THE SYLLABUS OF THE
BSc PLANT SCIENCE PROGRAMME
OF
UNIVERSITY OF CALICUT
(Effective from 2019 admissions)

B.Sc. PROGRAMME IN PLANT SCIENCE

Calicut University Regulations for Choice Based Credit and Semester System for Under-Graduate (UG) Curriculum 2019 (CBCSSUG Regulations 2019) are to be followed for admission, registration, examinations, internal and external evaluation and grading.

PLANT SCIENCE CORE COURSES

COURSE STRUCTURE, WORK LOAD AND CREDIT DISTRIBUTION

Semester	Paper Code	Title of Paper	Instructional hours/ Semester	Hours allotted / Week	Credit
S- I	PLA1B01T	CORE COURSE I. Plant Anatomy	36 h	2	3
	PLA1B01P	CORE COURSE. PRACTICAL - I	36 h	2	
S -II	PLA2B02T	CORE COURSE II. Methodology and Perspective of Science	36 h	2	3
	PLA2B02P	CORE COURSE. PRACTICAL - II	36 h	2	
S-III	PLA3B03T	CORE COURSE III. Algae, Fungi, Lichens, Bacteria, viruses & Plant Diseases	54 h	3	4
	PLA3B03P	CORE COURSE. PRACTICAL - III	36 h	2	
S-IV	PLA4B04T	CORE COURSE IV Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany	54 h	3	4
	PLA4B04P	CORE COURSE. PRACTICAL - IV	36 h	2	
		PRACTICAL PAPER - I - EXTERNAL			2.5
		PRACTICAL PAPER - II - EXTERNAL			2.5
	PLA5B05T	CORE COURSE V Morphology & Taxonomy of Angiosperms	72 h	4	4
	PLA5B05P	CORE COURSE. PRACTICAL - V	45 h	2.5	

S-V	PLA5B06T	CORE COURSE VI Phytogeography, Ethnobotany, Economic Botany & Embryology	72 h	4	4
	PLA5B06P	CORE COURSE. PRACTICAL - VI	45 h	2.5	
	PLA5B07T	CORE COURSE VII	72 h	4	4
		Plant Physiology & Biochemistry			
	PLA5B07P	CORE COURSE. PRACTICAL VII	45 h	2.5	
S - VI	PLA6B08T	CORE COURSE. - VIII Cell Biology, Molecular Biology and Bioinformatics	72 h	4	4
	PLA6B08P	CORE COURSE. PRACTICAL - VIII	45 h	2.5	
	PLA6B09T	CORE COURSE. - IX Genetics, Evolution & Ecology	72 h	4	4
	PLA6B09P	CORE COURSE. PRACTICAL - IX	45 h	2.5	
	PLA6B10T	CORE COURSE - X Horticulture, Plant Breeding & Biostatistics	72 h	4	4
	PLA6B10P	CORE COURSE. PRACTICAL - X	45 h	2.5	
	PLA6B11T	ELECTIVE- CHOICE - I Biotechnology	72 h	4	4
	PLA6B012T	ELECTIVE- CHOICE II Medicinal Plants	72 h	4	4
	PLA6B013T	ELECTIVE - CHOICE III Forestry	72 h	4	4
		PROJECT			2
		PRACTICAL PAPER III - EXTERNAL			3
		PRACTICAL PAPER IV - EXTERNAL			3

Course structure, work load and credit distribution of Open Courses offered to students of other Departments

Semester	Course Code	Instructional Hours	Instructional Hours	Hours allotted/ Week	Credit
V	PLA5D01	OPEN COURSE - CHOICE I Mushroom Cultivation	54 h	3	3
	PLA5BD02	OPEN COURSE - CHOICE II Plant Tissue Culture	54 h	3	3
	PLA5D03	OPEN COURSE - CHOICE III Biofertilisers and Organic Farming	54 h	3	3

Course structure, work load and credit distribution of General Courses offered to Plant Science students

Semester	Course Name	Instructional Hours	Hours allotted/ Week	Credit
III	GENERAL COURSE - I	72 hrs	4	4
	GENERAL COURSE - II	72 hrs	4	4
IV	GENERAL COURSE -III	72 hrs	4	4
	GENERAL COURSE -IV	72 hrs	4	4

Semester-wise Credit Distribution for BSc Plant Science Programme

Semester	Common courses			Core courses	Complementary courses		Open Course	Total
	English	Additional Language	General Courses		Chem	Zool		
I	4+3	4		3	2	2		18
II	4+3	4		3	2	2		18
III			4+4	4	2	2		16
IV			4+4	4+2.5*+2.5*	2+4*	2+4*		29
V				4+4+4			3	15
VI				4+4+4 4 +3*+3* +2**				24
Total	**14**	**8**	**16**	**55**	**12**	**12**	**3**	**120**

*Credits for Practical Examinations; ** Credits for Project Work

Total Credits for the BSc Plant Science Programme. 120
Credits for common courses 38
Credits for core courses including project & elective. 55
Credits for complimentary courses… 24
Credits for open course 03

Credits for the complimentary course practical will be awarded at the end of the 4th semester. Credits for the main course practical will be awarded at the end of the sixth semester. Practical examinations shall be conducted by the University at 4th and 6th semesters.

Core Courses in Plant Science
Mark Distribution and Scheme of Examination

Course Code	Duration of Exams	Marks				Total
		Theory		Practical		
		EE	IE	EE	IE	
PLA1B01 T	2 h	60	15	--	--	75
PLA2B02 T	2 h	60	15	--	--	75
PLA3B03 T	3h	80	20	--	--	100
PLA4B04 T	3h	80	20	--	--	100

Core Pract. - I PLA1B01 P & PLA3B03 P	3h			120 [70+30+20] *EE+R+Sub	30	150
Core Pract. - II PLA2B02 P & PLA4B04 P	3 h			120 [70+30+20] EE+R+Sub	30	150
PLA5B05 T	3 h	80	20	--	--	100
PLA5B06 T	3 h	80	20	--	--	100
PLA5B07 T	3h	80	20	--	--	100
PLA6B08 T	3h	80	20	--	--	100
PLA6B09 T	3 h	80	20	--	--	100
PLA6B10 T	3h	80	20	--	--	100
PLA6B11/12/13 T	3h	80	20	--	--	100
Core Pract. – III PLA5B05P, PLA5B06P& PLA5B07P	3 h			120 [70+30+20] EE+R+Sub	30	150
Core Pract. - IV PLA6B08P, PLA6B09P& PLA6B10 P	3 h			120 [70+30+20] EE+R+Sub.	30	150
Project Report & Viva	10 Min/student			40	10	50
Total		**840**	**210**	**520**	**130**	**1700**

*EE – External Evaluation marks; R- Marks assigned for Record; Sub – Marks assigned for submission; IE - Internal Evaluation marks; T- Theory; P- Practical

Mark Distribution for the entire B.Sc Plant Science Programme

English Courses	Theory	4 x 100	400	**400**
Add. Lan. Courses	Theory	2 x 100	200	**200**
General Courses	Theory	4 x 100	400	**400**
Core Courses	Theory	9 x 100	900	**1700**
		2x75	150	
	Practical	4 x 150	600	
	Project	1 x 50	50	
Open Courses	Theory	1 x 75	75	75
Comp. Courses	Theory	8 x 75	600	**600**
	Practical	2 x 80	160	
TOTAL				**3375**

INSTRUCTIONS

A. Core Courses

The total number of core theory courses is eleven, one course each during the first four semesters, three courses each during fifth and sixth semesters and one elective course in the sixth semester. In the sixth semester there are three elective courses offered. An institution can choose any one of the following elective courses:

Elective 1- PLA6B11 Biotechnology, Elective 2- PLA6B12 Medicinal Plants, Elective 3- PLA6B13 Forestry.

B. Core Course Practicals

Practicals corresponding to each core course will be conducted during the corresponding semesters. There shall be four external practical examinations for the core course practicals. One external practical examination each shall be conducted for the following clusters of core course practical:

Practical Paper I: Core course I Practical & Core Course II [At the end of 4th Semester].

Practical Paper II: Core course III Practical & Core course IV Practical [At the end of 4th Semester].

Practical Paper III: Core course V Practical, Core course VI Practical & Core Course VII Practical [At the end of 6th Semester].

Practical Paper IV: Core course VIII Practical, Core course IX Practical & Core Course X Practical [At the end of 6th Semester]

C. Project

Project works will be carried out in fifth and sixth semesters. A group of students shall be given a combined project to minimize the work load on teachers. Each individual student should submit a copy of the project report duly attested by the supervising teacher and the Head of the Department. The evaluation of the project work shall be conducted at the end of the sixth semester along with the practical examination.

D. Complementary Courses

The Compulsory complementary course for the BSc Plant Science programme will be Chemistry. The Elective Complementary course can be selected from the following three subjects: Zoology, Biochemistry or Microbiology. The syllabus/Course offered by the University as per the recommendations of Boards of Studies in Chemistry/Zoology/Biochemistry/Microbiology for UG complimentary courses (Chemistry/ Zoology/Biochemistry/Microbiology) shall be followed for the complimentary courses.

E. Open Courses

In the 5th semester, Plants Science Main students shall opt for an open course offered by other Departments/streams. A Department offering Plant Science Main courses may offer the following open courses to students other than Plant Science main students:

Open Course 1- PLA5D01Mushroom Cultivation, Open Course 2- PLA5D02 Plant Tissue Culture, Open Course 3- PLA5D03 Biofertilisers and Organic Farming.

F. General Courses

As the BSc Plant Science programme is a course in the 'language reduced pattern' (alternate stream), four common language courses are replaced by four General Courses (General Course – I; General Course - II; General Course - III; & General Course - IV). General Courses I & II are in 3rd semester and General Courses III & IV are in 4th semester. The syllabi of these four General Courses are common for the following BSc programmes in the 'language reduced pattern': Biotechnology, Biochemistry, Aquaculture and Plant Science and shall be prepared jointly by the UG Boards of Studies in these subjects.

G. Examinations

There shall be university (theory) examinations at the end of each semester. Practical examinations shall be conducted by the university at the end of fourth and sixth semester. Project evaluation and viva-voce on the project shall be conducted along with the practical examination towards end of sixth semester. The question papers (for the Core Course Theory & Practical papers and the Open Course Theory Paper) are to be set in English and the answers are to be written in English.

H. Pattern of theory question papers

The external examination question paper is two types: - 4 credit papers in 80 marks external and 20 marks internal evaluation; 2/3 credit papers in 60 marks external and 15 marks internal valuation.

Question paper Type 1

Scheme of examination

The external QP with 80 marks and internal evaluation is of 20 marks. Duration of examination is 2.5 hours. The pattern of external examination is as given below. The students can answer all questions in Section A & B. But there will be ceiling in each section.

Section A

Short answer type carries 2 marks each – 15 questions	Ceiling -25

Section B

Paragraph/ problem type carries 5 marks each – 8 questions	Ceiling -35

Section C

Essay type 10 marks (2 out of 4)	2x10 = 20

Question paper Type 2

Scheme of examination

The external QP with 60 marks and internal evaluation is of 15 marks. Duration of examination is 2 hours. The pattern of external examination is as given below. The students can answer all questions in Section A & B. But there will be ceiling in each section.

Section A	
Short answer type carries 2 marks each – 12 questions	Ceiling -20
Section B	
Paragraph/ problem type carries 5 marks each – 7 questions	Ceiling -30
Section C	
Essay type 10 marks (1 out of 2)	1x10 = 10

I. Practical examinations

The Cluster I and Cluster II Practical (External) Examinations shall be conducted at the end of 4th semester and the Cluster III and Cluster IV examinations shall be conducted at the end of 6th semester. There is no practical examination for elective papers. All practical examinations are of three hour duration. The external evaluation of practical examination shall be conducted by two examiners appointed by the university. The Board of Examiners shall decide the pattern of question papers for the practical examinations.

J. Records

A duly certified record of practical exams should be submitted during the examination. The entire experiments mentioned in the practical syllabus are expected to be done and recorded. The criteria to be observed in the valuation of records are fixed and are appended below:

a. Content should cover the entire practical works mentioned under individual courses.
b. Neatness and scientific accuracy.
c. Timely submission of record sheets.

K. Submissions

Practical paper - I

Every student has to submit any ten locally available specimens belonging to algae, fungi, lichens and plant diseases at the time of Practical Examination Paper – I held at the end of fourth semester.

Practical paper - II

Every student has to submit any ten locally available specimens belonging to bryophytes, pteridophytes and gymnosperms at the time of Practical Examination Paper – II held at the end of fourth semester.

Practical Paper – III

Every student has to submit 20 properly identified herbarium sheets together with field book on the day of Practical Examination Paper – III at the end of sixth semester.

Practical Paper – IV

Every student has to submit a report on the visit to a Research Institute/Lab in the area of Plant Breeding/Biotechnology/Tissue Culture) at the time of Practical Examination Paper – IV held at the end of the sixth semester.

Syllabi of Core Courses

SEMESTER I

CORE COURSE I. PLA1B01. PLANT ANATOMY

Total -72 hrs. Theory - 36 hrs., Practicals- 36 hrs.

Theory

Module – I: Plant Anatomy 36 hrs.

1. Introduction: Significance of anatomy.
2. Plant cell- structure and types.

A. Structure and composition of cell wall. Middle lamella Primary and Secondary wall thickening, Pits.

B. Growth of cell wall – apposition, intussusception

C. Extra cell wall materials – lignin, cutin, suberin, callose, wax.

3. Non-living inclusions: Reserve materials – carbohydrates (starch grains and sugars) proteins (aleuron grains) fats & oils, examples. Excretory materials;Mineral crystals- cystolyth, raphids.
4. Tissues: Definition and Types

A. Meristematic tissues – classification, Theories on apical organisation - apical cell theory, histogen theory, Tunica-Corpus theory.

