ed., Academic Press.	
Module IV **10 hours**	**Introduction to Plant Breeding** - History- Biological foundations of plant breeding- conventional techniques- advanced techniques- special methods. Biological foundations of Plant breeding- Role of heredity and environment in character expression- Systems of reproduction in plants- Mating systems in sexually reproduced plants. Plant propagation- sexual, pseudosexual and asexual methods- special methods of plant propagation- micropropagation. Conventional methods of plant breeding- plant domestication, plant introduction, selection and hybridization. Modern methods of plant breeding- mutation breeding, polyploidy breeding and distant hybridization. Biotechnological approaches in plant breeding. Breeding for special purposes-breeding for pest, disease and stress resistance. Quality breeding- Heterosis breeding. Breeding synthetic varieties. Breeding composite varieties. **References** 1. Sadhu, M. K. (1989). Plant propagation. New Age International. 2. Allard, R. W. (1999). Principles of plant breeding. John Wiley & Sons. 3. Jain, H. K., & Kharkwal, M. C. (Eds.). (2012). Plant breeding: Mendelian to molecular approaches. Springer Science & Business Media. 4. Mohanan, K. V. (2010). Essentials of plant breeding. PHI Learning Pvt. Ltd. 5. Roy, D., & Kharkwal, M. C. (2004). Breeding for wider adaptability. In Plant Breeding: Mendelian	• The students will acquired is familiarity with basic and applied methods of plant breeding.

	to molecular approaches (pp. 573-584). Dordrecht: Springer Netherlands. 6. Hayward, M. D., Bosemark, N. O., & Romagosa, T. (Eds.). (2012). Plant breeding: principles and prospects. Springer Science & Business Media. 7. Gupta, S. K. (Ed.). (2015). Breeding oilseed crops for sustainable production: opportunities and constraints. Academic press.	

Course Code and Title	MSPSC03DSE07 MICROBIOLOGY Credits – 3 (45 hours)	Module Outcome
Course Objectives	• To prepare students by imparting skills to use technological developments related to current and advanced areas involving microbiology. • To understand the importance of microbe's classification • To acquire proficiency in good laboratory practices in microbiology laboratory. • To develop skill to observe, isolate, identify and cultivate microorganisms.	
Module I **12 hours**	**Introduction to Microbiology:** Definition, scope and history of microbiology. Diversity of microbial world. Classification of microorganisms – general principles and nomenclature, Basic understanding of classification of Bacteria, viruses and protozoa. Beneficial and harmful microbes. Difference between the prokaryotic and eukaryotic microorganisms. **References** 1. Alexopoulus C.J. and C W. Mims.(1993). Introductory Mycology (3rd edition).Wiley Eastern Ltd, New Delhi. 2. Heritage, J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press. 3. Prescott L.M. Harley J.P. and Klein D.A. (2003). Microbiology (5th edition) McGraw Hill, New York. 4. Madigan, M.T. Martinko.J.M and Parker J Brock T.D. (1997). Biology of Microorganisms. (8th edition).Prentice Hall International Inc, London.	▪ Thorough understanding the fundamentals of Microbiology as applicable to wide ranging contexts.
Module II **12 hours**	**Techniques in microbiology:** Principles and applications of microscopy simple, compound, bright field, dark field, phase contrast, fluorescent and electron microbiology. Principles of staining: Nature of dyes, types of staining – simple, differential, negative and spore staining, Sterilization: Sterilisation and disinfection – physical and chemical methods. **References** 1. Nester, E.W., Roberts, C.V. and Nester, M.T. (1995).Microbiology, A human perspective. IWOA, U.S.A. 2. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill. Inc, New York.	▪ Understand the applicability of technology in microbiology

	3. Salle, A.J. (1996). Fundamental principles of Bacteriology. (7th edition).Tata McGraw - Hill publishing company Ltd, New Delhi. 4. Caldwell, D.R. (1995). Microbial Physiology and metabolism, Wm. C. Brown Publishers, U.S.A.	
Module III **11 hours**	**Microbial physiology and metabolism:** Methods of bacterial identification- morphological, physiological, biochemical properties. Culture techniques: Types of media simple, defined, enriched and transport media. Types of streaking. Maintenance and preservation of microbes. Physiology of microbial growth and nutrition. Growth Curve. Nutritional requirements. Energy production in bacteria- Energy and ATP, aerobic respiration, Glycolysis and tricarboxylic acid cycle, Anaerobic respiration- Fermentation, alcohol fermentation by yeasts and bacteria, lactic acid fermentation. Antigen antibody reaction and types, ELISA. Role of microbes in soil fertility, Nitrogen fixation. **References** 1. Lansing M. Prescott, John P. Harley and Donald A. Klein. (2003). Microbiology. (5th edition). McGraw - Hill company, New York. 2. Schelegel, H.G. (1993) General Microbiology, 7th Edn.Cambridge University Press, Cambridge. 3. Microbiology Pelczar, Chan and Krieg. Ananthanarayan and Paniker's Textbook of Microbiology R. Ananthanarayan, C.K. JayaramPanikar 4. Prescott/Harley/Klein's Microbiology by Joanne Willey, Linda Sherwood, and Chris Woolverton	▪ Understand the concepts of application and research in Microbiology and inculcate sense of scientific responsibilities.
Module IV **10 hours**	**Industrial microbiology:** Sources of industrially important microbes and methods for their isolation, preservation (brief account only). Production of alcohol, vinegar, bread, dairy products &single cell protein. Microbial production of industrial products Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes. **References** 1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited. 2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA.	▪ Applicability of knowledge and Interdisciplinary approach in microbiology

	3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell. 4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company. 5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited. 6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi. 7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.	

