

UNIVERSITY OF KERALA
THIRUVANANTHAPURAM



COURSE STRUCTURE AND SYLLABUS

FOR

FIRST DEGREE PROGRAMME

IN

BOTANY

UNDER

CHOICE BASED CREDIT- SEMESTER SYSTEM
(w.e.f. 2014 admission)

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OBJECTIVES OF THE PROGRAMME

- ❖ To impart knowledge of Science is the basic objective of education.
- ❖ To develop scientific attitude is the major objective to make the students open minded, critical, curious.
- ❖ To develop skill in practical work, experiments and laboratory materials and equipments along with the collection and interpretation of scientific data to contribute the science.
- ❖ To understand scientific terms, concepts, facts, phenomenon and their relationships.
- ❖ To make the students aware of natural resources and environment.
- ❖ To provide practical experience to the students as a part of the course to develop scientific ability to work in the field of research and other fields of their own interest and to make them fit for society.
- ❖ The students are expected to acquire knowledge of plant and related subjects so as to understand natural phenomenon, manipulation of nature and environment in the benefit of human beings.
- ❖ To develop ability for the application of the acquired knowledge to improve agriculture and other related fields to make the country self reliant and sufficient.
- ❖ Understand and appreciate the role of biology in societal issues, such as the environment and biological resources, biodiversity, ethics and human health and diseases.
- ❖ To enrich the students with the latest developments in the field of Information technology, Biotechnology, Bioinformatics and other related fields of research and development
- ❖ To create enthusiasm to understand more about the beautiful planet Earth and to give awareness to the public the need to protect the planet from all kinds of exploitation.
- ❖ To keep the scientific temper which the student acquired from school level and to develop a research culture

Table 1. General Structure of the First Degree Programme in Botany

Sem No.	Course Code	Course Title	Instructional hours/week		Credits	Uty Exam Duration	Evaluation		Total credits
			T	P			Internal	University exam	
I	EN1111	English Language I	5	-	4	3hrs	25%	75%	16
	1111	Additional Language I	4	-	3	„			
	EN1121	Foundation Course I	4	-	2	„			
	BO1141	Core Course I	2	2	3	„			
	CH/BC1131	Compl. courseI(CH/BC)	2	2	2	„			
	ZO1131	Complementary Course II(ZO)	2	2	2	„			
II	EN1211	English Language II	5	-	4	„	25%	75%	17
	EN1212	English Language III	4	-	3	„			
	1211	Additional Language II	4	-	3	„			
	BO1221	Foundation Course II	2	2	3	„			
	CH/BC1231	Compl. Course III(CH/BC)	2	2	2	„			
	ZO1231	Complementary Course IV(ZO)	2	2	2	„			
III	EN1311	English Language IV	5	-	4	„	25%	75%	17
	1311	Additional Language III	5	-	4	„			
	BO1341	Core Course II	3	2	3	„			
	CH/BC1331	Compl. Course V(CH/BC)	3	2	3	„			
	ZO1331	Complementary Course VI(ZO)	3	2	3	„			
IV	EN1411	English Language V	5	--	4	„	25%	75%	25
	1411	Additional Language IV	5	-	4	„			
	BO1441	Core Course III	3	2	3	„			
	CH/BC1431	Compl. CourseVII(CH/BC)	3	2	3	„			
	ZO1431	Complementary courseVIII(ZO)	3	2	3	„			
	CH/BC1432	Compl IX (Practical CH/BC)	-	(8)*	4	„			
	ZO1432	Compl X (Practical ZO)	-	(8)*	4	„			
V	BO1541	Core Course IV	4	3	4	„	25%	75%	20
	BO1542	Core Course V	5	2	4	„			
	BO1543	Core Course VI	4	2	3	„			
	BO1544	Core (Practical-1) VII	-	(4)*	3	„			
	BO1545	Core (Practical-2)VIII	-	(4)*	4	„			
	BO1551.1	Open Course I Horticulture	3	-	2	„			
	BO1551.2	Mushroom cultivation & Marketing	-	-	-	„			
	BO1551.3	Forestry Project	-	2	-	„			
VI	BO1641	Core CourseIX	5	2	4	„	25%	75%	25
	BO1642	Core Course X	4	2	4	„			
	BO1643	Core Course XI	4	2	4	„			
	BO1644	Core (Practical-3)XII	-	(5)*	3	„			
	BO1645	Core (Practical-4)XIII	-	(8)*	4	„			
	BO1651	Elective Course II	3	-	2	„			
	BO1646	Project	-	3	4	„			
									120

L = Lecture P = Practical ()*Practical hour already distributed in the semester concerned