B. Permanent tissues- definition, Classification- simple complex and secretory.

i. Simple tissues - parenchyma. collenchyma, sclerenchyma, - fibres and sclereids- structure, occurrence and function.

ii. Complex tissues - definition - xylem & phloem structure, function.

iii. Secretory tissues – glands, glandular hairs, nectaries, hydathodes, and laticifers.

5. Structure of stomata, classification (Metcalfe & Chalk), cuticIe.
6. Vascular tissue system: vascular bundles - origin and types - conjoint, collateral bi-collateral, radial, concentric – amphicribal and amphivasal, protoxylem, metaxylem, protophloem, metaphloem, cambium, open and closed, endarch and exarch.
7. Primary growth of plant body- Dicot stem - Centella and bi-collateral (*Cephalandra*, *Cucurbita*); Dicot root - (aerial *Ficus*, *Tinospora*), Monocot stem - (Grass, Monocot root – *Colocasia*, Dicot leaf – *Ixora*, Monocot leaf – Grass.
8. Secondary body of the plant.

A. Normal secondary growth in dicot stem and dicot root. Formation of vascular cambial ring

- Structure and activity of cambium - storied and non-storied, fusiform and ray initials.

Formation of secondary wood, annual rings, porous and diffuse porous wood, heart wood, sapwood, tyloses, secondary phloem, vascular rays.

Extra stelar secondary thickening in stem and root - periderm formation. Lenticels - structure & function.

B. Anomalous secondary growth in dicot stem (*Boerhaavia*. *Bignonia)* and monocot stem (*Dracaena*).

9. Applied anatomy – Identification of fragmentary plant material, detection of adulterants, identification of wood, archeological and forensic applications,, meristem culture, adaptations, taxonomic significance

Practical

PLANT ANATOMY 36 Hrs.

I. Study of primary plant structures – stem, root and leaf (dicots and monocots).

2. Study of secondary plant structures (dicot stem and root after secondary thickening)
3. Study of anomalous secondary thickening -*Boerhaavia, Bignonia, Dracaena*
4. Identification of different cell types - tissues, vascular bundles (all types).

REFERENCES

1.Cutler, D. F., Botha, T., Stevenson, D. W. 2008. Plant anatomy: an applied approach. Blackwell.
2.Cutter, E.G. 1969. Plant Anatomy - Part 1 Cells & Tissue. Edward Arnold.
3.Cutter, E.G. 1971. Plant Anatomy, Part 2 Organs. Edward Arnold.
4.Eames, A. J. & L H Mac Daniels. 1987. Introduction to Plant Anatomy. Tata-McGraw.
5.Esau K. 1985. Plant Anatomy (2nd ed.). Wiley Eastern Ltd. New Delhi.
6.Fahn A.2000. Plant Anatomy. Pergamon Press.
7.Pandey B.P. 2001. Plant Anatomy. S. Chand & Co.
8.Srivastava, S. and Singh S.K. 2009. Anatomy of Angiosperms. Crescent Publishing Corporation.
9.Tayal M.S. 2004. Plant Anatomy. Rastogi Publishers, Meerut.
10. Vasishta P.C. 1974. Plant Anatomy, Pradeep Publication.
11. http://www.biologydiscussion.com/plant-anatomy/applications-plant-anatomy/top-7-applications-of-plant-anatomy-botany/69516
12. Beck C. B. 2010. An Introduction to Plant Structure and Development. Cambridge University Press.
13. Dickison W. C. 2000. Integrative Plant Anatomy. Academic Press.
14. Pandey S.N. and A. Chadha 2015. Plant Anatomy and Embryology. Vikas Publishing House.
15. Roy P. 2016. Plant Anatomy. New Central Book Agency.
16. Rudall P. 2007. Anatomy of Flowering Plants. Edition 3, Cambridge University Press.

SEMESTER II

CORE COURSE II. PLA2B02 METHODOLOGY AND PERSPECTIVES OF SCIENCE

Total 72 hrs. Theory. 36 hrs. Practicals. 36 hrs.

Theory

Module -I: Scientific knowledge and methods and tools of science: 16 hrs.

Types of knowledge: Practical, theoretical and scientific knowledge, information. What is science; what is not science; laws of science. Basis for scientific laws and factual truths, scientific temper, empiricism,

Formulation of hypothesis; hypothetico-deductive model, inductive model. Signification of verifications (proving) corroborations and falsification (disproving), auxiliary hypothesis, adhoc hypothesis.

Experimentation in Science: design of experiments- selection of variables, study area and design. Research report writing, Journals, Methods of presentation.

Module - Ill: Microtechnique 18 hrs.

1. Microscopy-Principles of Microscopy. Brief account on light microscope, phase contrast microscope and fluorescent microscope. Electron microscopes- Principles and Types, Transmission Electron Microscope (TEM) Scanning Electron Microscope (SEM).
2. Microtomes - Rotary and Sledge.
3. Killing and Fixation - Fixatives- Carnoy's fixative, Farmer's fixative, FAA.
4. Dehydration- Common Reagents.
5. Paraffin Infiltration and Embedding.

6. Serial section cutting.
7. Staining - Types of staining, Single staining and Double staining, Natural and Synthetic stains, Hematoxylin, Safranin, Fast green.
8. Squash preparation.
9. Micrometry – Stage micrometer, Ocular micrometer, Calibration and measuring.
10. Acids and bases, buffers and pH, measurement of pH.
11. Chromatography principle and types: adsorption chromatography, partition chromatography, Ion exchange chromatography, molecular sieving.

Module - V: Ethics in science 2 hrs

Transparency and honesty in reporting of observational and experimental data; Biased observations, Influence of observer on observations. Patents, Plagiarism.

Practical

Microtechnique 36 hrs

1. Parts of microscope and operation.
2. Free hand sectioning of root, stems and leaves- Single and Double staining.
3. Demonstration of killing and fixing, dehydration, paraffin-infiltration, embedding, Microtoming, deparaffinisation and permanent slide preparation.
4. Measuring pH
5. Caliberating micrometer, measuring width of algal filament/pollen grain.
6. Paper Chromatography to separate leaf pigments.

REFERENCES

1. Toji, T. 2004. Essentials of botanical microtechnique. Apex Infotec.
2. Hewitt, P.G., Lyons, S., Suchocki, J.A. and Yeh J. 2006. Conceptual Integrated Science. Addison Wesley.
3. Newton R.G. 2010.The truth of science, Viva Books.
4. Bailey, N. T. J. 1995. Statistical Methods in Biology. Cambridge University Press.
5. Johansen, D.A. 1940. Plant Microtechnique. McGraw-Hill.
6. Jasra P.K. and Raj G. 2004. Biostatistics. Krishna Prakashan Media (P) Ltd.
7. Kanika, S. 2007. Manual of Microbiology - Tools and Techniques. Ane's student edition.
8. Khasim, S.K. 2002. Botanical Microtechnique; principles and Practice, Capital Publishing Company.
9. Khan, I.A. and Khanum, A. 2004. Fundamentals of Biostatistics. Ukaaz Publications.
10. Collins, H. and Pinch, T. 1993. The Golem: What Everyone Should Know About Science. Cambridge University Press.
11. Gieryn, T. F. 1999. Cultural Boundaries of Science. University of Chicago Press.
12. Gupta, S. P. 2002. Statistical Methods. S. Chand & Co.
13. Holmes, D., Moody, P. and Dine, D. 2006. Research Methods for the Biosciences, Oxford University Press.
14. Pechenik, J. A. 1987. A Short Guide to Writing about Biology. Little Brown.
15. Prasad, S. 2004. Elements of Biostatistics, Rastogi Publishers.
16. Ruxton, G. D. and Colegrave, N. 2006. Experimental Design for Life Sciences. Oxford University Press.
17. Ramakrishnan, P. 2015. Biostatistics. Saras Publishers
18. Rastogi, V. B. 2009. Fundamentals of Biostatistics. Ane Books.

19. Snedcor, G. W. and Cochran, W. G. Statistical Methods. Allied East-West Press,
20. Sokal, R. R. and Rohlf, F. J. 2009. Introduction to Biostatistics, W.H. Freeman.
21. Steel, R.G.D. and Torrie, J.H. 1960. Principles and Practice of Statistics with special reference to Biological Science. McGraw Hill.
22. McMillan. V. E. 1997. Writing Papers in the Biological Sciences, Bedford Books.
23. Yadav, K. 1993. Teaching of Life Sciences. Anmol Publications.
24. www.cfkeep.orglhtml/stitch.php?s=98965698293378 & id = 44650773279975.
25. www.ruf.rice.edu/-bioslabs/tools/report/reportform.html.

SEMESTER III

CORE COURSE III. PLA3B03. ALGAE, FUNGI, LICHENS, BACTERIA, VIRUSES & PLANT DISEASES

Total – 90 Hrs. Theory – 54 Hrs, Practicals- 36 Hrs.

Distribution of Hours	Theory	Practical
1) Bacteria & Viruses	9	9
2) Fungi & Lichens	18	9
3) Algae	18	9
4) Plant Diseases	9	9
Total	54	36

Module – I: Algae

Theory

1. Classification of Algae: van den Hoek *et al.*'s (1995) system.
2. General Features: Occurrence, cell morphology, range of thallus structure, reproduction and life cycles.
3. Cyanophyceae: General characters of Cyanophyceae. Type: *Nostoc.*
4. Chlorophyceae: General characteristics, occurrence, thallus structure, cell structure, flagella, reproduction, interrelationships. Types - *Chlamydomonas*, *Spirogyra*, *Oedogonium*, *Chara*.
5. Xanthophyceae: General characteristics, occurrence, range of thallus structure, reproduction, interrelationships. Type- *Vaucheria*.
6. Bacillariophyceae (Diatoms): General characteristics, occurrence, thallus structure, cell structure, cell division, sexual reproduction, auxospores, classification, interrelationships. Type -*Pinnularia*.
7. Phaeophyceae: General characteristics, occurrence, range of thallus structure, anatomy, cell structure, flagella, reproduction, alternation of generations, interrelationships. Type - *Sargassum*.
8. Rhodophyceae: General characteristics, occurrence, range of thallus structure, cell structure, reproduction, life cycle, phylogeny and interrelationships. Type- *Polysiphonia*.
9. Economic Importance: Algae as food, fodder, green manure, bio-fuels, pollution indicators, research tools, medicinal uses of algae, Commercial Products - carrageenin, agar-agar, alginates, diatomaceous earth. Harmful effects – Water bloom, eutrophication, neurotoxins, and parasitic algae.

Practical

1. Identification of the vegetative and reproductive structures of the types studied.
2. Familiarization of the technique of making algal herbarium.
3. Anatomical study of *Sargassum* stipe, leaf

REFERENCES

1. Chapman, V. J. & Chapman, D. J. 1973. The Algae. Macmillan.
2. Kumar, H. D. 1990. Introductory phycology. East West Press Pvt. Ltd.
3. Prescott, G. W.1969. The Algae. A Review. Thomas Nelson and Sons Ltd.
4. Round, F. E. 1975. The Biology of Algae. Edward Arnold.
5. Smith, G. M. 1978. Manual of Phycology. The Ronald Press Company.
6. Trainor, F. R. 1978. Introductory Phycology. John Wiley and Sons.
7. van den Hoek, C, Mann, D.G., Jahns, H.M. 1995. Algae. An Introduction to Phycology. Cambridge University Press.
8. Lee, R.E. 2008. Phycology. Cambridge University Press, Cambridge. 4th edition.
9. Prescott, L.M., Harley J.P., Klein D. A. 2005. Microbiology. McGraw Hill, India.
10. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press.
11. Sahoo, D. 2000. Farming the ocean: seaweeds cultivation and utilization. Aravali International.

Module – II: Fungi & Lichens

Fungi

Theory

1. General characters of fungi.
2. Distinction between true fungi and pseudofungi. Phylum-level classification of fungi proposed by Alexopoulos et al. (1996).
3. Myxomycota: General characteristics, occurrence, reproduction, and life cycle – Type: *Stemonitis*
4. Oomycota: General characteristics, occurrence, reproduction, and life cycle – Type: *Pythium*
4. Zygomycota: General characters, occurrence, reproduction, and life cycle – Type: *Mucor*
5. Ascomycota: General characters, occurrence, reproduction and life cycle – Types: *Peziza, Saccharomyces*.
6. Basidiomycota: General characters, occurrence, reproduction and lifecycle -Types: *Puccinia, Agaricus*
7. Mitosporic fungi (deuteromycetes): General characters, occurrence, reproduction and life cycle- Type: *Penicillium*.
8. Economic importance of fungi: medicinal, industrial, agricultural, food; fungal toxins.

Practical

1. Examination of micropreparation/slides of the above mentioned types.
2. Isolation and culturing of fungi from soil.

REFERENCES

1. Alexopoulos, C.J. et. al. 1996. Introductory Mycology, 4th Edition, Wiley.
2. Hudler, G.W. 1998. Magical Mushrooms, Mischievous Molds. Princeton University Press.
3. Kavanagh, K. 2005. Fungi, Biology and Applications. Wiley.
4. Money N. P. 2016. Fungi: A Very Short Introduction. Oxford University Press.
5. Rangaswami G. 1999. Diseases of Crop Plants of India, 4th ed. Prentice Hall of India.