MULTIDISCIPLINARY ELECTIVE COURSES (MDC) OFFERED FOR OTHER DEPARTMENTS		
Course Code and Title	**MSPSC03MDC03** **AGRI-BUSINESS** **Credits – 4 (60 hours)**	**Module Outcome**
Course Objectives	• Develop professional skill and employability skill in agriculture • The course aims to educate the students about the use and interrelationship of various information systems like crop production, market information and food processing. • To familiarize the students with the agrochemicals, their structure, classification and development and also how to manage the agro-chemical industries	
Module I **20 hours**	**Agribusiness:** Meaning of Agribusiness, Definition of Agribusiness, Transformation of agriculture into agribusiness. Careers in Agribusiness- Types of Businesses Importance of Agribusiness in Indian Economy. New Agricultural Policies. Agro based Industries, Classification of Agro based Industries, Types of Agro based Industries- Sugar Mills, Cotton Ginning Mills, Dal Mills, Rice Mills, Poha Mills, Fruit Processing Industries etc. Global agri-food system. **References** 1. Agribusiness Management by Dr. Shivaji Nagpure & Dr. R.G. Deshmukh, M/s. AGROMET Publishers, Nagpur. 2. Indian Agriculture & Agri-Business Management by Dr. Smita Diwase, M/s. Scientific Publishers, Jodhpur, Rajasthan. 3. Agricultural Finance & Management by S. Subha Reddy, & P. Raghu Ram, M/s. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi. 4. Brenda Clark (Author), Judy Commers (Author) Entrepreneurship 2nd Edition, 2016.	Agribusiness is designed to give students a background in the decision making process and day-to-day financial management skills required to effectively operate a business.
Module II **20 hours**	**Management of organic farming in agri-business:** Organic farming-concept, definition, principles and components. Status of organic farming in India and in other countries. Organic certification system. National programme on organic production in India. Marketing of organic produce. Agri entrepreneurship in organic agriculture. Bio-village concept. Organic food industry and trade of organic products. **References** 1. Acharya SS & Agarwal NL. 2004. Agricultural Marketing in India. 4th Ed. Oxford & IBH.	The students will possess the knowledge and understanding necessary to implement organic farming principles.

	2. Broadway AC & Broadway Arif A. 2003. A Text Book of Agri-Business Management. Kalyani. 3. Singh AK & Pandey S. 2005. Rural Marketing. New Age. 4. Singh Sukhpal 2004. Rural Marketing- Focus on Agricultural Inputs. Vikas Publ. House. 5. Arun K. Sharma. 2002. A Hand book of organic farming. Agrobios, India. 627p. 6. Palaniappan, S.P and Annadurai, K.1999. Organic farming-Theory and Practice. Scientific publishers, Jodhpur,India. 257p. 7. Mukund Joshi and Prabhakarasetty, T.K. 2006. Sustainability through organic farming. Kalyani publishers, New Delhi. 349p.	
Module III **20 hours**	**E commerce in agri-business** E-commerce overview: Introduction, features, importance to economy, limitations and challenges in e-commerce with special reference to India. Success stories of organisations involved in e-agri business, case studies and future vision of e-agri business in India. **References** 1. Agri Business Management by Dr. J.S. Amarnath & Dr. A.P.V. Samvel, M/s. Satish Serial Publishing House, Delhi-110033. 2. The Agribusiness Book by Mukesh Pandey, Deepali Tewari, M/s. ibdc Publishers, Lukhnow (U.P.), Pin-226 001. 3. Satyveer Singh Meena / Aditi Mathur- 2024, Agri Business A Managerial Perspective-216p 4. Sawalia Bihari Verma, 2023 Agricultural Marketing in India : Concept & Challenges 443p 5. Sawalia Bihari Verma, 2022., Agricultural Marketing: 2nd Revised And Enlarged Edition, 404p	Students can acquire Knowledge in agriculture marketing and understand the marketing efforts for rural areas and to provide practically and facilitate enhanced learning.

Course Code and Title	MSPSC03MDC04 **ENVIRONMENTAL AUDITING AND IMPACT ASSESSMENT** **Credits – 4 (60 hours)**	**Module Outcome**
Course Objectives	▪ This course, while providing the required technical knowledge on conducting an EIA, examines EIA from a critical perspective as a strategic, comprehensive, and pro-active process employed to integrate the ecological and social aspects of development into planning and environmental/resource management processes. ▪ Introduce students to the concept of Environmental Management ▪ Develop skills in identifying and solving environmental problems. ▪ Teach the principles and practices of effective environmental management system audits	
Module I **20 hrs**	**Introduction to Environment:** Definition, scope, components, structure and composition. Environmental pollution due to increasing growth rate, population and human interaction. Water, land and air pollution. Environmental quality, and pollution monitoring. Sources of Pollution and prevention. Carbon reduction solution- Greenhouse Gas Emissions, Kyoto Protocol, Carbon Footprint, Carbon Trading, Carbon Diet, Carbon Credits, Role of Trees and Forest in Reducing Atmospheric Carbon, Carbon sequestration, bioremediation, phytoremediation **References** 1. Water (Prevention and Control of Pollution) Act 1974. Air (Prevention and Control of Pollution) Act 1981. 2. Trivedi, P.R., Natural Resources Conservation, APH Publishing Corporation, New Delhi. 3. Introduction to Carbon Capture and Sequestration, Smit, B., Reimer, J. A., Oldenburg, C. M. and Bourg, I. C. (2014), Imperial College Press, London.	Identify the pollution status of present environment and calculate the carbon footprint of any organization and identify suitable mitigation strategies for carbon reduction solutions.
Module II **20 hrs**	**Environmental Impact Assessment:** Definition and scope, preliminary screening requiring EIA of projects. Impact identification, Assessment of Impact; Impact Evaluation. Types of EIA, rapid and comprehensive. Environmental Protection acts, Rules and Standards, EIA guidelines. EIA Case studies- Land Clearing Projects – Dam sites –Aquaculture- Power Plants – Industrial Projects. Inter linking of Rivers and River Basin Management.	Explain the concepts about Environmental Impact Assessment, develop skills in identifying and solving problems