Table 2. SEMESTER – I

Sem No.	Course Code	Course Title	Instructional hours/week		Credits	Uty Exam Duration	Evaluation		Total credits
			T	P			Internal	University exam	
I	EN1111	English Language I	5	-	4	3hrs	25%	75%	16
	1111	Additional Language I	4	-	3	”			
	EN1121	Foundation Course I	4	-	2	”			
	BO1141	Core Course I -Angiosperm Anatomy Reproductive Botany & Palynology	2	2	3	”			
	CH/BC11	Compl. courseI(CH/BC)	2	2	2	”			
	31	Complementary Course	2	2	2	”			
	ZO1131	II(ZO)				”			

Table 3. SEMESTER – II

Sem No.	Course Code	Course Title	Instructional hours/week		Credits	Uty Exam Duration	Evaluation		Total credits
			T	P			Internal	University exam	
II	EN1211	English Language II	5	-	4	”	25%	75%	17
	EN1212	English Language III	4	-	3	”			
	1211	Additional Language II	4	-	3	”			
	BO1221	Foundation Course II- Methodology & Perspectives in Plant Science	2		3	”			
	CH/BC1231	Compl. Course III(CH/BC)	2		2	”			
	ZO1231	Complementary Course	2	2	2	”			
	IV(ZO)		2	2	2	”			

Table 4. SEMESTER – III

Sem No.	Course Code	Course Title	Instructional hours/week		Credits	Uty Exam Duration	Evaluation		Total credits
			T	P			Internal	University exam	
III	EN1311	English Language IV	5	-	4	”	25%	75%	17
	1311	Additional Language III	5	-	4				
	BO1341	Core Course II- Microbiology, Phycology, Mycology, Lichenology & Plant Pathology	3	2	3				
	CH/BC1331	Compl. Course V(CH/BC)	3	2	3				
	ZO1331	Complementary Course VI(ZO)	3	2	3				

Table 5. SEMESTER –IV

Sem No.	Course Code	Course Title	Instructional hours/week		Credits	Uty Exam Duration	Evaluation		Total credit
			T	P			Internal	University exam	
IV	EN1411	English Language V		--		”	25%	75%	25
	1411	Additional Language IV	5	-	4				
	BO1441	Core Course III- Bryology, Pteridology, Gymnosperms & Paleobotany	5	2	4				
			3		3				
	CH/BC1431	Compl. Course VII(CH/BC)		2					
	ZO1431	Complementary Course VIII(ZO)	3	2	3				
				(8)	3				
CH/BC1432	Compl IX (Practical CH/BC)	3	*	3					
		-		4					
ZO1432	Compl X (Practical ZO)	-	(8)	4					
			*						

Table 6. SEMESTER - V

Sem No.	Course Code	Course Title	Instructional hours/week		Credits	Uty Exam Duration	Evaluation		Total credits
			T	P			Internal	University exam	
V	BO1541	Core Course IV - Angiosperm Morphology, Systematic botany, Economic botany, Ethno botany & Pharmacognosy	4	3	4	”	25%	75%	20
	BO1542	Core Course V- Environmental Studies & Phytogeography	5	2	4				
	BO1543	Core Course VI- Cell Biology, Genetics & Evolutionary Biology	4	2	3				
	BO1544	Core (Practical-1) VII (BO1141, BO1221)	-	(4)*	3				
	BO1545	Core (Practical-2)VIII (BO1341 & BO1441)	-	(4)*	4				
	BO1551.1	Open Course I Horticulture	-	(4)*	-				
	BO1551.2	Mushroom cultivation & Marketing	3	-	2				
	BO1551.3	Forestry Project	-	-	-				

Table 7. SEMESTER – VI

Sem No.	Course Code	Course Title	Instructional hours/week		Credits	Uty Exam Duration	Evaluation		Total credits
			T	P			Internal	University exam	
VI	BO1641	Core Course IX Plant physiology & Biochemistry	5	2	4	”	25%	75%	25
	BO1642	Core Course X- Molecular Biology, General informatics and Bioinformatics	4	2	4	”			
	BO1643	Core Course XI- Plant breeding, Horticulture & Research methodology	4	2	4	”			
	BO1644	Core (Practical-3)XII (BO1541 & BO1542)	-	(5)*	3	”			
	BO1645	Core (Practical-4)XIII IV (BO1543, BO1641, BO1642, 1643)	-	(8)*	4	”			
	BO1651	Open Course II- Biotechnology & Nano biotechnology	3	-	2	”			
	BO1646	Project	-	3	4	”			

Table 8. Distribution of Contact Hours and Credits
(CORE, FOUNDATION & OPEN COURSES, PROJECT/DISSERTATION)