6. Webster, J. and Weber, R. 2007. Introduction to Fungi. Cambridge University Press.
7. Mehrotra R.S. and Aneja K.R. 1990. An Introduction to Mycology, Wiley, Eastern Limited, New Delhi.
8. Sethi, I.K. and Walia, S.K. 2011. Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
9. Deacon J. 2007. Fungal Biology, 4th edition, Blackwell publishing.
10. Watkinson S. C., Boddy L., Money N. P. 2016. The Fungi. Academic Press.

Lichens

Theory

Lichens as examples of mutualistic symbiosis. mycobiont and photobiont (green alga or cyanobacterium).Growth forms – crustose, filamentous, foliose, fruticose, leprose, squamulose, gelatinous. Structure of lichen thallus. Type: *Usnea*

Reproduction and dispersal – fragmentation, isidia, soridia, cephalodia. Sexual Reproduction – Typical of fungal partner, producing spores.

Ecophysiological features of lichen: extreme endurance and longevity, drought tolerance, epiphytic adaptations, sensitivity to pollutants, chemical degradation and physical disruption of mineral surfaces

Economic Uses: Dyes, Cosmetics and perfumes, Medicinal uses, Lichens as food, Ecological indicators, Pollution indicators, Lichen in Soil formation.

Practical

1. Morphology and anatomical features of lichen- *Usnea*
2. Identification of different growth forms of lichen

REFERENCES

1.Gilbert, O. 2004. Lichen Hunters. The Book Guild Ltd. England
2.Kershaw, K.A. 1985. Physiological Ecology of Lichen. Cambridge University Press.
3.Nash, T. H. 1996. Lichen Biology. Cambridge University Press.
4.Sanders, W.B. 2001. Lichen - Interface between mycology and plant morphology. Bioscience, 51: 1025-1035.
5. https://www.anbg.gov.au/lichen/what-is-lichen.html
6. http://www.britishlichensociety.org.uk/about-lichens/what-is-a-lichen
7. Baron, G. 1999. Understanding Lichens. The British Lichen Society.

Module - III: Bacteria & Viruses

Theory

1. Major groups of prokaryotes, differences between Bacteria and Archaea. Major groups of Bacteria and Archaea.
2. Morphology and fine structure of bacteria. Bacterial growth, Nutrition, Reproduction, Economic importance of bacteria
3. Gene transfer mechanisms in bacteria: Transformation, Transduction and conjugation
5. Viruses: Structure and chemistry; architecture and multiplication of T4 phage and TMV. Brief account of retroviruses, HIV, Viroids and Prions.
6. Techniques used to study bacteria – Sterilization, isolation of pure culture by Spread plate, Streak plate and Pour plate methods, counting bacteria.

Practical

1. Simple staining using crystal violet.

2. Gram staining of bacteria present in curd and root nodules.
3. Isolation and culturing of bacteria using nutrient agar medium.

REFERENCES

1. Dubay R.C. & Maheswari D.K. 2000. A Textbook of Microbiology. S. Chand & Co.
2. Frazier W.C. 1998. Food Microbiology. Prentice Hall of India Pvt. Ltd.
3. Kumar H.D. & S. Kumar. 1998. Modern Concepts of Microbiology. Tata McGraw Hill, Delhi.
4. Pelzar M.J., E.C.S. Chan & N.R. Kreig. 1986. Microbiology McGraw Hill.
5. Rangaswami, R & C.K.J. Paniker. 1998. Textbook of Microbiology, Orient Longman.
6. Ross, F.C. 1983. Introductory Microbiology. Charles E. Merill Publishing Company.
7. Sharma P.D., 2004. Microbiology and Plant Pathology. Rastogi Publication.
8. Tortora, G.J., Funke, B.R., Case. C.L. 2007. Microbiology. Pearson Benjamin Cummings.
9. Alain Durieux 2009. Applied Microbiology. Springer.
10. Schlegel 2008. General Microbiology. Cambridge University press.

Module - IV: Plant Diseases Theory

1. Causative agents of plant diseases – biotic & abiotic; disease triangle; Koch's Postulates.
2. Structural & biochemical defences of plants; chemical weapons of pathogens.
3. Symptoms of plant diseases: spots, blights, wilts, rots, galls, canker, gummosis, necrosis, chlorosis, smut, rust, damping off.
4. Control measures: Regulatory, Cultural, Physical, biological and Chemical methods.
5. Brief study of the following plant diseases seen in Kerala (Name of disease, pathogen, symptom and control measures need to be studied): 1. Soft rot of carrot 2. Blast of rice, 3. Grey leaf spot of coconut, 4. Mosaic disease of tapioca, 5. Rhizome rot of ginger, 6. Rust of Justicia, 7. Citrus canker, 8. Nematode infection in banana.

Practical

Identification of the disease, pathogen, symptoms and control measures of the following:
Grey leaf spot of coconut, Tapioca mosaic disease, Blast of rice, Rust of Justicia, Citrus canker.

REFERENCES

1. Agrios, G. N. 2005. Plant Pathology, 5th edition. Academic Press
2. Bilgrami, K.H. & Dube, H.C. 1976. A textbook of Modern Plant Pathology. International Book Distributing Co.
3. Mehrotra, R.S. 1980. Plant Pathology. Tata McGraw Hill.
4. Lucas, J. A. 1998. Plant Pathology and Plant Pathogens. Blackwell.
5. Pandey, B.P. 1999. Plant Pathology. Pathogen and Plant diseases. S. Chand & Co.
6. Rangaswami, G. 1999. Disease of Crop plants of India. Prentice Hall of India Pvt. Ltd.
7. Sharma P.D. 2004. Plant Pathology. Rastogi Publishers.

SEMESTER IV

CORE COURSE VI. PLA4B04. BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY

Total – 90 Hrs. Theory – 54 Hrs., Practicals- 36 Hrs.

Distribution of Hours	Theory	Practicals
1) Bryophytes	9	9

2) Pteridophytes	18	12
3) Gymnosperms	18	12
4) Palaeobotany	9	3
Total	54	36

Module – Bryophytes

Theory

1. Introduction, general characters of the three lineages: Marchantiophyta, Anthocerotophyta, Bryophyta
2. Study of distribution, structure (external and internal), reproduction, life cycle and affinities of following types (Developmental details are not required) *Riccia* (Marchantiophyta), *Anthoceros* (Anthocerotophyta), *Funaria* (Bryophyta).
3. Evolution of gametophyte and sporophyte among Bryophytes.
4. Economic importance of Bryophytes.

Practical

Riccia – habit, internal structure of thallus, V.S. of thallus through antheridium, archegonium and sporophyte.

Anthoceros- habit, internal structure of thallus. V.S. of thallus through antheridium, archegonium and sporophyte.

Funaria- habit, structure of antheridial cluster, archegonial cluster, L.S. of sporophyte.

REFERENCES

1. Chopra R.N. and Kumar, P.K. 1988. Biology of Bryophytes. Wiley Eastern Ltd.
2. Parihar, N.S. 1965. An Introduction to Bryophyta. Central Book Depot.
3. Sporne K.R. 1967. The Morphology of Bryophytes. Hutchinson University Library.
4. Vasishta B.R. et al. 2010. Botany for Degree Students – Bryophyta. S. Chand and Co.
5. Watson E.V. 1971. The structure and life of Bryophytes. Hutchinson University Library.
6. Vanderoorten, A. and Giffinet, B. 2009. Introduction to Bryophytes. Cambridge University Press.
7. Parihar, N.S. 1991. An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot.
8. Shaw A. J. and Goffinet B. 2008. Bryophyte Biology. Cambridge University Press.

Module- II: Pteridophytes Theory

1. Introduction, general characters and classification (Pichi-Sermolli, 1977 & Smith et al., 2006 – brief outline only).
2. Study of distribution, structure (external and internal), reproduction, life cycle and affinities of following types (Developmental details are not required): *Psilotum* (Psilopsida), *Selaginella* (Lycopsida), *Equisetum* (Sphenopsida), *Pteris* & *Marsilea* (Pteropsida). 3. Apogamy and apospory in Pteridophytes; Stelar evolution in Pteridophytes Heterospory and seed habit; Affinities of Pteridophytes; Economic importance of Pteridophytes with special reference to biofertilizers.

Practical

Psilotum- habit, T.S. of stem, C.S. of synangium

Selaginella – habit, T.S. of stem, T.S. of rhizophore, L.S. of Strobilus

Equisetum- habit, T.S. of stem, L.S. of Strobilus

Pteris- Habit, T.S. of petiole and T.S. of sporophyll.
Marsilea - habit, T.S. of rhizome. T.S. of petiole.

REFERENCES

1. Chandra S. & Srivastava M., 2003. Pteridology in New Millennium, Kluwer Academic Publishers.
2. Eames, A.J. 1979. Morphology of Vascular Plants, lower group. Wiley International.
3. Parihar, N.S. 1977. Biology and Morphology of Pteridophytes, Central Book Depot.
4. Pichi Sermolli, R.E.G. 1977. A tentative classification of Pteridophyte genera. Webbia (2): 313-512.
5. Rashid, A. 1976. An Introduction to Pteridophyta, Vikas publ. Co. New Delhi.
6. Smith, A., K. Pryer, E. Schuettpelz, P. Korall, H. Schneider, AND P. Wolf. 2006. A classification for extent ferns. Taxon 55: 705-731.
7. Sporne, K.R. 1967. Morphology of Pteridophytes – Hutchinson University Library.
8. Vashistha, P.C., Sinha, A.K., Kumar, A. 2010. Botany for Degree Students - Pteridophyta. S. Chand & Co.
9. Ranker, T.A. & Haufler, C.H. (eds.), 2008. Biology and Evolution of Ferns and Lycophytes. Cambridege University Press.
10. Mehltreter, K., Walker, L.R. & Sharpe, J.M. (eds.) 2010. Fern Ecology. Cambridge University Press.

Module – III: Gymnosperms

Theory

1. Introduction:- General characters and Classification (Sporne, 1965)
2. Distribution, structure (external and internal), reproduction, life cycle and affinities of following plants (Developmental details are not required): *Cycas*, *Pinus*, *Gnetum*
3. Evolutionary trends in Gymnosperms; affinities of Gymnosperms with Pteridophytes and Angiosperms.
4. Economic importance of Gymnosperms.

Practical

1. *Cycas*- *Cycas* seedling, coralloid root, T.S. of coralloid root, T.S. of leaflet, petiole, male cone and L.S. of male cone, microsporophyll, megasporophyll, T.S. of microsporophyll, ovule, L.S. of ovule and seed.
2. *Pinus*- branch of unlimited growth, spur shoot, T.S. of stem and needle, male cone and female cone, L.S. of male cone and female cone, seed.
3. *Gnetum*- Habit, stem T.S., leaf T.S., male and female cones, L.S. of ovule, seed.

REFERENCES

1. Coutler, J.M. and Chamberlain, C.J. 1958. Morphology of Gymnosperms. Central Book Depot.
2. Sporne K.R. 1965. The Morphology of Gymnosperms, Hutchinson and Co. Ltd.
3. Sreevastava H.N. 1980. A Text Book of Gymnosperms. S. Chand and Co.
4.8. Vashistha, P.C., Sinha, A.K., Kumar, A. 2010. Botany for Degree Students - Gymnosperms. S. Chandand & Co.
5.Bhatnagar, S.P. & Moitra, A. 1996. Gymnosperms. New Age International (P) Ltd Publishers.

Module-IV: Palaeobotany

Theory.

1. Fossil formation and types of fossils.
2. Geological time scale- sequence of plants in geological time.
3. Fossil Pteridophytes- *Rhynia*, *Lepidodendron*, *Lepidocarpon*, *Calamites*.
4. Fossil gymnosperms- *Williamsonia*.
5. Brief mention of fossil deposits in India.
6. Applied aspects of Palaeobotany- Exploration of fossil fuels.

Practical

Fossil Pteridophytes- *Rhynia* stem, *Lepidodendron*, *Lepidocarpon* and Calamites Fossil gymnosperms- *Williamsonia*

REFERENCES

1. Andrews H.N. 1961. Studies in Palaeobotany. John Wiley and Sons Inc.
2. Arnold C.A. 1947. Introduction to palaeobotany, Tata McGraw Hill.
3. Shukla, A.C. & S.P. Misra, 1975, Essential of Palaeobotany, Vikas Publishing House.
4. Sreevastava H.N., 1998. Palaeobotany, Pradeep Publishing Company.
5. Sewart, W.N., 1983. Palaeobotany and the Evolution of Plants. Cambridge Uni. Press.
6. Taylor, T.N. 1981. Paleobotany. An Introduction to Fossil Plant Biology. McGraw-Hill.
7. Misra, S.R. 2010. Text Book of Palaeobotany. Discovery Publishing Pvt.Ltd.
8. Watson J. 1953. An introduction to study of fossil plants. Adams and Charles Black Ltd.

SEMESTER V

CORE COURSE V. PLA5B05. MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Total – 117 Hrs. Theory – 72 Hrs. Practicals - 45 Hrs.