	References 1. MoEF, GoI, Environment Impact Assessment, Impact Assessment Division, January 2001 (Manual). 2. Westman, Walter E., "Ecology, Impact Assessment and Environment Planning" John Wiley and Sons, Canada, 1985. 3. Environmental Impact Assessment, Canter, L.W. (1996), McGraw Hill, New York. 4. Environmental Impact Assessment- A Comprehensive Guide to Project and Strategic Planning, Eccleston, C. H. (2000), John Wiley and Sons.	
Module III **20 hrs**	**Environmental auditing** Introduction, Necessity, Procedure for Environmental Auditing, Environmental audit Significance for Industry - Elements of Environmental audit. Process of environmental audit-Pre-audit- Activity -Activities at site- Post audit. Environmental Management System- ISO 14000 series of standards. Green Entrepreneurship- Green Consumerism, Green belt development, Green Technology. Certification Process – Different Phases of Audit, Certification Audit. Various Certifying Agencies in Operation. Carbon neutral Panchayath of Wayanad- Case study. **References** 1. Sharma, R.D. (1976), Organisational Management, Light and Life Publishers, New Delhi 2. Kovntz, H and C. Danvel (1978): Essential of management, second edition, Tata Mc Graw Hill publishing company, New Delhi. 3. Erickson, P.A. (1977) Environmental Impact Assessment – Principles and Erickson, P.A. (1977) 4. Green Accounting, Bartelmus, P. and Seifert, E. K. (2017), Taylor & Francis Limited.	Explain the importance of environmental audits and other management tools in business for social benefit by improving environmental performance

Course Code and Title	MSPSC03MDC05 **PLANT TISSUE CULTURE AND CONSERVATION** **Credits – 4 (60 hrs)**	**Module Outcome**
Course Objectives	▪ Highlight the role played by plant tissue culture and conservation and its relevance to sustainable solutions for agriculture. ▪ Understand the basic concepts of conservation biology on current research and issues. ▪ To familiarize with plant tissue culture techniques and secondary metabolite production.	
Module I **15 hrs**	Introduction to Plant Tissue culture, Historical background, Terms and definitions, Totipotency of cells, differentiation, dedifferentiation and cytodifferentiation, Tools and techniques. Media and Culture Preparation, Role of Micro and macro nutrients, Vitamins and carbon source in tissue culture, Media preparation, culture media, Murashige and Skoog's (MS medium), - pH, Temperature, Solidifying agents, Maintenance of cultures, explants characteristics. **References** 1. Bhojwani, S. S., & Razdan, M. K. (1986). Plant tissue culture: theory and practice. Elsevier. 2. Chrispeels, M. J., & Sadava, D. E. (2003). Plants, genes, and crop biotechnology. Jones & Bartlett Learning. 3. De, K. K. (1997). Plant tissue culture. New Central Book Agency. 4. Kumar, N. (Ed.). (2022). Biotechnology and Crop Improvement: Tissue Culture and Transgenic Approaches. CRC Press. 5. Mascarenhas, A. F. (Ed.). (1991). Handbook of plant tissue culture. Publ. and Information Division, Indian Council of Agricultural Research. 6. Smith, R. H. (2012). Plant tissue culture: techniques and experiments. academic press. 7. Smith, R.2000. Plant Tissue Culture: Techniques and Experiments.2nd ed., Academic Press.	The students will get in-depth knowledge both theoretically and practically about plant cell culture.
Module II **15 hrs**	Initiation of Cultures, Induction and growth parameters; Culture initiation, Callus culture. Micropropagation through various explants. Organ Culture - Anther, Pollen, Embryo and Endosperm	The students will get knowledge different methods of culture techniques.

	culture, Hairy Root Culture and their applications. Organogenesis and Somatic embryogenesis- Techniques and Applications. Protoplast Culture, Protoplast-Isolation regeneration and Viability test, Somatic hybridization and methods of protoplast fusion. Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and "synthetic seeds". Cryopreservation, Germ plasm conservation. **References** 1. Bhowjwani, S.S. (1990). Plant Tissue Culture: Application and Limitations. Amsterdam, Elsevier 2. Cunningham, C., & Porter, A. J. (Eds.). (2008). Recombinant proteins from plants (Vol. 3). Springer Science & Business Media. 3. Dubey, R. C. Publications of Prof. RC Dubey A. Books Published: 12. 4. Narayanaswamy, S. (1994). Plant cell and tissue culture. Tata McGraw-Hill Education. 5. Rashid, A. (2009). Molecular physiology and biotechnology of flowering plants. Alpha Science International. 6. Razdan, M. K. (2002). An introduction to plant tissue culture. Oxford and IBH publishing. 7. Slater, A., Scott, N., & Fowler, M. (2008). Plant biotechnology: the genetic manipulation of plants. OUP Oxford.	
Module III **15 hrs**	Production of secondary metabolites from plant cell cultures - Processes for enhancing the production of secondary metabolites- Technology of plant cell culture for production of chemicals- Bioreactor systems and models for mass cultivation of plant cells, Types of Bioreactor. **References** 1. Doods, J. H. & Roberts, L. W. (1985). Experiments in Plant Tissue culture, Cambridge University Press. 2. Flynne, W. G. (2008). Biotechnology and bioengineering. Nova Publishers. 3. George, E. F. (1993). Plant propagation by tissue culture part 1. The technology. 4. Gupta, P. K. (1994). Elements of biotechnology. Rastogi Publications. 5. Hammond, J., McGarvey, P., & Yusibov, V. (Eds.). (2012). Plant biotechnology: new	To will understand the concepts of bioreactor technology pertaining to large scale production of Plant secondary products