Course Code	Course Title	Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI		Total		
		Contact hours	credit													
																T
BO1141	Angiosperm anatomy Reproductive Botany & Palynology	2	2	3										4	3	
BO1221	Methodology & Perspectives in Plant Science			2	2	3								4	3	
BO1341	Microbiology, Phycology, Mycology Lichenology & Plant Pathology					3	2	3						5	3	
BO1441	Bryology, Pteridology, Gymnosperms &Paleobotany							3	2	3				5	3	
BO1541	Angiosperm Morphology Systematic botany, Economic botany Ethno botany & Pharmacognosy									4	3	4		7	4	
BO1542	Environmental Studies & Phytogeography									5	2	4		7	4	
BO1543	Cell Biology, Genetics & Evolutionary Biology									4	2	3		6	3	
BO1544	Practical-I (BO1141, BO1221)		2 *		*	2								4	3	
BO1545	Practical-II (BO1341 & BO1441)					*	2		*	2				4	4	
BO1551.1 BO1551.2 BO1551.3	Horticulture Mushroom cultivation & Marketing Forestry									3				3	2	
BO1641	Plant Physiology &Biochemistry											5	2	4	7	4
BO1642	Molecular Biology, General informatics and Bioinformatics											4	2	4	6	4
BO1643	Plant breeding, Horticulture & Research methodology											4	2	4	6	4
BO1644	Practical-III (BO1541 & BO1542)									5*					3	
BO1645	Practical-IV (BO1543, BO1641,BO1642, 1643)											8 *			4	
BO1651	Biotechnology & Nano biotechnology											3		3	2	
BO1646	Project report, Tour Diary, Viva-Voce									2			3	5	4	
	Total														57	

L = Lecture P = Practical *Practical hour already distributed in the semester concerned

Table 9. Scheme of Evaluation of Foundation Course II, Core Courses, Open Courses & Project

Semester	Course Code	Course Title	Marks		Duration of University Exam.
			CE	ESE	
I	BO1141	Angiosperm anatomy Reproductive Botany & Palynology	20	80	3 hrs
II	BO1221	Methodology & Perspectives in Plant Science	20	80	3 hrs
III	BO1341	Microbiology, Phycology, Mycology Lichenology & Plant Pathology	20	80	3 hrs
IV	BO1441	Bryology, Pteridology, Gymnosperms & Paleobotany	20	80	3 hrs
V	BO1541	Angiosperm Morphology Systematic botany, Economic botany Ethno botany & Pharmacognosy	20	80	3 hrs
	BO1542	Environmental Studies & Phytogeography	20	80	3 hrs
	BO1543	Cell biology, Genetics & Evolutionary Biology	20	80	3 hrs
	BO1544	Practical-I (BO1141, BO1221)	20	80	3 hrs
	BO1545	Practical-II (BO1341 & BO1441)	20	80	3 hrs
	BO1551.1 BO1551.2 BO1551.3	Horticulture Mushroom cultivation & Marketting Forestry	20	80	3 hrs
VI	BO1641	Plant Physiology & Biochemistry	20	80	3 hrs
	BO1642	Molecular Biology, General informatics and Bioinformatics	20	80	3 hrs
	BO1643	Plant breeding, Horticulture & Research methodology	20	80	3 hrs
	BO1644	Practical-III (BO1541 & BO1542)	20	80	3 hrs
	BO1645	Practical-IV (BO1543, BO1641, BO1642, 1643)	20	80	3 hrs
	BO1651	Biotechnology & Nano biotechnology	20	80	3 hrs
	BO1646	Project report, Tour Diary, Viva-Voce	20	80	-

END SEMESTER ASSESSMENT (ESA)

The University shall conduct the external examinations for all semesters. There will not be any supplementary exams. The practical examinations for **Core courses** shall be conducted after 4th, 5th and 6th semesters and **Complementary** courses at the end of 4th semester according to the common calendar and questions set up by the University. The Board of Examiners constituted by the University will have the right to make necessary changes in the pattern of practical examination as and when needed.

ELIGIBILITY TO APPEAR FOR PRACTICAL EXAMINATION

Submission of the following

- Certified and bonafide practical record
- Certified herbarium sheets
- Certified field work
- Certified tour report
- Project report/Dissertation (certified and bonafide)

PROJECT

Project work/Dissertation is compulsory. It can be carried out either individually or by a group not exceeding 15 students. The topics shall either be allotted by the supervising teacher or be selected by the student in consultation with the supervising teacher. The project report/dissertation duly attested by the Supervising teacher and Certified by the Head of the Department, has to be submitted on the day of examination of **Practical - III (Core)**. The project shall be evaluated by an external examiner. The project report/ Dissertation (not less than 40 pages) shall be prepared as per the format given below.