Distribution of Hours	Theory	Practical
Morphology of Angiosperms	18	10
Taxonomy of Angiosperms	54	35
Total	72	45

Module- I: Angiosperm Morphology

Theory

1. Morphological description of a flowering plant- Plant Habit.
   A. Root: types - tap root, fibrous root; modifications - definition with examples - storage roots, aerial roots, pneumatophores, buttress roots.
   B. Stem: habit - acaulescent, caulescent, caespitose prostrate, repent, decumbent, arborescent, suffrutescent (definition with examples); modification - underground, aerial and subaerial with examples.
   C. Leaves: lamina, petiole, leaf tip, leaf base, stipule, pulvinus; phyllotaxy; types - simple and compound; shapes of lamina; leaf tip; leaf base; leaf margin; leaf surface features: hairiness - tomentose, glabrous, scabrous, strigose, hispid.
2. Inflorescence: racemose, cymose and specialised (cyathium, hypanthodium, coenanthium verticillaster, thyrsus)
3. Flower: flower as a modified shoot - detailed structure of flowers - floral parts -their arrangement, relative position, cohesion and adhesion - symmetry of flowers - floral diagram and floral formula.
4. Fruits - types, classification with examples; seed structure - dicot and monocot - albuminous and exalbuminous, aril, caruncle; dispersal of fruits and seeds - types and

adaptations

Practical

1. Students have to identify the types mentioned in the syllabus but need not draw the diagrams in the record.
2. Examination of floral morphology of the following plants: *Crotalaria, Ixora, Allamanda, Hibiscus, Calotropis* and *Leucas*.

REFERENCES

1. Gangulee, H.C., Das, J.S. & Dutta, C. 1982. College Botany. New Central Book Agency.
2. Kumar A. 2012. Advanced Morphology Of Angiosperms. Random Publications.
3. Simpson, M.G. 2006. Plant Systematics. Elsevier Academic Press, London.
4. Sporne, K. R. 1994. Morphology of Angiosperms. Bi Publications Pvt Ltd.
5. Sinha, S.K. 2012. Encyclopaedia on Morphology of Angiosperm. Oxford Book Company.

Module-II: Taxonomy of Angiosperms

Theory

1. Introduction, objectives and importance of taxonomy.
2. Introduction to systems of classification – Artificial – Linnaeus; Natural – Bentham and Hooker; Phylogenetic system. Angiosperm Phylogeny Group system. Detailed study of Bentham and Hooker's system up to family level. Diagnostic features of families studied in practical classes viz. Annonaceae, Malvaceae, Nymphaeaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Amaranthaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Cyperaceae, Poaceae.
3. History of taxonomy in India – Contributions of Hendrich van Rheede, William Roxburg, Robert Wight, and J. S. Gamble.
4. Taxonomic structure – hierarchy; concepts of taxa; species concepts – biological, phenetic and phylogenetic; genus; family.
5. Taxonomic character – concept, primitive and advanced characters, sources, comparative morphology, vegetative, reproductive, macro- and micro-morphology, brief account of modern trends in taxonomy.
6. Plant nomenclature – limitations of common name, ICN, principles (introduction only); typification; Rule of Priority, effective and valid publication; author citation.
7. Taxonomic information resources – herbarium- principles and practices; world herbaria; BSI; Indian herbaria; botanic gardens; indexes; journals; monographs; revisions; floras; online resources and databases.

Practical

1. Learning the characters of families mentioned in the theory syllabus from demonstrations in the laboratory using one or more plants from each family, making suitable diagrams, describing them in technical terms and identifying them up to species using any standard flora.
2. Each student shall submit a minimum of 20 properly identified herbarium specimens in the standard format along with field notes (cultivars and ornamentals should be avoided)

Study Tour

Students are expected to undertake a study tour of not less than 3 days duration under the guidance of the teachers to identify plants in the field using diagnostic characters. They are also expected to visit at least one research station/herbarium/botanical garden and should submit a duly certified study tour report along with herbarium sheets and field notes for external evaluation.

REFERENCES

1. Forman, L. & Bridson, D. 1989. The Herbarium Hand Book. Royal Botanic Gardens, Kew.
2. Sivarajan, V.V. 1991. Introduction to Principles of Plant Taxonomy. Oxford & IBH.
3. Sporne, K.R. 1974. Morphology of Angiosperms. Hutchinson University Press.
4. Radford, A.E. 1986. Fundamentals of plant systematics. Harper & Row Publishers.
5. Naik, V.N. Taxonomy of Angiosperms. Tata McGraw Hill.
6. Burkill, I.H. 1965. Chapters on the History of Botany in India. Bombay Natural History Society.
7. Gurucharan Singh, 2001. Plant systematics - Theory and Practice. Oxford & IBH.
8. Davis, P.H. & V.H. Heywood 1963. Principles of Angiosperm Taxonomy. Oliver & Boyd.
9. Henry, A.N. & Bose, M.C. 2009. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers.
10. Jeffrey, C. 1968. An introduction to Plant Taxonomy. J. & A. Churchill.
11. Simpson, M.G. 2006. Plant Systematics. Elsevier Academic Press.
12. Steusy, T.F. 1990. Plant Taxonomy – The systematic evaluation of Comparative data. Columbia University Press.
13. Sharma, B.D. et al. (Eds.) Flora of India vol. I. Botanical Survey of India.
14. Pandey, S.N. & S.P. Misra. 2008. Taxonomy of Angiosperms. Ane Books.
15. Sharma, O.P. 1996. Plant Taxonomy. TATA McGraw Hill.
16. Sambamurthy A..S.S. 2005;Taxonomy of Angiosperms, I.K. International.
17. Pandey, S.N. & S.P. Misra. 2008. Taxonomy of Angiosperms. Ane Books.
18. Bharati Bhattacharyya 2009; Systematic Botany, Narosa Publishing House.
19. Mondal A.K. 2009: Advanced Plant Taxonomy, New Central Book Agency.

COURSE VI. PLA5B06. PHYTOGEOGRAPHY, ETHNOBOTANY, ECONOMIC BOTANY AND EMBRYOLOGY

Total – 117 Hrs. Theory – 72 Hrs. Practicals - 45 Hrs.

Distribution of Hours	Theory	Practical
Phytogeography	24	14
Ethnobotany	12	10
Economic Botany	30	15
Embryology	6	6
Total	72	45

Module – I Phytogeography

Theory

1. Definition, concept, scope and significance of phytogeography.
2. Centres of origin and distribution of species.
3. Patterns of plant distribution - continuous and discontinuous distribution, vicarism, migration and extinction.
4. Continental drift - evidences and impact; glaciation; theory of land bridges
5. Endemic distribution, theories on endemism, age and area hypothesis.
6. Phytogeographical zones (phytochoria) of the world and India

Practical

1. Field visit to any National Parks or natural vegetations to study species composition and characteristics.

2. Drawing the phytogeographic zones of the world.
3. Drawing the phytogeographic zones of India.

REFERENCES

1. Good, R. 1947. The Geography of Flowering Plants. Longmans, Green and Co, New York.
2. Takhtajan, A.1986. Floristic Regions of the World. University of California Press, Berkeley.
3. Sharma, P. D. 2009. Ecology and Environment, Rastogi Publications, Meerut.

Module – II Ethnobotany

Theory

1. Introduction, scope and significance
2. Major tribes of South India
3. Ethnobotanic significance of the following: *Aegle marmalos, Ficus religiosa, Curcuma longa, Cynodon dactylon, Ocimum sanctum, Trichopus zeylanica*

Practical

1. Field visits to local sites of ethnobotanical interest and collecting ethbobotanical information.

References

1. Jain. S. K. 1981. Glimpses of Indian Economic Botany. Oxford Baker. H.G. 1970. Plant and Civilization.
2. Jain. S. K. 1995. A Manual of Ethnobotany. Scientific Publishers, Jodhpur.
3. Cotton, C.M. 1996. Ethnobotany – Principles and Applications. Wiley and Sons.

Module – III Economic Botany

Classification of plants based on the economic use of the following plants. Study the binomial, family, morphology of useful part, products and uses of plants mentioned below.

1. Cereals and millets – rice, wheat, maize and ragi.
2. Pulses and legumes – green gram, Bengal gram, black gram, cow pea, winged bean, cluster bean, soya bean, and pigeon pea.
3. Sugar – sugar cane, beet root.
4. Fruits – apple, pine apple, papaya, banana, mango, guava, jackfruit, grapes, sapota, pomegranate, mangosteen.
5. Vegetables – root – carrot, beet root, tapioca; stem – corm, potato; fruits – cucurbits- bitter gourd, cucumber, snake gourd, ridged gourd; okra; leaves – cabbage, amaranth, moringa, Boerhaavia.
6. Ornamentals – rose, anthurium, jasmine.
7. Masticatories – betel vine, betel nut, tobacco.
8. Beverages – coffee, tea, cocoa.
9. Fibre – Coir, Cotton, Jute.
10. Timber – teak, rosewood, jackfruit tree, Ailanthus.
11. Fats and oils – coconut, sesame, mustard, sunflower, oil palm.
12. Latex – rubber
13. Gums and Resins – dammar, gum arabic, asafoetida
14. Spices –pepper, ginger, cardamom, turmeric, clove, mace, allspice, cinnamon
15. Medicinal – *Adathoda, Boerhaavia, Catheranthus, Eclipta, Phyllanthus, Rauvolfia, Aloe,* Long pepper.
16. Insecticides – Neem, tobacco, pyrethrum.
17. Essential oil – sandal wood oil, clove oil, lemon grass, patchouli oil, peppermint oil.

18. Perfumery – camphor, rose, lemon grass, champak, *Mimusops elengi*, *Cananga*.
19. Fuel – Jatropha.

References

1. Kochhar, S.L. 2011. Economic Botany in the Tropics. MacMillan.
2. Kochhar, S.L. 2016. Economic Botany: A Comprehensive Study. Cambridge University Press.
3. Sammbamurty, A.V.S.S. and Subramanyam, N.S. 2008. A Textbook of Modern Economic Botany. CBS Publishers & Distributors.

Practical

1. Students are expected to identify plants or plant products (raw or processed) studied in theory and to know the binomial, family and morphology of the useful parts of source plants (Submit a report preferably with photos)
2. Students shall submit 5 duly preserved specimens with certified index for practical examination.
3. Diagrams of items mentioned in the Economic Botany syllabus need not be recorded

Module – IV: Embryology

Theory 6 hrs

1. Morphology of flower - anther - structure, microsporogenesis, - dehiscence; ovule - structure, types, megasporogenesis, structure of typical embryo sac, types of megagametogenesis - monosporic (*Polygonum*), bisporic (*Allium*) tetrasporic (*Adoxa*)
2. Fertilization - pollen tube entry - types, double fertilization and triple fusion.
3. Endosperm formation - types - free nuclear, cellular and helobial haustoria.
4. Embryo - structure and development of dicot embryo. Structure of monocot embryo.
5. Apomixis types and polyembryony.

Practical 6 Hours

1. Observation of anther (young and mature). Types of ovules.
2. Observation of dicot and monocot embryos of Angiosperms.
3. Demonstration of embryo mounting e.g.: *Tridax*, *Crotalaria*.

REFERENCES

1. Varma, V. 2009. Text Book of Economic Botany. Ane Books India, New Delhi.
2. Sambamurty, A. V. S. S. and Subrahmanyam, N. S. 1989. A textbook of economic botany. Wiley Eastern Ltd.
3. Maiti, R.K. & Singh, V.P. 2006. An Introduction to Modern Economic Botany. Eastern Book Corporation.
4. Bhojwani S. & S. P. Bhatnagar 198. The Embryology of Angiosperms. Vikas Publishing.
5. Davis C.L. 1965. Systematic Embryology of Angiosperms. John Wiley, New York.
6. Eames M.S. 1960. Morphology of Angiosperms. Mc Graw Hill New York.
7. Johri B.M. (ed.) 1984. Embryology of Angiosperms Springer.
8. Maheswari P. 1985. Introduction to Embryology of Angiosperms - McGraw Hill, New York.
9. Pandey, A. K. 2000. Introduction to Embryology of Angiosperms. CBS.
10. Singh V., Pande P.C. & Jain D.K. 2001. Embryology of Angiosperms. Rastogi Publications.
11. Raghavan, V. 2000. Developmental Biology of Flowering plants. Springer.

COURSE VII. PLA5B07. PLANT PHYSIOLOGY AND BIOCHEMISTRY

Total 108 Hrs., Theory- 72 Hrs., Practical-45 Hrs.

Distribution of Hours Theory Practical

Physiology	45	25
Biochemistry	27	20
Total	72	45

PLANT PHYSIOLOGY

Theory

Module 1. Basics of plant physiology 18 hrs

1. Plant cell and water; Water and hydrogen bonds. Properties of water. Temperature and physical state. Adsorption and dissipation of heat. Water as a solvent. Cohesion and adhesion. Diffusion, osmosis, osmotic pressure, concept of water potential, components of water potential; imbibition, Water relations of the whole plant. Transpiration. Types and process. Mechanism of guard cell movement. K+ ion mechanism. Why transpiration? Antitranspirants.
2. The ascent of xylem water: Radial movement of water through root. Transpiration pull and cohesion of water molecules. Merits and demerits of cohesion-tension theory. Soil-plant-atmosphere continuum of water.
3. Plants and inorganic nutrients. Macro and Micro nutrients. Beneficial elements. Specific roles, deficiency and toxicity. Uptake of mineral elements. Difference between passive uptake and active uptake. Simple and facilitated diffusion. Carriers and channels. Aquaporins. Active uptake. Carrier concept. Evidences.

Module II. Photosynthesis and translocation of photoassimilates 18 hrs

1. Photosynthesis in higher plants.
General concept and equation. Photosynthetic apparatus. Electromagnetic radiation. Photosynthetically active radiation. Absorption of light. Fluorescence and phosphorescence. Organization of light harvesting antenna pigments. Photochemical and chemical phases of photosynthesis and its evidences. Red drop and Emerson enhancement effect. Two pigment systems, components. Redox potentials of the electron carriers. Photosynthetic electron transport and photophosphorylation. Assimilatory powers- ATP and NADPH.
Photosynthetic carbon reduction cycle (PCR), RUBISCO, C3. C4, and CAM pathways. Ecological significance of C4, and CAM metabolism. Photorespiration. Law of limiting factors.
2. Translocation and distribution of photo assimilates.
Composition of phloem exudates. Source-sink relationship. Mechanism of phloem transport. Brief account of phloem loading and unloading, pressure flow hypothesis. Partitioning of assimilates among sinks.