	products and applications (Vol. 240). Springer Science & Business Media. 6. Smith, R. H. (2012). Plant tissue culture: techniques and experiments. academic press. 7. Smith, R.2000. Plant Tissue Culture: Techniques and Experiments.2nd ed., Academic Press.	
Module IV **15 hrs**	Natural Resources Conservation, Role of individuals in Sustainable Environmental Management. Bioresource conservation: In situ and ex-situ conservation, protected area concepts, Wildlife Sanctuaries, National Parks and Biosphere Reserves; Botanical gardens and zoos, Conservation programmes: UNEP, MAB, Ramsar convention, Convention on Biodiversity. Conservation and Ecological movements in India and Kerala. **References** 1. Kareiva, P., & Marvier, M. (2015). Conservation science: balancing the needs of people and nature. Roberts & Co. 2. Bawa, K., Primack, R. B., & Oommen, M. A. (2011). Conservation biology: a primer for South Asia. Orient Blackswan. 3. von Fürer-Haimendorf, C., & Von, F. H. C. (1982). Tribes of India: the struggle for survival. Univ of California Press. 4. Hunter Jr, M. L., & Gibbs, J. P. (2006). Fundamentals of conservation biology. John Wiley & Sons. 5. Primack, R. B. (2006). Essentials of conservation biology (Vol. 23). Sunderland: Sinauer Associates.	Students will have a thorough understanding of the different conservation approaches.

Course Code and Title	MSPSC03MDC06 ETHNOBOTANY AND CONSERVATION Credits 4 (60 hrs)	Module Outcome
Course Objectives	▪ Explore the general principles of ethnobotany, including its history and importance in traditional and modern culture across continents. ▪ Introduce students to the basic concepts of ethnobotany with emphasis on plant-human interactions.	
Module I **15 hrs**	Interdisciplinary approaches in Ethnobotany. Introduction - relevance, scope and status. Classification, International, National and Regional (Kerala State) Contributions. AICRPE All India Coordinated Research Project on Ethnobiology, Contributions of AICRPE. Study in brief about Tribal/Folk communities of Kerala State focusing on Anthropology, Customs and Beliefs & Archaeological Ethnobotany. (Koraga, Kurichiya, Adiyan, Paniya, Cholanaikan, Kadar, Kurumba, Kuruman, Kani, Ulladan). Role of ethnomedicine and its scope in modern times. Role of Ethnobotany in conservation and sustainable development **References** 1. Chaudhuri, Rai, H. N., Guha, A., Roychowdhury, E. & Pal, D. C. 1980. Ethnobotanical uses of Herbaria-II. J. Econ. Tax. Bot. 1:163-168. 2. Chaudhuri, Rai, H. N., Banerjee, D. K. & Guha, A. 1977. Ethnobotanical uses of herbaria. Bull. Bot. Surv. India19:256-261. 3. Faulks, P.J. 1958. An Introduction to Ethnobotany. Moredale Publications Ltd., London. 4. Ford, R. I. (Ed.). 1978. The Nature and Status of Ethnobotany. Anthropological Paper no.67. Museum of Anthrop., Univ. of Michigan. 5. Harshberger, J. W. 1896. The Purpose of Ethnobotany. Bot. Gazette 31: 146-154. 6. Jain, S. K. 1964. The role of a Botanist in folklore Research. Folklore 5:145-150 7. Bibliography of Ethnobotany. Botanical Survey of India. 8. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 1, Eastern Ghats and Deccan. Apple Academic Press, Inc. Taylor & Francis Group 9. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 2 Western Ghats and West Coast of Peninsular India. Apple Academic Press, Inc. Taylor & Francis Group	• Students will be able to classify and discuss International, National, and Regional (Kerala State) contributions to Ethnobotany. • Students will be able to discuss the role of ethnomedicine and its scope in modern times.

	10. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 5, The Indo-Gangetic Region and Central India. Apple Academic Press, Inc. Taylor & Francis Group 11. Singh K. S. 2002. People of India: Kerala (3 pts.) Volume 27, Issue 2, Anthropological Survey of India 12. Luiz A. A. D. 1986. Tribes of Kerala Bharatiya Adimjati Sevak Sangh	
Module II **15 hrs**	Plant collection: Nature and uses of voucher specimens, Plant identification. The plant used in ethnomedicine-. Preparation and their uses. Ethnobotany and its role in conservation of native plant genetic resources. Ethnobotany in development and conservation of resources. Plant derived drugs used in orthodox medical practice; Traditional Plant management and Environmental conservation; Traditional germplasm management: in situ and ex-situ conservation; Local benefits: Cultural survival and community development: Renewable plant products: Sustainable source of income; Protecting local resources. Commercialization and conservation: Sustainable development - Economic growth and resource conservation. Documentation and analysis of ethnobotanical data. **References** 1. Jain, S. K. & Rao, R. R. 1983. Ethnobotany in India-An Overview. Botanical Survey of India. 2. Jain, S. K. (Ed.). 1981. Glimpses of Indian Ethnobotany. Oxford & IBH Publishing Co. 3. Jain, S. K. 1967a. Ethnobotany – Its scope and study. Indian Museum Bull. 2:39-43. 4. Jain, S. K. 1995. A Manual of Ethnobotany. Scientific Publishers. 5. Jain, S. K., Mudgal, V., Banerjee, D. K., Guha, A., Pal, D. C. & Das, D.1984 6. Anthony B Cunningham Applied 2001. Ethnobotany People, Wild Plant Use and Conservation. Earthscan Publications Ltd 7. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 1, Eastern Ghats and Deccan. Apple Academic Press, Inc. Taylor & Francis Group 8. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 2 Western Ghats and West Coast of Peninsular India. Apple Academic Press, Inc. Taylor & Francis Group 9. Pullaiah, T, K. V. Krishnamurthy, and Bir Bahadur, 2017. Ethnobotany of India, Volume 5, The Indo-	• Students will be able to identify traditional plant management practices that promote conservation. • Students will be able to identify ways in which ethnobotanical knowledge can be used to support sustainable development and conservation. • Students will be able to develop and implement ethnobotany-based projects that benefit local communities and the environment.