1. Title page /Front page (Certified by the **HOD**)
2. Declaration by the candidate
3. Certificate attested by the Supervising teacher
4. Acknowledgement, if any
5. Table of contents
6. Abbreviation, if any
7. Introduction & Review of Literature
8. Material and Methods
9. Results and Discussion (Not less than 10 pages)
10. Summary and Conclusion
11. References

Tables, Graphs, Photographs etc. can be used to present the data. Topics selected once should not be repeated.

STUDY TOUR

- Field trip to a place of plant diversity within or outside Kerala with a minimum duration of 3 days is compulsory. (Field trips are to be conducted for three days either as continuous or one day trips).
- A brief report of the trip has to be submitted

CORE COURSES

Semester	Course Code	Course Title	Contact hrs/week		Credits
			L	P	
I	BO1141	Angiosperm anatomy Reproductive Botany & Palynology	2	2	3
III	BO1341	Microbiology, Phycology, Mycology Lichenology & Plant Pathology	3	2	3
IV	BO1441	Bryology, Pteridology, Gymnosperms & Paleobotany	3	2	3
V	BO1541	Angiosperm Morphology Systematic botany, Economic botany Ethno botany & Pharmacognosy	4	3	4
	BO1542	Environmental Studies & Phytogeography	5	2	4
	BO1543	Cell Biology, Genetics & Evolutionary Biology	4	2	3
	BO1544	Practical-I (BO1141, BO1221)		4	3
	BO1545	Practical-II (BO1341 & BO1441)		4	4
VI	BO1641	Plant Physiology & Biochemistry	5	2	4
	BO1642	Molecular Biology, General informatics and Bioinformatics	4	2	4
	BO1643	Plant breeding, Horticulture & Research methodology	4	2	4
	BO1644	Practical-III (BO1541 & BO1542)		5	3
	BO1645	Practical-IV (BO 1543, BO1642, BO1642 & BO1643)		8	4

SEMESTER-I

ANGIOSPERM ANATOMY, REPRODUCTIVE BOTANY AND PALYNOLOGY

Course code : BO1141

Number of credits : 3

Number of contact hours: Lecture: 36 hrs; Practical: 36 hrs; Total: 72 hrs

Distribution of Hours	Theory	Practical
Angiosperm Anatomy	22 hrs	27 hrs
Reproductive Botany & Palynology	14 hrs	09 hrs
Total	36 hrs	36 hrs

Angiosperm Anatomy

MODULE-I

04hrs

1. Objective and scope of plant anatomy
2. Cell wall organization - Gross structure - Primary and secondary wall pits – plasmodesmata -microscopic and sub microscopic structures – Extra cell wall material. Non living inclusions of the cell – Reserve food - secretory products, by products.

MODULE-II

09hrs

3. Tissues – Meristems, Definition, Classification based on origin, position, growth patterns, functions.
4. Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica -Corpus theory. Organization of root apex in dicots & monocots.
5. Permanent tissues – Definition, classification - simple, complex and secretory.
6. Tissue systems – Epidermal tissue systems-stomata, structure and functions, Ground tissue systems & vascular tissue systems. Different types of vascular arrangements

MODULE-III

09 hrs

7. Primary structure – Root, stem and leaf [Dicot & Monocot].
8. Secondary growth - Root and stem- cambium (structure and function) annular rings, heart wood and sap wood, tyloses, ring porous wood and diffuse porous wood, periderm formation-phellum, phellogen and phelloderm ; lenticels
9. Anomalous secondary growth – *Boerhaavia*, *Bignonia*, *Dracaena*.

Practical**27 hrs**

1. Non living inclusions - Cystolith, Raphide, Sphaero-raphide, Aleurone grains.
2. Starch grains (Eccentric, concentric, compound)
3. Simple permanent tissue – Parenchyma, Chlorenchyma, Aerenchyma, Collenchyma and Sclerenchyma
4. Primary structure – Dicot stem: *Hydrocotyle*, *Eupatorium*.
5. Monocot stem: Grass and *Asparagus*.
6. Dicot root: Pea and *Limnanthemum*
7. Monocot root: *Colocasia* or any monocot root.
8. Secondary structure - Stem [Normal type]- *Vernonia*
9. Secondary structure - Root [Normal type]- *Tinospora*, *Ficus*, *Carica papaya*, or any normal type
10. Epidermal structures –Stomata.
11. Anomalous secondary thickening – *Boerhaavia*, *Dracaena*, *Bignonia*