Module III. Plant growth and development. 9 hrs

1. The hormone concept in plants. Plant growth and development. Auxins, gibberellins, cytokinins, abscisic acid and ethylene, their physiological roles. Photoperiodism and vernalization (Brief study).
2. Plant movements. Phototropism, gravitropism. Nyctinastic and seismonatic movements.
3. Photomorphogenesis: Phytochrome: chemistry and physiological effects (Brief study).
4. Seed dormancy and germination (Brief study).
5. Stresses encountered by plants and its defense mechanisms (Brief study)

Practical 25 hrs

Students have to record data by conducting the experiment

1. Determination of water potential by tissue weight change method.
2. Study of stomatal index.
3. Relation between water absorption and transpiration.
4. Extraction of leaf pigments.
5. Separation of leaf pigments by paper chromatography/ column chromatography/TLC.
6. Effects of light intensity on photosynthesis by Wilmot's bubbler.
7. Effect of scarification on seed germination.
8. Photomorphogenesis in seedlings grown under normal light and darkness.
9. Testing of seed viability by 2,3,5-triphenyl tetrazolium chloride test.
10. Demonstration of gravitropism using Klinostat.
11. Determination of the rate of transpiration using Ganong's photometer.

REFERENCES.

1. Hopkins W. G. 2003. Introduction to Plant Physiology, 3rd edition, John Wiley.
2. Taiz L. and Zeiger E. 2002. Plant Physiology 2nd edition. Sinauer Associates, Inc.
3. Salisbury F. B. and Ross C. W. 2004. Plant Physiology. CBS publishers and distributors.
4. Noggle G. R. and Fritz G. J. 1983. Introductory Plant Physiology. Prentice Hall.
5. Goodwin Y.W. and Mercer E.I. 2003. Introduction to Plant Biochemistry. CBS Publishers.
6. Pandey S.N. & Sinha B.K 2005. Plant Physiology. Vikas Publishing.
7. Jain, V.K. 2017. Fundamentals of Plant Physiology, S. Chand & Co.
8. Hopkins, W. G. Introduction to Plant Physiology, John Wiley & Sons.
9. Sinha, R.K. 2013. Modern Plant Physiology, Narosa publishing.

BIOCHEMISTRY

Theory

Module- 1. Boimolecules and Secondary Metabolism 12 hrs

1. Biomolecules. Hierarchy of biomolecules: (organelle- supramolecular assemblies-macromolecules-building block biomolecules - metabolic intermediates-precursors).

2. Carbohydrates. Classification; structure and functions of simple sugars and compound carbohydrates.

3. Lipids. Classification. Complex lipids, Simple lipids. Storage and structural lipids, Fatty acids saturated and unsaturated, triacyl glycerols, phospholipids, sphingolipids. Lipids in membranes, the supramolecular architecture of membranes.

4. Amino acids, peptides and proteins. Amino acids: classification based on polarity; properties, zwitterions, acid base properties. Proteins: Classification based on function and physical and chemical properties. Covalent structure of proteins. Three dimensional structures of proteins. Primary, secondary, tertiary and quaternary structures of proteins. Native conformation and biological functions of proteins. Weak interactions. Denaturation and renaturation.

5. Nucleotides structure of nucleotides. Purine and pyrimidine derivative in nucleotides. Functions of nucleotides and nucleotide derivatives.

6. A brief survey of secondary metabolites and their physiological roles and significance (plant-plant interaction, plant-pathogen interaction, as defence compounds and as phytoalexins).

Module II. Metabolism, Catalysis and Intermediary Metabolism 15 hrs

1. Enzymes Classification (IUB), Mechanism of enzyme action, optimization of weak interactions in the transition state. Co-enzymes, inhibition, regulation: allosteric enzymes, covalently modulated enzymes. Isoenzymes.

2. Plants and nitrogen metabolism. Biological nitrogen fixation, symbiotic nitrogen fixation in leguminous plants. Biochemistry of nitrogen fixation. Export of fixed nitrogen from nodules.

Ammonia assimilation, assimilation of nitrate. Biosynthesis of amino acids reductive aminatlon and transaminatlon.

3. Catabolism of hexoses. Glycolysis: Two phases of glycolysis. Overall balance sheet. Fate of pyruvate under aerobic and anaerobic conditions. Citric acid cycle: Formation of acetate, reaction of citric acid cycle, anapleurotic reactions of citric acid cycle. Glyoxylate cycle. Amphibolic nature of citric acid cycle.

4. Oxidation of fatty acids. Activation and entry of fatty acids, β oxidation of saturated fatty acids in plants.

5. Biosynthesis of saturated fatty acids in plants. Involvement of fatty acid synthase complex and acyl carrier protein.

7. Oxidative phosphorylation: Electron transport reactions in mitochondrion. Electron carriers, redox potential, electron carriers function as multienzyme complexes, ATP synthesis. Chemiosmotic hypothesis. Shuttle systems.

Practical 20 hrs

1. Qualitative tests for monosaccharides, and reducing non reducing oligosaccharides, starch, amino acids and protein.

a. Molisch's test for all carbohydrates
b. Benedict's test for reducing sugars
c. Barfoed's test for monosaccharides
d. Iodine test for starch
e. Ninhydrin test for amino acids and protein
f. Xanthoproteic test for amino acids with aromatic R-groups

2. Chlorophyll estimation (Arnon 1949) using spectrophotometer.

REFERENCES:

1. Nelson D. L. and Cox M. M. 2008. Lehninger Principles of Biochemistry. 5th edition. W. H. Freeman.

2. Zubay, G. 1993. Biochemistry. MacMillan Publishing Company, New York

3. Plummer, D. T. 2004. An Introduction to Practical Biochemistry. Tata Mc Grow Hill.

4. Sadasivam and Manickam, Biochemical methods. New Age International Publishers. New Delhi.

5. Secondary plant products, vol.8. Encyclopaedia of Plant Physiology, 1980, Springer – Verlag, Berlin.

6. Goodwin Y.W., and Mercer E.I. 2003. Introduction to Plant Biochemistry. 2nd edition. CBS Publishers and distributors.

7. Voet, D. and Voet, J. 2004. Biochemistry. 3rd edition. Wiley international edition.

8. Wilson, K. and Walker, J. 2008. Principles and techniques of Biochemistry and Molecular Biology. 6th edition. Cambridge University Press.

9. Campbell, P.N. and Smith A.D. 2011. Biochemistry Illustrated. Churchill Livingstone.

10. Tymoczko J.L., Berg J.M. and Stryer L. 2012. Biochemistry: A short course. W.H. Freeman.

SEMESTER VI

CORE COURSE VIII. PLA6B08. CELL BIOLOGY, MOLECULAR BIOLOGY AND BIOINFORMATICS

Total – 117 Hrs. Theory – 72 Hrs., Practicals- 45 Hrs.

Distribution of Hours		Theory	Practicals
1.	Cell Biology	25	15
2.	Molecular Biology	30	15
3.	Bioinformatics	17	15
	Total	72	45

Module–I Cell Biology

Theory 25 hrs

1. Architecture of cells. Prokaryotic and Eukaryotic cells.
2. Structure and function of the following: cell membrane (fluid mosaic model), endoplasmic reticulum, Golgi complex, mitochondria, chloroplast, lysosomes, peroxisomes, glyoxisomes, ribosomes, cytoskeleton, cytosol, and vacuole.
3. Nucleus: nuclear membrane, nucleoplasm, nuclear pore complex, organisation of interphase nucleus, euchromatin and heterochromatin, nucleolus.
4. Chromosomes: morphology, centromere, telomere and its significance, chemical composition, ultrastructure (nucleosome model); chromosome banding - C-banding, G-banding, N-banding, R-banding, Q-banding; special types of chromosomes - Polytene chromosomes, lampbrush chromosomes
5. Cell division: mitosis and meiosis, significance, molecular control of cell division; cell cycle and its regulation.
6. Chromosomal aberrations: structural changes like deletion, duplication, inversion, translocation - their meiotic consequences and significance.
7. Numerical aberration: definition, basic chromosome number (genomic number) aneuploidy, haploidy and polyploidy - their meiotic behaviour and significance.

Practical 15 hrs

1. Mitosis - acetocarmine squash preparation of onion root tip.
2. Calculation of mitotic index
3. Demonstration of meiosis in Rhoeo/Chlorophytum/Maize and identification of different stages of meiosis.

REFERENCES

1. Arumugham N. 2014. Cell Biology. Sara Publication, Nagercoil.
2. De Robertis E.D.P., & De Robertis E.M.S. 1998 Cell and Molecular Biology, Lea & Febiger.
3. Cooper G. M. & Haufman R. E. 2007. The cell - a molecular approach, A.S.S. Press.
4. Kleinsmith L. J. & Kish V. M. 1995. Principles of Cell & Molecular Biology.
5. Lewin B. 2007. Genes IX. Jones & Bartlett Publishers.
6. Lodish H. et. al., 2000. Molecular Cell Biology. Freeman & Company.
7. Powar C.B. 1988. Essentials of Cytology. Himalaya Publishing House.
8. Rastogi S.G. Cell Biology. Tata McGraw Hill.
9. Karp, G. 2010. Cell Biology, John Wiley & Sons.
10. Hardin, J., Becker, G., Skliensmith, L.J. 2012. Becker's World of the Cell, Pearson Education.
11. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates.
12. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. Pearson Benjamin Cummings.

Module – II. Molecular Biology

Theory 30 hrs

1. Nucleic acids - DNA - The genetic material, discovery of bacterial transformation (Griffith's & Avery's experiments), Hershey and Chase experiment.
DNA - structure, Watson & Crick's Model, Types of DNA-(A,B,Z)
-Replication - Semi conservative replication – Meselson and Stahl's experiment -Molecular mechanism of Replication; RNA - structure, types and properties.
2. Genetic code - Characters of genetic code
3. Central dogma of molecular biology, protein synthesis, transcription, post-transcriptional modification of RNA, translation; Teminism.
4. Gene regulation in prokaryotes - operon concept Lac operon, trp operon). Gene regulation in eukaryotes (brief account)
5. One gene-one enzyme hypothesis, one cistron-one polypeptide hypothesis, modern concept of gene- cistrons, recons and mutons
6. Genome sequencing - brief account, Human Genome Project - brief account.

Practicals 15 hrs

1. Extraction of DNA from plant tissue.
2. Study of genetic engineering tools, techniques and protocols using photographs/diagrams/flow-charts (Southern blotting, DNA finger printing, PCR).

REFERENCES

1. Spend G. S. & Calender, R. 1986. Molecular Genetics. CBS Publishers.
2. Lewin B. 2000. Genes VII. Oxford University Press.
3. Rastogi V.B. 2008. Fundamentals of Molecular Biology, Ane Books, India.
4. Verma, P.S. & Agarwal 1999. Text book of Genetics. S. Chand & Co., New Delhi.
5. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. 2007. Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
6. Russell, P. J. 2010. Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
7. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. 2010. Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
8. Upadhyaya, A. & Upadhyaya, K. 2005. Basic Molecular Biology, Himalaya Publishers.

Module – III: Bioinformatics

Theory 17 hrs

1. Introduction to bioinformatics, importance of bioinformatics, biological databases- Classification- primary, secondary & derived.
2. DNA sequence data bases (GenBank, DDBJ, EMBL); Genome databases (FlyBase).
3. Protein sequence databases (PIR, SWISS-PROT, TrEMBL); protein structure databases (ModBase,); protein structure prediction.
4. Sequence alignment and database searches: tools for sequence alignment and comparison - multiple sequence alignment tools (CLUSTALW), tools for similarity/homology search (BLAST);
5. Genome annotation – Brief account
6. DNA sequencing and computational evolutionary biology (phylogenetic analysis); Computer tools for phylogenetic analysis (PAUP).
7. Applications of Bioinformatics- Structural Bioinformatics in Drug Discovery, Microbial genome applications, Crop improvement, drug design.

Practicals 15 hrs

1. Visit to nucleic acid and protein databases in the internet.
2. BLAST search of DNA sequences using Entrez browser of NCBI.

REFERENCES

1. Rajaraman, V. 2012. Introduction to Information Technology, Prentice Hall India.
2. Baxevanis A.D. & Ouellette B.F.F. 2001. Bioinformatics - A practical guide to the analysis of genes and proteins, Wiley Interscience.
3. Attwood D.J. and Smith A. Introductionto Bioinformatics; Pearson education.
4. Sundararajan S. & Balaji R.2005. Introduction to Bioinformatics; Himalaya publishing House.
5. Mount D.W. 2004. Bioinformatics – sequence and Genome analysis; CBS Publishers and Distributers.
6. Ignacimuthu S. 2005. Basic Bioinformatics. Narosa Publishing House.
7. Lesk A.M. 2005. Introduction to Bioinformatics. Oxford University Press.
8. Gautham N. 2006. Bioinformatics databases and algorithms. Narosa Publication house.
9. Rastogi S.C., Mendiratta N. and Rastogi P. 2003. Bioinformatics, Concepts, Skill and Application. CBS publishers and distributes.
10. Xiong, J. 2006. Essential bioinformatics. Cambridge University Press.
11. Ghosh Z. and Bibekanand M. 2008. Bioinformatics: Principles and Applications. Oxford University Press.
12. Pevsner J. 2009. Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
13. Campbell A. M., Heyer L. J. 2006. Discovering Genomics, Proteomics and Bioinformatics. Benjamin Cummings.