	Gangetic Region and Central India. Apple Academic Press, Inc. Taylor & Francis Group 10. Anita Jain and S.K. Jain. 2016. Indian Ethnobotany – Bibliography of 21st Century (2001-2015). Scientific Publishers (India). 11. Ashok K. Jain. 2016. Indian Ethnobotany: Emerging Trends (Dr. S.K. Jain Felicitation Volume). Scientific Publishers (India) 12. Jain, S. K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi 13. Jain, S. K. (1989). Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow 12 14. Jain, S. K. (1995). A manual of Ethnobotany. Scientific Publishers, Jodhpur 15. Jain, S. K., Mudgal, V., Banerjee, D. K., Guha, A., Pal, D. C. and Das, D. (1984). Bibliography of Ethnobotany. Botanical Survey of India, Howrah 16. Jain S.K. (1997). Contribution to Indian Ethnobotany, Sci. Publ. Jodhpur	
Module III **15 hrs**	Introduction, scope and relevance pharmacology. Difference between herbal/botanicals and pharmaceutical medicine. Role of ethnopharmacology in drug development. Biological screening of herbal drugs- introduction and need for phytopharmacological screening. Basic definition and types of toxicology, Regulatory guidelines for conducting toxicity studies as per OECD. Intellectual Property Rights (IPR). Ethnopharmacology and IPR issue. **References** 1. Traditional plant medicines as sources of new drugs. P J Houghton in Pharmacognosy Trease and Evan's.16 Ed .2009 2. Cunningham, A. B. (2001). Applied Ethnobotany. Earthscan Publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996). 3. Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England 4. In vivo and in vitro assays Glimpses of ethnopharmacology 1994 Eds. P Pushpangadan, V George and U.Nyman 5. Jose Boban K. (1998). Tribal Ethnomedicine: Continuity and change. APH publishing corporation 5, Ansari Road, Darya Ganj, New Delhi 6. Phytochemical Methods. Harborne JB. 1984.Chapman and Hall, London	• Students will be able to define herbal/botanical medicine and pharmaceutical medicine. • Students will be able to discuss the successes and challenges of ethnopharmacology in drug development. • Students will be able to discuss the ethical implications of IPR protection for ethnopharmacological knowledge.

	7. Padmaja Udaykumar. 2021. Medical Pharmacology, Sixth Edition, CBS Publishers & Distributors Pvt Ltd 8. John T. Romeo. 2004.Recent advances in phytochemistry. volume 38. Secondary Metabolism in Model Systems. Elscvicr Ltd. All rights reserved. 9. Jeliazkov (Zheljazkov) and Cantrell. 2016. Medicinal and Aromatic Crops: Production, Phytochemistry, and Utilization. American Chemical Society, Washington, DC. Distributed in print by Oxford University Press 10. Runeckles V. C. and E. Conn Metabolism and Regulation of secondary plant products. academic press New York San Francisco London. 11. Reinhard Jetter. Phytochemicals—Biosynthesis, Function and Application. Springer International Publishing Switzerland 2014	
Module IV **15 hrs**	Indigenous/Traditional Knowledge: Plants used by ethnic groups as food, medicines (Ethnomedicine), beverages, fodder, fibre, resins, oils, fragrances, and other uses. NWFP (Non-Wood Forest Produces), animal products, minerals, artefacts, and rituals, used by Tribal and Folk Communities of Kerala. Traditional/indigenous knowledge and its importance. Ethnobotany and Ethnopharmacology as a tool to protect interests of ethnic groups and rural development. **References** 1. C.P. Khare (Ed.). 2007. Indian Medicinal Plants: An Illustrated Dictionary. Springer Science 2. Sheona Shackleton, Charlie Shackleton and Patricia Shanley. 2011. Non-Timber Forest Products in the Global Context. Springer-Verlag Berlin Heidelberg. 3. Sarah A. Laird, Rebecca J. McLain and Rachel P. Wynberg 2010. Wild Product Governance: Finding Policies that Work for Non-timber Forest Products. Earthscan publication. 4. Azamal Husen, Rakesh Kumar Bachheti, Archana Bachheti. 2021. Non-Timber Forest Products Food, Healthcare and Industrial Applications. Springer 5. Traditional plant medicines as sources of new drugs. P J Houghton in Pharmacognosy Trease and Evan's.16 Ed. 2009 6. Cunningham, A. B. (2001). Applied Ethnobotany. Earthscan publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996).	• Students will be able to explain the importance of ITK for biodiversity conservation, sustainable development, and cultural survival. • Acquire knowledge on non-timber forest products used by the indigenous community and also to understand the commercial importance of NTFP • Students will be able to describe the different methods used to conduct ethnobotanical and ethnopharmacological studies.

FOURTH SEMESTER

<table>
<tr><th colspan="3">DISCIPLINE SPECIFIC CORE COURSE (DSC)</th></tr>
<tr><td>Course Code and Title</td><td>MSPSC04DSC17
CONSERVATION BIOLOGY
Credits – 3 (52 hrs)</td><td>Module Outcome</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• The course aims to introduce conservation biology to students with an emphasis on current research and issues.
• Introduce students to the basic concepts of conservation biology with emphasis on tribal communities and bio conservation practices of the Western Ghats.</td></tr>
<tr><td>Module I
11 hrs</td><td>Conservation biology: Introduction to Conservation Biology, Conservation, and its approaches. Biodiversity - levels, measurement, documentation and valuation. Extinctions - causes of extinction – overexploitation, habitat destruction, Predicting extinction risk of species. Species invasions– large- and large-scale patterns and issues. Management of Invasive Alien Species (IAS). Biotic responses to climate change, global climate change and extinction of species, conservation management tools and issues.