MODULE- IV**Reproductive Botany & Palynology****14 hrs**

1. Introduction to angiosperm embryology with special reference to Indian embryologists.
2. Micro sporogenesis - structure and functions of wall layers.
3. Development of male gametophyte - Dehiscence of anther.
4. Megasporogenesis - Development of female gametophyte - Embryo sac - Development and types - Monosporic – *Polygonum* type, Bisporic - *Allium* type, Tetrasporic – *Adoxa* type.
5. Pollination - Fertilization - Barriers of fertilization - Germination of pollen grains – Double fertilization.
6. Structure of Embryo- Dicot [*Capsella*], Monocot [*Sagittaria*] & Endosperm types.
7. Palynology: Pollen structure, pollen morphology, pollen allergy, Economic and Taxonomic importance

Practical**09 hrs**

Students should be familiar with the structure of anther and embryo,
(Permanent slides can be used)

REFERENCES

1. Coutler E. G. (1969) Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
2. Esau K. (1965) - Plant Anatomy – Wiley Eastern, New York.
3. Fahn A. (1985) - Plant Anatomy – Pergamon Press, Oxford.
4. Pandey, B .P. (1997) - Plant Anatomy - S.Chand and co. New Delhi Biology - McGraw Hill Co, New York.
5. Vashista .P. C (1984) - Plant Anatomy – Pradeep Publications – Jalandhar
6. Maheswari P. - Embryology of Angiosperms - Vikas Pub:
7. Nair PKK Palynology of Angiosperms

SEMESTER-II

FOUNDATION COURSE

METHODOLOGY AND PERSPECTIVES IN PLANT SCIENCES

Course code : BO1221

Number of credits : 3

Number of contact hours: 36 hrs (Lecture); 36hrs (Practical) = 72 hours

Distribution of Hours	Theory	Practical
MODULE-I - Scientific Studies	08 hrs	
MODULE- II - Data handling in science	12 hrs	16 hrs
MODULE-III - Microtechnique	06 hrs	08 hrs
MODULE-IV - Biophysics	10 hrs	12 hrs
Total	36 hrs	36 hrs

Aim of the course: To introduce the methodology and perspectives of Science in general so as to enable the students to systematically pursue his particular discipline in science in relation to other disciplines that come under the rubric of sciences.

Objectives:

- To familiarize the students with the fundamental characteristics of science as a human enterprise
- To see how science works
- To apply scientific methods independently
- To interpret scientific data using basic statistical methods

MODULE-I Scientific Studies

08 hrs

1. Types of knowledge: practical, theoretical and scientific knowledge
2. Information: What is science; what is not science; laws of science; basis of scientific laws and factual truths.
3. Science as a human activity; scientific temper and empiricism, Science disciplines
4. Revolution in Science and Technology
5. Ethics in Science: Scientific information; depositories of scientific information, Primary, secondary and digital sources; sharing of knowledge; transparency and Honesty; danger of pre conceived ideas.

6. Methods and tools in science: Steps in scientific method. Null hypothesis and alternative hypothesis. Inductive and deductive reasoning.

MODULE- II Data handling in science-

12 hrs

1. Nature and types of data-typical examples, Data collection, Data presentation- Classification and tabulation, diagrammatic (bar, pie diagrams) and graphic presentation.

2. Samples and sampling techniques.

3. Statistical treatment of data: Statistical terms and symbols. Measures of central tendencies (mean, median, mode), Measures of dispersion (range, mean deviation, variance, standard deviation, coefficient of variation), Significance tests (chi-square test).

4. Data analysis – Normal frequency distribution and binomial distribution.

Practical

16 hrs

1. Workout problems on frequency distribution, measures of central tendencies (Mean, Median, Mode)
2. Workout problems on measures of dispersion. (range, mean deviation, variance, standard deviation, coefficient of variation)
3. Workout problems on chi-square test.

MODULE-I11

Microtechnique

06 hrs

1. Introduction - microscopy - simple and compound – phase contrast; dark field illumination and electron microscopes (SEM and TEM).
2. Micrometry, Camera lucida
3. Sectioning - hand and microtome– rotary and sledge
4. Killing and fixation agents – Carnoy's formula, Farmers formula, F .A. A
5. Dehydration - reagents
6. Stains and staining techniques - double staining. General account; Stains: safranin, haematoxylin, acetocarmine.
7. Mounting media - D. P. X and Canada balsam
8. Whole mounts - cytological methods: maceration, smear and squash preparation.

Practical

08 hrs

1. Familiarize stains, fixatives and mounting media
2. General awareness of Micro technique - maceration, smears & squash
3. Demonstration of microtome sectioning and hand sectioning
4. Measurement of specimens using micrometer (Demonstration only).
5. Photomicrography and Camera lucida drawings (Demonstration only).