CORE COURSE IX. PLA6B09. GENETICS, EVOLUTION AND ECOLOGY

Total – 117Hrs. Theory – 72 Hrs., Practicals- 45 Hrs.

Distribution of Hours	Theory	Practical
Genetics	35	25
Evolution	12	--
Ecology	25	20
Total	72	45

Module- I. Genetics

Theory 35 hrs

1. Mendel's experiments - symbols terminology. Mendelian laws, monohybrid dihybrid, test cross and backcross.
2. Modification of Mendelian ratios. Incomplete dominance – Mirabilis (1 : 2: 1, 1 : 2 : 1 : 2 : 4 : 2 : 1 : 2 : 1, 3 : 6 : 3 : 1 : 2 : 1 Co-dominance - Blood groups in man Lethal genes - coat colour in mice.

Non-allelic interaction (genic) Epistasis – a) Dominant - Fruit colour in summer squashes

b) Recessive epistasis - Coat colour in mouse; Complementary genes - Flower colour in sweet pea; Non-epistasis - Comb pattern in Fowls.

3. Multiple alleles - self sterility in Nicotiana. Multiple gene inheritance – ear size in corn.
4. Linkage and crossing over - chromosome theory of linkage, crossing over, types of crossing over, mechanism of crossing over (Holliday model) Linkage map, 2 point and 3 point crosses, interference and coincidence.
5. Sex-linked inheritance: X-linked, Y-linked, Morgan's experiment eg. eye colour in Drosophila, sex limited and sex influenced inheritance, pedigree analysis.
6. Extra-nuclear inheritance - Plastid inheritance in Mirabilis, Coiling pattern in snails.
7. Mutation - types - mutagens - physical, chemical and molecular mechanisms of gene

mutation.
8. Population genetics, Hardy-Weinberg law, factors affecting genetic equilibrium, selection, migration, meiotic drive, genetic drift.

Practical 25 hrs

Solving problems in dihybrid inheritance, modified ratios, and in chromosome mapping - 2 point and 3 point crosses.

Module II. Evolution

Theory 12 hrs

1. Origin of Earth – Introduction. Evidences of organic evolution – evidences from morphology, Anatomy, Embryology, Palynology, genetics and molecular biology.
2. Origin of Life: Origin of basic biological molecules – Condensation and Polymerisation. Protenoids and Prions – Oparin concept, Miller's experiment, Evolution of prokaryotic and eukaryotic cells. Archaebacteria – Early fossilized cells. Anaerobic metabolism, Photosynthesis and Aerobic metabolism.
3. Theories on origin and evolution of species; Spontaneous generation – Lamarckism – Darwinism, Weismann and deVries. Neo-Darwinism and its objection. The arguments and support for Darwinism.
4. Genetic Constancy and Creation of Variability; Cell divisions and genetic constancy – Genetic variability by multiple allelism and recombination – Chromosomal variations – Gene mutations –Application of Hardy Weinberg's Principle Mutation and Selection – Random genetic drift – Genetic Polymorphism.
5. Biomolecules – Evolutionat molecular level (brief account); evolutionary clocks.
6. Speciation: Isolating mechanism – Modes of speciation – sympatric and allopatric.

REFERENCES

1. Crick F., 1981. Life itself: Its origin and Nature. Simon and Schuster, New York.
2. Drake J.W., 1970. The molecular basis of mutation. Holden Day, San Francisco.
3. Dott R.H., R.L. Batten, 1981. Evolution of the earth 3rd edn. McGraw Hill New York.
4. Fox S.W. and K. Dose, 1972. Molecular evolution and the origin of life. W.H. Freeman & Co., San Francisco.
5. Gould S.J. 1977. Ontogeny and Phylogeny. Harvard Univ. Press, Cambridge, Mass.
6. Jardine N., D. McKenzie, 1972. Continental drift and the dispersal and evolution of organisms. Nature, 234. 20-24.
7. Miller, S.L. 1953. A production of amino acids under possible primitive earth conditions. Science, 117., 528-529.
8. Strickberger, 1990. Evolution, Jones and Bastlett Publishers International, England.

Module III. Ecology

Theory 25 hrs

1. Ecology: definition, scope and objectives, significance.
2. Ecosystem: definition, abiotic and biotic factors, trophic structure, food chain and food web, ecological pyramids, energy flow, productivity of ecosystems, biogeochemical cycles (carbon, nitrogen, phosphorous).
3. Plant adaptations: adaptations of the following plant groups – hydrophytes, xerophytes, halophytes, epiphytes, parasites.
4. Plant succession: definition, primary and secondary succession, autogenic and allogenic succession, mechanism of plant succession, xerosere, hydrosere.
5. Biodiversity and Conservation: definition – levels of biodiversity – values of biodiversity — Biodiversity in global and Indian scenario – mega diversity nations and hotspots – Biosphere reserves – threats to biodiversity; endangered and endemic plant species – Red data book - Exotic and indigenous plant species – Keystone species – Flagship species – Conservation

strategies - ex situ and in situ methods. Organizations – IUCN, UNEP & WWF – Biodiversity centres in India (NBPGR) Biodiversity Board of Kerala (KSBDB).

6. Natural Resources: Types – Renewable and non-renewable resources – Over explored and under explored resources. Petro crops – Sustainable management of resources (brief account).

– Pollution:–Sources and types of pollution – air, water, soil, thermal and noise – biodegradable and non-biodegradable pollutants – biomagnifications – BOD – Heavy metal contamination – Bhopal gas tragedy – Chernobyl disaster – Global environmental changes – climatic changes – global warming and greenhouse gases – acid rains – El Niño – Efforts of world organizations in the regulation of green house gases emission – Earth summit – Kyoto Protocol – World Summit on sustainable development, 2002 (WSSD), Carbon trade. Management of environmental pollution – conventional and phytotechnological approaches solid wastes management including e-wastes-environmental legislations in India (Prevention and Control of Pollution act, 1981).

7. Autecology: Population growth – exponential and logistic – population density – Natality – Mortality - Age distribution – Ecological amplitude – Ecological indicators – Role of indicators in environmental monitoring.

8. Synecology: Ecological community – Co-evolution of populations – Association of flowering plants and honeybees – Population interactions – Symbiosis, mutualism, commensalism, predation, parasitism, herbivory – concept of species diversity - α, β, r – sampling techniques in plant community studies Quadrat and transect methods – species area curve – density, frequency, abundance, dominance of populations – importance value index – construction of phytographs.

Practical 20 hrs

1. Construction of a schematic food web from the given set of data (representative of a natural ecosystem).
2. Construction of schematic ecological pyramids of number, biomass, energy from the given set of data (representative of a natural ecosystem).
3. Determination of pH of soil solution by using pH meter.
4. Determination of biomass of any plant species in your locality.
5. Study of plant communities – Determination of density, abundance, dominance, frequency by quadrate method.
6. Determination of dissolved oxygen by Winkler's method.
7. Study of morphological and anatomical characteristics of plant groups – Hydrophytes, Xerophytes, halophytes, epiphytes, parasites.

REFERENCES

1. Ahluvalia V.K. Malhotra S. 2009. Environmental Science. Ane Books.
2. Ambasht R.S. 1988. A text book of Plant Ecology. Students Friends Co.
3. Beeby A. & Brennan A.M. First Ecology. Ecological Principles and Environmental Issues. International Student Edition.
4. Benon E. Plant Conservation Biotechnology. Taylor & Francis.
5. Cunninghan W.P. and M.A. Cunningham 2003. Principles of Environmental Science: Inquiry and Applications. Tata McGraw Hill.
6. Dash M.C. 1993. Fundamentals of Ecology. Tata McGraw Hill Publishing Company Ltd.
7. Dix J.H. 1989. Environmental Pollution. Atmosphere, Land, Water and Noise. Wiley.
8. Khitoliya R.K. 2007. Environmental Pollution – Management and Control for Sustainable development S. Chand and Co.

9. Kumar H.D. 1977. Modern Concepts of Ecology. Vikas Publications.
10. Michael S. 1996. Ecology. Oxford University Press.
11. Mishra D.D 2008. Fundamental Concepts in Environmental Studies. S. Chand & Co.,
12. Mishra S.P. & S.N. Pandey 2008. Essential Environmental Studies. Ane Books Pvt. Ltd.
13. Odum E.P. 1983. Basics of Ecology. Saunders International.
14. Shukla R.S. & P.S. Chandel 2005. A Text Book of Plant Ecology S. Chand & Co.
15. Wise D.L. 2005. Global Environmental Biotechnology. Ane Books.
16. Bharucha E. 2005. Text Book of Environmental Studies for UG courses. University Press (India) Private Limited.
17. Archibold. O.W. 1995. Ecology of World Vegetation. Chapman & Hall.
18. Diamond, J., T.J. Case 1986. Community ecology. Harper & Row.
19. Futuyma P.J., Slatkin M. 1983. Co-evolution. Sinauer Associates.
20. Krebs, C.J. 1985. Ecology 3rd edn. Harper & Row.
21. Sharma, P.D. 2008-2009. Ecology and Environment. Rastogi Publication.
22. Wilkinson, D.M. 2007. Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press.
23. Kormondy, E.J. 1996. Concepts of ecology. PHI Learning Pvt. Ltd.

CORE COURSE X. PLA6B10. HORTICULTURE, PLANT BREEDING & BIOSTATISTICS

(Theory 72 hours Practical 45 hrs)

Distribution of Hours:	Theory	Practical
Horticulture	37	25
Plant Breeding	28	10
Biostatistics	7	10
Total	**72**	**45**

HORTICULTURE

Theory

Module – I. Fundamentals of Horticulture 10 hrs

1. Introduction: scope and significance, branches of horticulture.
2. Soil: components of soil, types of soil, soil analysis, soil testing,
3. Fertilizers: chemical, organic, biofertilizer, composting systems: non-container, container; vermi-composting.
4. Pots & potting: earthen, fibre, polythene bags, potting mixture, potting, repotting, top dressing.
5. Irrigation: surface-, sprinkle-, drip- and gravity irrigation.

Module – II. Plant Propagation Methods 12 hrs

1. Seed propagation: seed dormancy, seed viability and longevity, seed quality tests, seed treatment, essential condition for successful propagation, raising of seed beds, transplanting techniques.

(a) Vegetative propagation: Cutting (stem, roots, leaves)
(b) Grafting (approach, side tongue)
(c) Budding (T-budding, patch)

2. Layering (simple trench, air). Micro propagation: general account, multiple shooting, somatic embryogenesis, advantages.

Module – III Principles and Practice of Gardening 15 hrs

1. Gardening: definition; site selection, propagating structure: green house, poly house, mist chamber, net frame – garden tools and implements.

Indoor gardening: principles, selection of indoor plants, care and maintenance of indoor plants; bonsai: principle, creating the bonsai.

Outdoor gardening: landscaping:- goals, types.

Cultivation and post harvest management of ornamental plants: Rose, Jasmine, Orchids and Anthurium.

Cultivation and post harvest management of vegetables: okra, bitter gourd, chilli, brinjal, pea.

2. Protection of Horticultural plants: Principles, Precautions to avoid pests and diseases. Methods of pest control: Cultural, Biological, Chemical, Mechanical, Physical and Legislative. Major pests of horticulture plants, Pest management, Diseases and disease management, Pesticides – types and preparation.

3. Mushroom cultivation – Oyster mushroom

Practical 30 hrs

1. Preparation of nursery bed and polybag filling.
2. Preparation of potting mixture – Potting, repotting.
3. Field work in cutting, grafting, budding, layering.
4. Identification of pest and diseases in campus.
5. Preparation and application of neem kernel suspension, tobacco decoction and Bordeaux mixture.
6. Familiarizing gardening tools and implements.
7. Training in topiary and pruning.
8. Preparation of vermi-compost.
9. Cultivation of mushroom.
10. Establishment of vegetable garden.
11. Visit to nurseries and tissue culture laboratories and preparation of notes.
12. Basic training in Vegetable carving and flower arrangement
13. Basic training in fruit preservation

REFERENCES

1. Sinha, N. 1993. Gardening in India, Abhinav Publications.
2. Andiance, G.W. and Brison, F.R. 1979. Propagation of Horticultural Plants. Krieger Pub. Co.
3. Sarin, R. 1997. The Art of Flower Arrangement, UBS Publishers.
4. Katyal, S.C.1977. Vegetable growing in India, Oxford &IBH.
5. Naik, K.C. 1963. South Indian Fruits and their Culture. P. Varadachary.
6. Chadha, K.L. 2011. Ornamental Horticulture in India.
7. Acquaah, G. 2008. Horticulture: Principles and Practices. Pearson Education, Delhi.
8. Prasad, S. and U. Kumar. 2018. Green house Management for Horticultural Crops, Agrobios.
9. Kumar, U. 2012. Methods in Plant Tissue Culture. Agrobios.
10. Kolay, A.K. 2001. Basic Concepts of Soil Science. New Age International Publishers, Delhi.
11. Bal, J.S., 2010. Fruit growing, Kalyani Publishers, Delhi.
12. Rodgran, M.K. 2004. Plant Tissue Culture, Oxford & IBH.
13. Nesamony, S. 2001. *Oushadha Sasyangal*. State Institute of Languages, Kerala.
14. Prakash, R and Raj Mohan, K. *Jaivakrishi*. State Institute of Languages, Kerala.
15. Hartmann H.T., Kester D.E., Davies F.T., Geneve, R.L. 2015. Plant Propagation, Principles and Practices. Pearson.