References
1. Marvier, M. and Kareiva, P.M. (2011). Conservation Science: Balancing the Needs of People and Nature. Roberts and Company
2. Bawa, K.S., Primack, R.B. and Oomen, M.A. (2011). Conservation Biology. A primer for South Asia. Universities Press, Hyderabad, India. 589 pp
3. Hunter, L.M. and Gibbs, J.P. (2006). Fundamentals of Conservation Biology, 3rd Edition. Wiley-Blackwell Publications, New Jersey, USA. 516 pp</td><td>As a result of taking this course, students should:
Recognize and articulate the key aspects of biodiversity, the causes of biodiversity loss, and the role of conservation biology in preserving biodiversity</td></tr>
<tr><td>Module II
11 hrs</td><td>Demographic issues: Population viability analysis, ecological restoration. Consequences of small populations. Minimum viable populations and the extinction debt. Rarity - demography and genetics. Minimum viable population concept. Choosing conservation priority areas.</td><td>Know the problems facing various populations at the global level.</td></tr>
</table>

	References 1. Pielou, E.C. (1975). Ecological Diversity. Wiley Inter-science Pub. 2. Primack, R.B. (1993). Essentials of Conservation Biology. Soiner, MA 3. Hunter, M.L. (1996). Fundamentals of Conservation Biology. Blackwell	
Module III **15 hrs**	**Conservation management tools and issues**: Single species care; costs. Establishing new populations. Habitat maintenance. Restoration, captive breeding, cryogenesis, re-introductions, cloning. Conservation policy around the world. Legislations in India and Kerala. Wildlife Conservation Act (1972) Indian Forest Conservation Act (1980) Biodiversity Conservation Act (2002). International conservation agreements. Conservation Genetics, Management and conservation of genetic variation in natural populations. Ex-situ and In-situ conservation. Designing conservation reserve **References** 1. Furer-Haimendorf, C.V. (1985). Tribes of India - the struggle for survival. OUP. New Delhi 2. Hasnain, N. (2007). Tribal India. New Royal Book Company 3. Hasnain, N. (2011). Indian Anthropology. Palaka Prakashan	Recognize the science involved in conservation, in addition to the laws, policies, and regulations at all levels of government relevant to conservation
Module IV **15 hrs**	**Ethics and conservation:** The structure and nature of the traditional Indian social system. Tribes and aborigines- an anthropological perspective. Racial classification and distribution of tribes. Tribes in India and Kerala. Appraisal of tribal development - problems of tribal identity and integration in the mainstream. Relation between tribes and forests- Forests as the means of livelihood - changes consequent to government control of forests. Forest management and tribal welfare- management conflicts and way forward. Role of government in tribal welfare. Indigenous knowledge and tribal development,	Able to know the ethical issue among various tribal populations of India, in particular Kerala tribes. Moreover, it also provides ethnobotanical knowledge and relationships between tribes and forests.

	Ethnomedicinal practices and traditional wisdom, Biopiracy of medicinal plants, Bio imperialism and bioprospecting. **References** 1. Sharma, R.N. and Bakshi, S. (1984). Tribes and tribal development. Uppal Publ. House, New Delhi 2. Sharma, R. N., Sharma, R.K. (1997). Anthropology. Atlantic Publishers &; Distributors. 3. Thakur, D. (1986). Socio-economic development of tribes in India. Deep and Deep Publications, New Delhi	

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)		
Course Code and Title	**MSPSC04DSE08** **FOREST BOTANY** **Credits – 3 (45 hrs)**	**Module Outcome**
Course Objectives	• This course aims to provide students with an understanding of the core topics in forest botany. • *To examine pattern & process in plant distribution, with emphasis on both* ecological and evolutionary perspectives.	
Module I **12 hrs**	**General Introduction to Forest:** Status of forests in India and their role. History of forestry development in India. Site factors - climatic, edaphic, physiographic, biotic and their interactions. Classification of climatic factors. Edaphic factors - influence of biological agencies, parent rock, topography on the soil formation. Physiographic factors - influence of altitude, latitude, aspect and lope on vegetation. Biotic factors - influence of plants, insects, wild animals, man and domestic animals on vegetation. Theories of succession. Classification of forests - Forest types of India and their distribution. Forests as potential carbon sinks- C sequestration **References:** 1. Balakathiresan, S. 1986. Essentials of forest management, Nataraj Publishers, D'Doon. 2. Champion, H. and Seth, S.K. 1968. A revised survey ofthe forest types ofIndia. Delhi: Manager of Publications. https://dds.crl.edu/crldelivery/23005.	▪ Students learn the concepts of forest ecosystems, factors influencing forest formation, and their adaptation to various climatic conditions.

Module II **12 hrs**	**Forest and Biodiversity**: Biodiversity and conservation — definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, measurement of diversity and diversity indices. Principles of conservation biology, Ex-situ and In situ methods of Conservation, Wildlife sanctuaries, Genetic and evolutionary principles in conservation. Biosphere concept. Conservation — efforts in India and worldwide. Mangrove forest ecosystem, Social forestry and community forestry- concepts. National forest policies, Miyawaki forest concept, Forest Utilization- Introduction, methods of collection- Classification, management and importance of Non-Timber Forest Products (NTFP) **References** ▪ Misra, K.c. 1974. Manual of P1ant Ecologv. Oxford &IBH Pub co. New Delhi etc. 491p ▪ Evans, J E. 1982. Plantation Forestry in the Tropics. The English Language Book Society and Clarendon Press — Oxford ▪ Tropical Forest Ecology, Florencia Montagnini, Carl F. Jordan, Springer, 2005	▪ Students are able to understand the forest biodiversity, human-animal interactions, and conservation of forests and wildlife.
Module III **11 hrs**	**Forest reproduction:** - flowering, fruiting and seeding behavior. Regeneration of forests Objectives ecology of regeneration- factors governing the choice of regeneration techniques. Natural, artificial and mixed regeneration. seed production, dispersal, germination and establishment. Importance of seed forestry- Seed production areas- seed orchards—plus tree - elite seed tree, isolated tree. Methods of seed collection. Fruit and seed handling - Seed storage- Seed dormancy- classification of types of dormancy. Treatments for breaking exogenous and endogenous dormancy. Seed testing - definition- ISTA rules. **References** 1. Evans, J E. 1982. Plantation Forestry in the Tropics. The English Language Book Society and Clarendon Press — Oxford 2. Haig, I. T. et al 1986. Tropical Silviculture, Vol. I and Il. Food and Agriculture	▪ The study of forest reproduction is essential to understanding forest seed propagation and preservation.