MODULE-IV

Biophysics

10 hrs

1. Principles and applications of Colorimeter, Spectrophotometer and Centrifuge.
2. Basic knowledge of the separation methods: - Chromatography, Electrophoresis.
3. Buffers -their functions in biological systems -Uses of buffers in biological research, pH meter.
4. Cryobiology – cryopreservation, freeze drying (lyophilisation) and its applications.

Practical

02 hrs

1. Preparation of buffer
2. Measurement of pH
3. Separation of plant pigments by paper chromatography/TLC.
4. Construct the absorption spectrum of any sample.

REFERENCE

1. Gieryn T.F. (1999) *Cultural Boundaries of Science* Univer. Chicago Press.
2. Jeffrey A. Lee (2010) *The Scientific Endeavor*. Pearson Delhi
3. Collins H. and T Punch (1993). *The Golem. What everyone should know about Science*. Cambridge Univ. Press
4. Hewitt, Paul G, Suzanne Lyons, John A, Suchocki and Jennifer Yeh (2007) *Conceptual Integrated Science*, Addison-Wesley
5. Newton RG: *The truth of Science*, 2nd edition
6. Bass, Joel, E *et al* (2009) *Methods for teaching Science as Inquiry*, Allyn & Bacon
7. Veer Bala Rastogi (2008) *Fundamentals of Biostatistics*, Ane Books Pvt. Ltd
8. Stephen W. Looney (2009) *Biostatistical Methods*, Humana Press, Springer International Edn.
9. Sasidharan A. – *An introduction to Biophysics*
10. Willard H. H., J. A. Dean, L. L. Merritt and F. A. Settle-Instrumental methods of analysis CBS Publishers and Distributors Delhi
11. Blair E. J. - *Introduction to chemical instrumentation* Mc-Graw Hill Book Company
12. T. J. Bailey - *Statistical Methods in Biology* (3rd Edition) – Cambridge University Press India Pvt Ltd.
13. Casey E. J. - *Biophysics – Concepts and Mechanics* Van Nostrand Reinhold Company
14. Elizabeth Allman (2004) *Mathematical Methods in Biology*, Cambridge University Press India Pvt. Ltd
15. Rarnco - *Bio-Statistics – Saras Pub:*
16. T. K. Saha - *Bio-statistics – Theory & Practical - Emkay Pub:*
17. Richard Grey – *Hand book of microtechnique*-Mac Graw Hill Book company
18. Donald A. Johansen-*Plant Microtechnique*- Mac Graw Hill Book company
19. Prasad and Prasad (1972) *Out lines of Botanical Micro technique*, Emkay publishers, New Delhi

SEMESTER-III

MICROBIOLOGY, PHYCOLOGY, MYCOLOGY, LICHENOLOGY AND PLANT PATHOLOGY

Course code: BO1341

Number of credits: 3

Number of contact hours: Lecture: 54 hrs; Practical: 36 hrs; Total: 90 hrs

Distribution of Hours	Theory	Practical
Microbiology	08 hrs	07 hrs
Phycology	20hrs	15 hrs
Mycology	20hrs	10 hrs
Plant Pathology	06 hrs	04 hrs
Total	54 hrs	36 hrs

MODULE-I

Microbiology

08 hrs

1. History & scope of microbiology.
2. Bacterial classification: Morphological classification, classification based on staining reaction:
Ultra structure of bacteria, Reproduction, Economic importance.
3. Mycoplasma & Actinomycetes –General account.
4. Virus- General characteristics, nomenclature, classification, structure, chemical composition, properties and reproduction of bacteriophages and T. M. V. Economic importance.
5. Soil microbiology – Soil microorganisms, the rhizosphere
6. Aquatic microbiology - Microbiology of sewage or waste water. Methods of waste water treatment (Brief account only)
7. Food microbiology - Food spoilage and preservation methods. [General account].
8. Agricultural microbiology - Role of microbes in soil fertility, Nitrogen fixation, Biofertilizers

Practical

07 hrs

1. Gram staining of bacteria.
2. Test for the Coli form bacteria in contaminated water.
3. Isolation of *Rhizobium* from root nodules of leguminous plants. (Demonstration)
4. Examination of different forms of bacteria.(Demonstration)

MODULE II

20 hrs

Phycology

1. Introduction – Range of thallus structure – Phylogenic trends – Pigments – Reproduction
 2. Life cycle – Classification proposed by F .E Fritsch
 3. Salient features of the following major groups with reference to the structure, reproduction and life cycle of the types given below (**Excluding the developmental details**) –
 - a) Cyanophyceae – *Nostoc*
 - b) Chlorophyceae - *Chlorella*, *Volvox*, *Oedogonium* and *Chara*
 - c) Xanthophyceae – *Vaucheria*
 - d) Bacillariophyceae – *Pinnularia*
 - e) Phaeophyceae – *Sargassum*
 - f) Rhodophyceae – *Polysiphonia*
-
1. Economic importance of algae
 - a) Commercial products of algae – Agar, Alginates, Carrageenin, Diatomaceous earth
 - b) Algae - medicinal aspects, algal blooms and red tides

Practical

15 hrs

1. Make micro preparations of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level and make labeled sketches of the specimens observed.