PLANT BREEDING

Theory

Module I. Basics of Plant Breeding 28 hrs

1. Definition and objectives of plant breeding - important national and international plant breeding institutes
2. Plant genetic resources – components of plant genetic resources, significance
3. Breeding techniques- a) plant introduction; b) selection- mass selection, pure line selection and clonal selection; c) hybridization techniques, hybrid vigour, inbreeding depression; d) mutation breeding; e) polyploidy breeding; f)Breeding for disease resistance
4. Breeding techniques and achievements with reference to the following crops in India: rice,coconut.

Practical 15 hrs

Techniques of emasculation and hybridization of any bisexual flower.

REFERENCES

1. Allard. R.W. 1960. Principles of Plant Breeding. John Wiley & Sons.
2. Chaudhari. H.K. Elementary Principles of Plant breeding. Oxford & IBH Publishers.
3. Singh, B.D. 2005. Plant Breeding - Principles & Methods. Kalyani Publishers.
4. Sinha, U. & Sinha, S. 2000. Cytogenetics, Plant Breeding & Evolution Vikas Publishing.
5. Ram, M. 2014. Plant Breeding Methods. Prentice Hall India

Biostatistics - Data handling 7 hrs.

1. General introduction and application of biostatistics.
2. Collection of data: Sampling theory and methods.
3. Presentation of data: a) Graphic representation: histogram, frequency polygon and frequency curve; b) Diagrammatic representation: Line diagram, bar diagram, pie diagram.
4. Analysis of Data: a) Measures of central tendencies Mean- Median- Mode. b) Measures of dispersion Range, mean deviation, standard deviation and standard error.

Biostatistics

Practical 10 hrs

1. Measure the length of given plants / any sample of data and calculate the mean, median and mode.

2 Measure the size of given fruits / any sample of data and represent it in a graphical form and interpret it. Construct bar diagram, histogram and pie diagram using suitable data.

CORE COURSE 11 (ELECTIVE). PLA6B11. BIOTECHNOLOGY

Total 72hrs; Theory only.

Module- I. Tissue Culture 20 hrs

Introduction to biotechnology – history, definition, scope, significance.

Plant tissue culture – history, principle – totipotency, differentiation, dedifferentiation, redifferentiation. Facilities of tissue culture laboratory.

Media – MS medium composition and preparation, sterilization techniques; explant selection, sterilization and inoculation.

Types of culture – meristem culture, organ culture; callus culture; cell suspension culture; protoplast culture.

Isolation of protoplasts, somatic hybridization and its significance;

Somatic embryogenesis and synthetic seeds.

Haploid production – anther and pollen culture, its significance;
Embryo culture and embryo rescue.
Micropropagation – multiple shoot culture and large scale propagation of crop plants, Somaclonal variation – disease free plants.
Production of secondary metabolites in bioreactors.

Module – II. Recombinant DNA Technology 25 hrs

a) Tools- Enzymes: exonucleases; endonucleases; restriction endonucleases; ligases; reverse transcriptase, terminal transferase, polymerase, alkaline phosphatase. Vectors: general account of plasmids, cosmids, bacteriophages, Plasmids –Advantages and disadvantages; Structure of pBR 322; Artificial chromosome vectors – BAC, YAC, shuttle vectors
b) Isolation of gene of interest –Genomic library, cDNA library; screening of library- antibiotic screening, using probe, Reporter genes.
c) functional analysis of isolated genes- microarray, *in situ* hybridizations (Brief account)
d) Gene transfer methods in plants: Direct methods of gene transfer – biolistics, lipofection, electroporation, microinjection – advantages and disadvantages.Vector mediated gene transfer-Agrobacterium-mediated gene transfer – T DNA, Ti plasmid and Ri plasmid derived vector systems

Process of transfer - bacterial colonization, Induction of virulence, generation of TDNA transfer complex, T-DNA transfer, integration of TDNA into plant genome

Module III. Principles and Applications of Biotechnology Techniques 27 hrs

a. Polymerase chain reaction – Principle, types of primers, Taq polymerase, application and problems, Reverse Transcriptase PCR. Real time PCR
b. DNA sequencing – Maxam-Gilbert's method, Sanger's method, Automated DNA sequencing
c. Molecular Analysis of gene and gene products – Southern, Northern and Western blotting, ELISA.
d. Molecular markers – RAPD, RFLP, AFLP, Brief account of DNA Finger printing and Bar coding of plants
e. Brief account of: Antisense RNA technology – FLAVR SAVR Tomato; Gene Silencing; RNA interference; miRNA.

APPLICATIONS:

a. Medical Biotechnology: disease diagnosis– Biopsy, genetic tastings using probes, screening of infectious and genetic disease, gene expression analysis; Production of vaccine, antibiotics, hormones; Transgenic animals in medical research; Correction of genetic diseases- gene therapy, stem cell therapy, personalized medicines.
b. Agricultural Biotechnology: applications of plant tissue culture, production of transgenic plants - Bt cotton, Golden rice; bio-safety concern
c. Environmental Biotechnology: biodiversity and conservation; waste management and bioremediation
d. Industrial Biotechnology – development of vaccines & hormones, food processing and improving food quality, beverage industry, SCP, improved food and food products.

REFERENCES

1. Brown T.A. 2006. Gene cloning and DNA analysis; Blackwell scientific publishers.
2. Sobti R.C. & Pachauri S.S. 2009. Essentials of Biotechnology; Ane Books.
3. Dubey R.C. Introduction to Plant Biotechnology; S Chand & Co.
4. Purohit S.S. 2003. Agricultural Biotechnology, Agrobios (India).
5. Chawla H.S. 2000. Introduction to Plant Biotechnology.
6. Ignacimuthu S. 1997. Plant Biotechnology, New Hampshire Science Publishers.
7. Razdan M.K. 1995. Introduction to Plant Tissue Culture. Oxford & IBH.

8. Gupta P.K. 1996. Elements of Biotechnology; Rastogi and Company.
9. Primrose S.B., Twyman R.M. & Old R.W. 2001. Principles of gene manipulation : An Introduction to genetic engineering. Blackwell.
11. Smith J.E. 2005. Biotechnology. Cambridge University press.
12. Wilson K. & Walker J. 2008. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
13. Ignacimuthu S. 2008. Biotechnology: An introduction, Alpha science International Ltd.
14. Baaker, K.H. and Herson D.S. 1994. Bioremidation. McGraw Hill.
15. Ahmed, N., Qureshi, F. M. and Khan, O. Y. 2006. Industrial and Environmental Biotechnology. Horizon Press.
16. Rochelle, P. A. 2001. Environmental Molecular Biology, Horizon Press

CORE COURSE 11 (ELECTIVE). PLA6B12. MEDICINAL PLANTS

Total Hours 72; Theory only.

Module I 15 hrs

Medicinal plants and traditional medicines: history, major systems of traditional medicines with particular emphasis to Ayurvedic medicines, botanical drugs used in traditional medicines which led to useful modern drugs: *Adhatoda vasika, Catharanthus roseus, Gingko biloba, Rauvolfia serpentina, Taxus buccata, Digitalis lanata*. Protocol for medicinal plant drug discovery process and development.

Module II 12 hrs

A detailed study of the importance and conservation of medicinal plants – In situ, ex situ, sacred groves. Role of ICAR, IMPB, BSI, NBPGR and FRLHT in conservation and cultivation of medicinal plants. IPR issues.

Module III 15 hrs

Pharmacognosy – definition and scope – Significance of Pharmacognosy in various systems of medicines (sidha, ayurveda, unani and homeopathy); Factors influencing variability in drug activity, type of soils, fertilizers, plant hormones and their applications, polyploidy, mutation and hybridization in medicinal plants. Classification of vegetable drugs, identification of drugs (taxonomical, anatomical, and chemical). Phytoconstituents of medicinal importance: polysaccharides, mono-, di- and triterpenes, steroids, saponins, glycosides, flavonoids, phenolic compounds, tannins, carotenoides, alkaloids, iridoides and amino acids.

Module IV 15 hrs

A detailed study of the methodology of cultivation of medicinal plants. Rhizome – *Curcuma*, Ginger; Tuber- *Allium cepa*; Root – *Asparagus, Hemidesmus, Acorus calamus*; Twigs- *Adhatoda vasica, Catharanthus roseus, Phyllanthus amarus, Andrographis paniculata*; Leaves – *Aloe vera, Centella asiatica*. Factors influencing cultivation of medicinal plants: type of soils & fertilizers of common use - pest management & natural pest control agents - plant hormones and their applications - polyploidy, mutation & hybridization with reference to medicinal plants.

Module V 15 hrs

A detailed study of sources of vegetable drugs. Production of vegetable drugs. Deterioration of drugs and their control measures. Adulteration of drugs, common adulterants and their detection. WHO guidelines for standardisation of medicinal plants. Factors involved in the preparation of herbal drugs for market from cultivated and wild sources including collection, drying, storage and transport methods.

REFERENCES

1. Jain S K 1990. Contribution Indian ethnobotany. Scientific publishers.
2. Jain S K.1996. Ethnobotany in human welfare. Deep publishers.
3. Jyothiprakash E J. 2006. Medicinal botany and pharmacognosy. Emkay Publishers.
4. Maheshwary J. K. 2000. Ethnobotany and medicinal plants of Indian subcontinent. Scientific publishers.
5.Singh G. K. and Bhandari A. 2000. Textbook of Pharmacognosy. CBS publishers N.Delhi.
6. Verma V. 2009. Text book of Economic Botany. Ane Books.
7. Dutt A. 2008. An Introduction to Medicinal Plants. Adhyayan Publishers.
8. Dhiman A.K. 2003. Sacred Plants and their medicinal uses. Daya Publishing House.
9. Jain S K 1981. Glimpses of Indian ethnobotany. Oxford and IBH.
10. Prajapati, N.D. et al. 2006. A Handbook of Medicinal Plants : A Complete Source Book. Eastern Book Corporation.
11. R.S. Thakur, H.S. Puri and Akhtar Husain, 1989. Major Medicinal Plants of India. Vedams Books.
12. Trivedi, P.C. 2010. Drugs from Plants. Aavishkar Publishers.
13. Trivedi, P.C. 2010. Ethnic Tribes and Medicinal Plants. Pointer Publishers.
14. Ansary, P.Y. 2005. A Hand Book on the Plant Sources of Indigenous Drugs. International Book Distributors.
15. Reddy K. J., Bir Bahadur, B Bhadraiah and M L N Rao, 2007. Advances in Medicinal Plants. Universities Press.

CORE COURSE 11 (ELECTIVE). PLA6B13. FORESTRY

Total 72 hrs; Theory only

Module I 10 hrs

A detailed study of different types of forests: natural and man-made; tropical, temperate, evergreen semi-evergreen, deciduous; monoculture, multipurpose, social and industrial. Forests and gene conservation.

Module II 10 hrs

Silviculture: concept and scope of study of natural and artificial regeneration of forests. Clear felling, uniform shelter, wood selection, coppice and conservation systems. Silviculture of some of the economically important trees in India such as neem, teak, eucalyptus, mahogany, rosewood, sandal, jackfruit tree and rubber tree.

Module III 10 hrs

A detailed study of different types of wood: homogenous and heterogeneous- spring and autumn wood- porous and non-porous wood- heart- and sap wood. Anatomical structure of wood, defects and abnormalities of wood, relevance of wood anatomical studies in Kerala.Identification of wood- preparation of key and their uses.

Module IV 12 hrs

Agroforestry - scope and necessity; role in the life of people and domestic animals and in integrated land use, planning especially related to (i) soil and water conservation; (ii) water recharge; (iii) nutrient availability to crops; (iv) nature and eco-system preservation including ecological balances through pest-predator relationships and (v) providing opportunities for enhancing bio-diversity, medicinal and other flora and fauna. Agro forestry systems under different agro-ecological zones; selection of species and role of multipurpose trees and NTFPs, techniques, food, fodder and fuel security. Research and Extension needs. Social/Urban Forestry : objectives, scope and necessity; peoples participation. JFM - principles, objectives, methodology, scope, benefits and role of NGOs. Tribal participation in forestry programmes.

Module V 10 hrs

Seed orchards, seed dormancy- types of dormancy, physical and chemical methods to overcome seed dormancy. Forest laws - necessity, general principles, Indian forest act 1927 and its amendment.

Module VI 10 hrs

A detailed study of forest resources and their utilization. Forest products- timber, pulp wood, secondary timbers, non-timber forest products (NTFPs). Definition and scope (brief outline) - gums, resins, fibers, oil seeds, nuts, rubber, canes and bamboos, medicinal plants, charcoal. and lac collection and marketing.

Module VII 10 hrs

Forest Protection: Injuries to forest - abiotic and biotic, destructive agencies, insect-pests and disease, effects of air pollution on forests and forest die back. Susceptibility of forests to damage, nature of damage, cause, prevention, protective measures and benefits due to chemical and biological control. General forest protection against fire, equipment and methods, controlled use of fire, economic and environmental costs; timber salvage operations after natural disasters. Role of afforestation and forest regeneration in absorption of CO_2. Rotational and controlled grazing, different methods of control against grazing and browsing animals; effect of wild animals on forest regeneration, human impacts; encroachment, poaching, grazing, live fencing, theft, shifting cultivation and control.