	Organization of the United Nations Rome and Periodical Experts Book Agency, D-42, Vivek Vihar, Delhi - 110 032. 3. ISTA. 1993. International Rules for Seed Testing Rules. International Seed Testing Association, Zurich, Switzerland, 1993.	
Module IV **10 hrs**	**Phytogeography**: Importance. Descriptive Phytogeography: Types of plant distribution: Continuous distribution; cosmopolitan, circumpolar, circumboreal or circumaustral, and pantropical; discontinuous distribution; Theory of land- bridge, theory of continental drift, theory of polar oscillations or shifting of poles, glaciations. Centres of origin and diversity of plants; Methods of dispersal, migrations and isolation; Theories on the distribution of plants: theory of age and area, theory of tolerance. Factors influencing plant distribution; Floristic regions of the world: Major terrestrial biomes Vegetation Zones concerning latitudes and altitudes; a brief account of the phytogeographical regions of India (recent classification by BSI); Geographical Information Systems: definition, fundamental concepts and components of GIS; developments and future trends in GIS. Climatology: Climatic variability and climate change; Climatic classifications; Climatic regions of India; Use of satellite technologies in climate studies. **Reference** 1. Champion, H. and Seth, S.K. 1968. A revised survey ofthe forest types ofIndia. Delhi: 2. Manager of Publications. https://dds.crl.edu/crldelivery/23005. 3. Daniel, T.W., Helms, J.A., Baker, F.S. 1970. Principles ofSilviculture, McGraw Hill, N.Y.	▪ Phytogeography enhances our understanding of ecological processes and interactions between plants and their environment. This knowledge contributes to our understanding of ecosystem functioning, species interactions, and adaptations to different environmental conditions.

Course Code and Title	MSPSC04DSE09 LANDSCAPE ECOLOGY (45 Hrs Credits - 3)	Module Outcome
Course Objectives	• The main objective of this course is to develop students' in-depth understanding of landscape ecology. • Landscape ecology is a young, integrative field, and is still developing, and thus students will explore an overview of the field with hands-on, applicable experience with its concepts and tools.	
Module I 11 hrs	The link between landscape patterns and ecological processes at large spatial (landscape) scales. History and definition of landscape ecology, its relationship to other subfields of ecology, Causes of landscape pattern (abiotic, biotic, human land use and disturbance), Data for studying landscapes (GIS, remote sensing), Measuring landscape pattern (spatial statistics, landscape pattern analysis), Landscape disturbance dynamics, Conservation ecology. Landscape and Principles; - Landscape structure: - Hierarchical framework, Landscape metrics: quantification and applications; Fractals; Influences of land use patterns on landscape integrity; Human disturbances and landscape structure: Landscape equilibrium. **References:** 1. Swanson, F.J., T.K. Kratz, N. Caine, and R.G. Woodmansee. 1988. Landform effects on ecosystem patterns and processes. Bioscience 38:92-98. Landscape ecology (journal) 2. Landscape Ecology by Richard T.T. Forman and Michel Godron; Published by John Wiley & Sons, New York	Upon completion of the course, the students will have a thorough understanding of the principles of landscape ecology, the structure, hierarchy, species diversity, etc. Also, they would familiarise themselves with the analysis of landscape data using software tools.
Module II 12 hr	Landscape structure and Processes, Geographic Ecology: Isolation and Species Richness; Sampling Area and Number of species, Island Area and Species Richness, Island Isolation and Species richness, Theory of Island Biogeography, Equilibrium model of Island Biogeography, Concept of Metapopulation theory Spatial heterogeneity, landscape connectivity - Fragmentation — Landscape genetics Landscape elements: Heterogeneity, scale, pattern—process relationships, hierarchy, disturbance, coupled ecological-social dynamics, and sustainability,	Use the tools specific to landscape ecology to answer questions about heterogeneity, scale, and ecosystems dynamics.

	Conservation planning, ecosystem management, Neutral models of landscape patterns. **References**: 1. Landscape ecology in theory and practice, Turner, M.G., and R.H. Gardner. 2015. 2nd edition. Springer, New York. 482 pp. 2. Learning Landscape Ecology, Gergel, S.E., and M.G. Turner (eds.). 2017 2nd edition. Springer, New York. 347 pp.	
Module III 11 hrs	Scale concepts: Definition and theory, applications, types of scaling, scales of variation, Habitat assessment- Species Vulnerability. Landscape Pattern: Physical: biotic, Disturbance, Land use, populations, communities, Measuring landscape pattern, Analysis of pattern formation, Effects of landscape pattern on organisms, populations, communities and ecosystem processes, spatial pattern **References:** 1. *Essentials of Landscape Ecology*. Kimberly A. With, Oxford University Press (2019). © Kimberly A. With 2019. 2. Ecology of multiple ecosystems in time and space, Chen, J., and Saunders, S., 2006, in Chen, J., Saunders, S., Brosofske, K.D., and Crow, T.R., eds., Ecology of Hierarchical Landscapes: From Theory to Applications: New York, New York, USA, Nova Science Publishers, Inc., p. 1-36	Infer the abiotic and biotic processes that structure landscape mosaics and patterns of biodiversity at multiple spatial scales;
Module IV 11hr	Spatial statistics & autocorrelation — Landscape management: issues, prospects, and case studies. Computation of landscape metrics and parameters using FRAGSTATS or any other software; lab exercise on analysis of landscape data using spatial statistics software (SAM, ArcGIS, etc); analysis of meta-populations using RAMAS GIS. **References:** 1. Landscape Patterns in a Range of Spatio-Temporal Scales, Alexander V. Khoroshev, Kirill N. Dyakonov 2020. 2. Spatial Statistics in Landscape Ecology. Fortin, MJ. (1999) In: Klopatek, J.M., Gardner, R.H. (eds) Landscape Ecological Analysis. Springer, New York, NY. https://doi.org/10.1007/978-1-4612-0529-6_12	Learn methodology, and application of landscape ecology to contemporary issues in conservation biology and resource management

	3. Spatial analysis of landscapes: concepts and statistics Helene H. Wagner, Marie-Josée Fortin 2005, https://doi.org/10.1890/04-0914.	