MODULE-III

Mycology

20 hrs

1. Introduction, structure, reproduction, life cycle, evolutionary trends, Classification based on Ainsworth.
2. Distinguishing characters of different classes of fungi representing the following genera (**Excluding Developmental details**)
 - a. Myxomycotina -General characters.
 - b. Zygomycotina - *Rhizopus*
 - c. Ascomycotina
 - Hemiascomycetes - *Saccharomyces*
 - Plectomycetes - *Penicillium*
 - Pyrenomycetes - *Xylaria*
 - Discomycetes – *Peziza*
 - d. Basidiomycotina
 - Teliomycetes - *Puccinia*
 - Hymenomycetes - *Agaricus*
 - e. Deuteromycotina - *Cercospora*.
3. Economic importance of Fungi

Lichenology: General account and economic importance; the structure, reproduction and life cycle of *Usnea*

Practicals

10 hrs

A detailed study of structure and reproductive structures of types given in the syllabus and submission of record.

Rhizopus, Saccharomyces, Penicillium, Xylaria, Peziza, Puccinia, Agaricus, Cercospora and Usnea.

MODULE-IV

Plant Pathology

06 hrs

1. Classification of plant diseases on the basis of causative organisms and symptoms – Host parasite interaction, phytoalexins.
2. Study of the following diseases with emphasis on symptoms, disease cycle and control measures - Leaf mosaic of Tapioca, Citrus Canker, Blast disease of Paddy, Root wilt of Coconut
3. Brief account of the following fungicides- Bordeaux mixture, Lime sulphur, Tobacco decoction, Neem cake & oil.

Practical

04 hrs

1. Identify the Diseases mentioned with respect to causal organism and symptoms- Leaf mosaic of Tapioca, Citrus Canker, Blast disease of Paddy.
2. Students should be trained to prepare the fungicide Bordeaux mixture & Tobacco decoction.

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SEMESTER-IV

BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PALAEOBOTANY

Course code : BO1441

Number of Credits :3

Number of Contact Hours: Lecture- 54 Hours; Practicals-36 Hours Total- 90 Hrs

Distribution of Hours	Theory	Practical
Bryology	18 hrs	09 hrs
Pteridology	18 hrs	16 hrs
Gymnosperms	14 hrs	10 hrs
Paleobotany	04 hrs	01 hr
Total	54 hrs	36 hrs

MODULE-1

Bryology

18hrs

1. Introduction and classification- general account
- 2 Study of habit, thallus organization, vegetative and sexual reproduction and alternation of generation of the following types (Developmental details are not required)

Riccia, Marchantia, Funaria

- 3 .Economic importance of Bryophytes

Practical

09 Hrs

- 1.*Riccia*- Habit- Internal structure of thallus- V.S.of thallus through archegonia, antheridia and sporophyte
2. *Marchantia*- Habit- thallus with Archegonial receptacle, Male receptacle V.S, Female receptacle V.S. T.S of thallus through gemma, Sporophyte V.S
- 3.*Funaria*- Habit V.S. of archegonial cluster, V.S of Antheridial cluster, Sporophyte V.S

MODULE -11

Pteridology

18hrs

1. Introducton: General characters morphological and phylogenetic classification
2. Study of the habitat habit ,internal structure, reproduction and life cycle of the following types (Developmental details not required). *Psilotum, Selaginella, Pteris* and *Marselia*

3. General topics- Stellar evolution in Pteridophytes . Economic importance of Pteridophytes

Practical **16hrs**

1. *Psilotum* -External features, Stem T.S., Synangium T.S
2. *Selaginella* - Habit , stem and rhizophore , T.S, V.S of strobilus, Megasporophyll and Microsporophylls
3. *Pteris* - Habit , Rachis T.S Sporophyll T.S, Prothallus
4. *Marselia* - Habit, Rhizome and Petiole T.S, Sporocarp T.S , V.S

MODULE-III

Gymnosperms **14hrs**

1. Introduction –General characters and classification of Gymnosperms
2. Study of the habit, anatomy, reproduction and life cycle of the following types (Developmental details are not required) *Cycas*, *Pinus* and *Gnetum*
3. Evolutionary trends in gymnosperms, Economic importance of Gymnosperms

Practical **10hrs**

1. *Cycas*- T.S of leaf, T.S. of coralloid root. Micro and megasporophyll, V S of ovule
2. *Pinus*- T.S. of stem, T.S. of needle, male and female cone , V.S.
3. *Gnetum*-Habit, stem T.S,(young and mature), leaf T.S, male and female strobilus ,V.S of male and female cone ,ovule V.S and seed.