REFERENCES

1. Dhiman, A.K. 2003. Sacred plants and their medicinal uses. Daya Publishing House.
2. Anonymous, A Hand book of Kerala Timbers- KFRI, Trichur.
3. Chundawat B.S. and Gautham, S.K. 1996. Text book of Agroforestry. Oxford and IBH.
4. Kollmann and Cote 1988. Wood Science and Technology. Vol. I & II Springer.
5. Sagreiya, K.P. 1994. Forests and Forestry (Revised by S.S. Negi). National Book Trust.
6. Sharma P.D. 2004. Ecology and Environment. Rastogi publications, Meerut
7. Singh M.P. and Vishwakarma, V. 1997. Forest environment and Biodiversity. Daya Publishing House.
8. Tiwari K.M. 1983. Social forestry in India.
9. Mehta, T. 1981. A handbook of forest utilization. Periodical Expert Book Agency, New Delhi.
10. Bor, N. L. 2010. A Manual of Indian Forest Botany. Asiatic Publishers.
11. Benu Singh. 2010. A Modern Book on Forestry and Horticulture. Vista International Publishers.
12. Singh, S. 2006. Encyclopaedia of Forestry. Eastern Book Corporation.
13. Champion, H. G. & Seth, S.K. 2005. A Revised Survey of the Forest Types of India. Jain Book Agency.
14. Ghosh, A. K. 2006. Academic Dictionary of Forestry. Jain Book Agency.
15. Bebarta, K.C. 2004. Forest Resources and Sustainable Development - Principles, Perspectives and Practices. Jain Book Agency.

SYLLABI OF OPEN COURSES OFFERED TO STUDENTS FROM OTHER DEPARTMENTS/STREAMS

SEMESTER - V

OPEN COURSE 1. PLA5D01. MUSHROOM CULTIVATION

Total 54 hrs.

Module – I 6 hrs

Mushrooms: introduction, biodiversity, edible and poisonous species, systematic position, distribution and morphology. The role of mushrooms in nature: saprobes, parasites, mycorrhiza formers. Structure and life cycle of *Agaricus, Pleurotus, Calocybe* and *Ganoderma.*

Module – 2 2 hrs
Value of mushrooms – nutritional, medicinal, economic and environmental.
Module – 3 4 hrs
Raw materials for mushroom cultivation: logs, wood chips, paper products, cereal straws, grain hulls, sugar cane bagasse, banana fronds and other agro-wastes. Supplements added to substrate to enhance yields: corn meal, rice bran, oatmeal and bran, wheat grain and bran. Biological efficiency of mushroom production.
Module –4 12 hrs
Spawn; commercial and home-made; methods of spawn production: preparation of agar media (PDA, MEA); culturing mycelium on agar medium, preserving stock cultures; producing grain spawn: formulas for producing grain spawn; containers for spawn preparation; steps in generating first generation grain spawn masters; steps in generating second and third generation grain spawn. Spawn storage.
Module –5 12 hrs
Protocol for cultivating mushrooms on agricultural wastes: heat-treating the bulk substrate, submerged pasteurization, steam pasteurization, chemical treatment of straw, cropping containers, tray culture and bag culture, casing, growth parameters (incubation temperature, relative humidity, duration, CO_2 concentration, fresh air exchange, light requirement) for Pleurotus and Calocybe at stages such as spawn run, primordia formation, and fruit body development; cropping cycle.

Module –6 6 hrs
Harvesting, storing and packaging the crop for market.
Module-7 6 hrs
Constraints in production: adverse environmental factors, pests and pathogens.
Module-8 6 hrs
Demonstration of laboratory-scale cultivation of *Pleurotus* and *Calocybe*.

References:
1. Singh, H. 1991. Mushrooms The Art of Cultivation. Sterling Publishers.
2. Kaul, T.N. 2001 Biology and Conservation of Mushrooms. Oxford and IBH.
3. Pandey, B.P. 1996. A Text Book of Fungi. S. Chand and Co.
4. Stamets, P. and J.S. Chilton. 1983. The Mushroom Cultivator. Ten Speed Press.
5. Tripathi. Mushroom Cultivation. Oxford & IBH.
6. Stamets, P. 2000. Growing Gourmet And Medicinal Mushrooms. Ten Speed Press.
7. EIRI. Handbook of Mushroom Cultivation, Processing and Packaging. Engineers India Research institute.
8. Suman, B.C. & Sharma, V.P. 2007. Mushroom Cultivation in India. Eastern Book Corporation.
9. Suman, B. C. and V. P. Sharma. 2007. Mushroom Cultivation, Processing and Uses. Agrobios.
10. Singh, R. and U. C. Singh. 2005. Modern Mushroom Cultivation. Agrobios.

SEMESTER - V
OPEN COURSE 2 PLA5D02 PLANT TISSUE CULTURE
(Total - 54 hrs)

Module – I 15 hrs

Introduction, objectives and goals of plant tissue culture. Plant cell and tissue culture – laboratory design and development. Essential facilities required for a tissue culture lab. Tissue culture media – a general account, MS Medium composition, preparation, sterilization and storage.

Module – II 12 hrs

Protocols in tissue culture – explant selection, sterilization, inoculation, induction of callus, organogenesis and hardening.

Module – III 15 hrs

Application of plant tissue culture – micropropagation, somatic embryogenesis, artificial seeds, germplasm conservation and transfer, embryo rescue and culture, protoplast isolation, culture and fusion, anther, pollen and ovary culture for production of haploids, cryopreservation, DNA banks and germplasm conservation, secondary metabolite production, shoot apical meristem culture and production of pathogen-free stocks and somaclonal variation.

Module –IV 12 hrs

Plant transformation technology – transgenic plant production, gene transfer methods in plants, multiple gene transfers, vector-less or direct gene transfer techniques.

REFERENCES

1. Dixon, R.A. & R.A. Gonzales. 1994. Plant Cell Culture – A Practical Approach. Oxford University Press.
2. Mantel & Smith 1983. Plant Biotechnology. Cambridge University Press.
3. Mantel, S. H, Mathew, J.A. et al. 1985. An Introduction to Genetic Engineering in Plants. Blackwell Scientific Publishers.
4. Gupta, P.K. 1996. Elementary Biotechnology. Rastogi & Company.
5. Hammond, J., Megary, P et al. 2000. Plant Biotechnology. Springer.
6. Gamborg, O.L. & G.C. Philips (Eds.) 1995. Plant Cell, Tissue and Organ Culture Fundamental Methods. Narosa Pulishing House.
7. Reinert & Bajaj Plant Cell, Tissue and Organ Culture.
8. Das, H.K. (Ed) 2005. Text book of Biotechnology. Wiley India (Pvt.) Ltd.

SEMESTER - V

OPEN COURSE 3 PLA5D03 BIOFERTILIZERS AND ORGANIC FARMING

(Total - 54 hrs.)

Module – I 9 hrs

Biofertilizers - introduction , history, definition , importance of biofertilizers, ecofarming chemical fertilizers – health and the environment.

Module- II 15 hrs

Cyanobacteria as biofertilizers. Isolation of cyanobacteria, culturing of cyanobacteria, identification, characterization and selection of cyanobacteria, inoculum preparation – small scale and large scale. Factors affecting cyanobacterial growth. *Azolla* as biofertilizer and other uses. Morphology and life cycle of *Azolla* and *Anabaena azollae*. Nitrogen fixation by *Azolla*. Growth rate and Nitrogen input. Factors affecting the growth of *Azolla*. Decomposition of *Azolla* and mobilization of its nitrogen. Methods of *Azolla* utilization Control of insects and diseases

Module – III 15 hrs

1. *Rhizobium*: Isolation of *Rhizobium* from nodules, classification, identification, plant tests, maintenance of culture, cultivation and mass production, quality control, methods of inoculation.
2. *Azotobacter*: Isolation of *Azotobacter* by soil dilution plating method, identification and

classification, maintenance and cultivation, crop response.
3. *Azospirillum*: Isolation of *Azospirillum* from rice root, identification and classification Maintenance and cultivation crop response.
4. Isolation of phosphate-solubilizing microorganisms: *Pseudomonas, Bacillus* - quantitative measurement of phosphate solubilization in culture-medium, agronomic aspects.
5. Mycorrhiza: Isolation and identification of ectomycorrhizal fungi; inoculation technique for ectomycorrhizal fungi; isolation and identification of VAM fungal spores; inoculum production of VAM Fungi; field response.

Module – IV 15 hrs

Organic Farming: introduction and history.
Methods of organic farming- Biological/natural pest and weed control, Composting, Cover cropping, Crop rotation, Diversity on the farm, Do-nothing farming, Effective Microorganism (EM), Green manuring and green leaf manuring, Indigenous seeds, Intercropping, Integration of systems, Living fences, Microbial biofertilisers, Mulching, Multicropping, Multipurpose trees, Permaculture, Polyculture, Reduced tillage, Soil and water conservation, Specialised organic farming techniques, Vermi-composting.
Integrated Pest management; biological pest control; non-chemical pesticide formulations like kerosene emulsion, tobacco decoction, neem kernel suspension, and pheromone traps.

REFERENCES

1. Kanniyan.S.1990. Biofertilizer Technology for Rice. TNAU , Coimbatore.
2. Lumpkin T.A and D.L. Plucknett, 1980. Azolla; Botany, Physiology and use as a green manure. Econ. Bot. 34:111-153.
3. Balasundaran, V.R, and Subha Rao, N.S. 1977. A review of development of rhizobial inoculants for soybeans in India. Fertilizer News. 22 : 42-46.
4. Subha Rao, N.S. 1993, Biofertilizers in agriculture and forestry. Oxford & IBH.
5. Elkan, H.H.1984. Taxonomy and metabolism of Rhizobium and its genetic relationship in biological nitrogen fixation, Ed. M. Alexander. Plenum Press.
6. Date , R.A. 1976. Principles of *Rhizobium* strain selection. In symbiotic nitrogen fixation in plants. Ed. P.S. Nutman. Cambridge University Press.
7. Brown, M. 1962. Population of *Azotobacter* in the rhizosphere and effect of artificial inoculation. Plant and soil. 17 :15.
8. Lehri, L.K and C.L. Mehrotra. 1972 . Effect of *Azotobacter* inoculation on the yield of vegetable crops . Indian J. Agriculture Research. 9 : 210 -204.
9. Terrand, J.J., Kreig, N.R. and Dobereiner, J. 1978. A taxonomic study of *Spirillum lipoferum* group, with description of a new genus *Azospirillum* gen. nov. and two species. Azospirillum braseilliense sp. nov., Can. J. Microbial., 24: 967 -980.
10. Trappe, J.M.1962. Fungus associates of ectotrophic mycorrhizae. Bot. Rev. 28: 538-606.

Annexture I: Model Question Papers

MODEL QUESTION PAPER FOR CORE COURSE (THEORY)

Question Paper Type 1 (Time 2.5 Hours Total: 80 marks)

CORE COURSE 3 – Algae, Fungi, Lichens, Bacteria, viruses and Plant Diseases
Time 2.5 Hours Total: 80 marks

PART A (Eeah questions carries 2 Marks. 15 questions. Ceiling 25)

1. What is karyogamy?
2. What is an apothecium? Illustrate the structure.
3. Illustrate sex organs of *Chara*?
4. What are the asexual reproductive structures found in lichens?
5. What is symbiosis? Give an example.
6. What is dikaryotization?
7. Distinguish between smut and rust.
8. Write a short note on rhizophere.
9. Describe the apothecium of *Peziza.*
10. What is endospore?
11. What is mycoplasma? Name a disease caused by it.
12. What are plasmids?
13. Define systemic fungicide.
14. What is the economic importance of lichens.
15. Explain the thallus structure of *Polysiphonia.*

Part B (Eeah questions carries 5 Marks. 8 questions. Ceiling 35)

16. Write a brief account of the features of ascomycetes.
17. Give a brief account of Gram staining.
18. Enumerate the economic importance of fungi.
19. Briefly explain the physiology of parasitism.
20. Briefly explain reproduction in lichens.
21. Describe the gene transfer methods in bacteria.
26. Give an outline of van den Hoek *et al.*'s (1995) system of algal classification.
27. Briefly describe the harmful aspects of algae.

Part C (Answer any two of the following. 2 x10 = 20 marks)

28. Briefly explain the life cycle of a facultative saprophyte fungus with special emphasis on damping-off of seedling.
29. Describe the structure and reproduction of TMV.
30. With the help of diagrams, describe the reproduction and life cycle of *Mucor*.
31. Explain the morphology and structure of bacteria with suitable diagrams.

Question Paper Type 2 (Time 2 Hours Total: 60 marks)

MODEL QUESTION PAPER FOR OPEN COURSE (THEORY)
OPEN COURSE 1. – Tissue Culture
Time 2 Hours Total: 60 marks

PART A (Eeah questions carries 2 Marks. 12 questions. Ceiling 20)

1. What are the uses of callus culture?
2. Why *Agrobacterium tumefaciens* is known as natural genetic engineer of plants?
3. What is dedifferentiation and redifferentiation?
4. Write some uses of cell suspension cultures.
5. Differentiate between explants culture and callus culture.
6. Differentiate between in vivo gene banks and in vitro gene banks.
7. What is parasexual hybridization?
8. What are the differences between plant cell culture and animal cell culture?
9. What functions are performed by laminar air flow chamber?
10. Write a short account on meristem culture.
11. Write a short account on somatic embryogenesis.
12. Write a short account on anther culture.

Part B (Eeah questions carries 5 Marks. 7 questions. Ceiling 30)

13. Briefly describe the basic facilities required for a plant tissue culture laboratory.
14. Briefly describe the protocol for cryopreservation of plant cell culture.
15. Briefly describe the methods of sterilisation adopted for plant tissue culture.
16. Write a note on organ culture.
17. How germplasm is conserved?
18. What are the characteristics of vectors?
19. What is somaclonal variation and what is its application?

Part C (Eeah questions carries 10 Marks. 2 questions. Ceiling 10)

20. What are the methods of gene transfer ? Explain the merits and demerits.
21. Ennumerate the different steps in micropropagation.