Course Code and Title	MSPSC04DSE10 **WETLAND ECOLOGY** **Credits – 3 (45 hrs)**	**Module Outcome**
Course Objectives	▪ This course aims to provide students with an understanding of the core topics in wetland ecology ▪ Upon completion of the course, the students will have a thorough understanding of the wetland ecosystems of the world, the biodiversity associated, the conservation aspects associated etc. ▪ Students would familiarise with the mapping of wetlands, wetland surveys to measure aquatic plant diversity.	
Module I **11 hrs**	**Wetlands:** definition, concepts, and functions – Wetland hydrology – Seasonality – Wetland nutrient cycles and buffers – Classification, inventory, and delineation of wetlands, Cultural attitudes toward wetlands. Types of wetlands: Coastal wetlands – Inland wetlands - Freshwater Swamps, Coastal marshes, Mangrove swamps, "Vital" ecosystem – Wetland flora and fauna–Wetland communities, zonation, and succession and composition of species, plant communities, microbiology and soils, biogeochemistry (C & N cycles) (P and other nutrients) **References** 1. Austin, M.P., Smith, T.M. (1990). A new model for the continuum concept. In: Grabherr, G., Mucina, L., Dale, M.B., Ter Braak, C.J.F. (eds) Progress in theoretical vegetation science. Advances in vegetation science, vol 2. Springer, Dordrecht 2. Carter, R. W. G. 1988. Coastal Environments: An Introduction to the Physical, Ecological, and Cultural Systems of Coastlines. Academic Press, London, UK. 3. Keddy, P.A. Wetland Ecology: Principles and Conservation. Cambridge University Press, Cambridge, UK. 4. Mitsch, W. J., & J. G. Gosselink. 1993. Wetlands, 2nd Edition. John Wiley & Sons, Hoboken, NJ.	• Define and explain the concepts and functions of wetlands. • Differentiate between different types of wetlands like coastal wetlands and inland wetlands.

	5. Mitsch, W. J., J.G. Gosselink, C.J. Anderson, L. Zhang. Wetland ecosystems. 2009. John Wiley & Sons, Hoboken, NJ.	
Module II **10 hrs**	**Carbon sequestration in wetlands** – Biological adaptations to wetland ecosystems, degradation, the adaption of species, mapping of wetlands, estimation of primary productivity, wetland surveys to measure aquatic plant diversity. Climate change and wetlands. **References** 1. Batzer, D. P., & Sharitz, R. R. (Eds.). (2006). Ecology of freshwater and estuarine wetlands. University of California Press 2. McVoy, C. W., Park, W. A., Obeysekera, J., VanArman, J. A., & Dreschel, T. W. (2011). Landscapes and hydrology of the pre-drainage Everglades. University Press of Florida. 3. Mitsch, W. J., & Gosselink, J. G. (1993). Wetlands (2nd ed.). John Wiley & Sons 4. Mitsch, W. J., Gosselink, J. G., Anderson, C. J., & Zhang, L. (2009). Wetland ecosystems. John Wiley & Sons	• Describe the biological adaptations to wetland ecosystems. • Explain the impact of wetland degradation on carbon storage and identify techniques for assessing and mitigating these effects.
Module III **12 hrs**	**Primary productivity of wetlands**– Biodiversity and ecosystem values of wetlands – Valuation of wetland ecosystem functions and services – Human impacts and management of wetlands – Factors influencing wetland properties: hydrology, fertility, disturbance, competition, and sedimentation. Wetland restoration – Methods, Active and passive restoration, Rehabilitation, the impact of restoration, Water Quality Treatment of Wetlands, Invasive species management **References** 1. Pittman, Craig, & Matthew Waite. 2009. Paving Paradise: Florida's Vanishing Wetlands and the Failure of No Net Loss. University Press of Florida, Gainesville, FL. 2. Rydin, H., & J. Jeglum. 2006. The Biology of Peatlands. Oxford University Press. Oxford, UK. 343.	• Identify and describe the key factors that influence wetland primary productivity, including hydrology, fertility, disturbance, competition, and sedimentation

	3. Batzer, D. P., & Sharitz, R. R. (Eds.). (2006). Ecology of freshwater and estuarine wetlands. University of California Press 4. Keddy, P. A. (2000). Wetland ecology: Principles and conservation. Cambridge University Press 5. Lodge, T. E. (2010). The Everglades handbook: Understanding the ecosystem (3rd ed.). CRC Press. 6. Mitsch, W. J., & Gosselink, J. G. (1993). Wetlands (2nd ed.). John Wiley & Sons	
Module IV **12 hrs**	**Wetland conservation and management**– Conventions and Treaties – International agencies in wetland conservation – Indian legal framework for wetland management. Field exercise in wetland mapping, water and sediment sampling, sampling of benthic fauna and planktons; lab analysis of water and sediment properties; estimation of primary productivity; quantification of benthic fauna and planktons; wetland surveys to measure floral diversity. **References** 1. Carter, R. W. G. (1988). Coastal environments: An introduction to the physical, ecological and cultural systems of coastlines. Academic Press. 2. Keddy, P. A. (2000). Wetland ecology: Principles and conservation. Cambridge University Press1 3. Pittman, C., & Waite, M. (2009). Paving paradise: Florida's vanishing wetlands and the failure of no net loss. University Press of Florida. 4. Tomlinson, P. B. (1986). The botany of mangroves. Cambridge University Press.	• Explain the international conventions and treaties related to wetland conservation. • Estimate primary productivity in wetlands, using various methods.

PROJECT WORK
Course Code – MSPSC04DSC18 Credits - 10

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