MODULE –IV

Palaeobotany **04hrs**

1. Geological time scale, Fossil formation, types of fossils.
2. Fossil Pteridophytes- *Rhynia*, *Lepidodendron*, *Lepidocarpon*. Fossil gymnosperms- *Lygnopteris*.

Practical **01hr**

1. Fossil Pteridophytes- *Rhynia* stem, *Lepidodendron*, *Lepidocarpon*.
2. Gymnosperm- *Lygenopteris*

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2. Parihar N .S. – An introduction to Bryophyta - Central Book Depot. Alahabad
3. Vasishta B. R. - Bryophyta - S. Chand and Co. New Delhi
4. Coutler. J. M. - and Chamberlain C. J. (1958) – Morphology of Gymnosperms - Central Book Depot , Allahabad
5. Gupta V .K. and Varshneya U. D (1967) – An Introduction to Gymnosperms –Kedarnath, Ramnath – Meerut.
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12. Arnold C. A (1947) - Introduction to Palaeobotany - McGraw Hill Co. New Delhi.

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SEMESTER-V

ANGIOSPERM MORPHOLOGY, SYSTEMATIC BOTANY, ECONOMIC BOTANY, ETHNO BOTANY AND PHARMACOGNOSY

Course code : BO 1541

Number of credits : 4

Number of contact hours : Lecture: 72 hrs; Practical: 54 hrs; Total: 126 hrs

Distribution of Hours	Theory	Practical
Morphology	10 hr	10 hr
Systematic Botany	38 hr	35 hr
Economic Botany	12 hr	06 hr
Ethnobotany & Pharmacognosy	12 hr	03 hr
Total	72 hr	54 hr

MODULE-I

Morphology

10 hrs

Brief account on the various types of inflorescence including special types (Cyathium, Verticillaster, Hypanthodium, Coenanthium and Thyrsus) with examples; floral morphology- Flower-as a modified shoot, Flower parts, their arrangements, relative position, numeric- plan, cohesion, adhesion, symmetry of flower, aestivation types, placentation types; floral diagram and floral formula

Fruit types: simple, aggregate and multiple. Seeds: albuminous and exalbuminous .

MODULE-II

Systematic Botany

04 hrs

Definition, scope and significance of Taxonomy, Historical development of the systems of classification:

1. Artificial- Linnaeus sexual system
2. Natural - Bentham and Hooker (detailed account)
- 3 Phylogenetic- Engler and Prantl (Brief account only)

MODULE-III

04 hrs

Basic rules of Binomial Nomenclature and International Code of Botanical Nomenclature (ICBN).

Importance of Herbarium, Herbarium techniques and Botanical gardens. A brief account on the

Modern trends in taxonomy; Chemotaxonomy and Molecular taxonomy

MODULE-IV

30 hr

A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)

- | | | |
|-------------------|----------------------|--------------|
| (1) Annonaceae | (13) Apocynaceae | (25) Poaceae |
| (2) Nymphaeaceae | (14) Asclepiadiaceae | |
| (3) Malvaceae | (15) Solanaceae | |
| (4) Rutaceae | (16) Acanthaceae | |
| (5) Anacardiaceae | (17) Verbenaceae | |
| (6) Leguminosae | (18) Lamiaceae | |
| (7) Myrtaceae | (19) Nyctaginaceae | |
| (8) Cucurbitaceae | (20) Euphorbiaceae | |
| (9) Apiaceae | (21) Orchidaceae | |
| (10) Rubiaceae | (22) Scitaminae | |
| (11) Asteraceae | (23) Liliaceae | |
| (12) Sapotaceae | (24) Arecaceae | |

Practical

45 hrs

1. Study on various types of inflorescences, Flowers and fruits with vivid record of practical work.
2. Students must be able to identify the angiosperm members included in the syllabus up to the level of families. Draw labeled diagram of the habit, floral parts, L S of flower, T S of ovary, floral diagram, floral formula and describe the salient features of the member in technical terms.
3. Students must submit practical records, Herbarium sheets (25 Nos:) and Field book at the time of practical examination.
4. Field trips are to be conducted for three days either as continuous or one day trips.

MODULE-V

12 hrs

a) Economic botany

1. Study of the major crops in Kerala with special reference to their Botanical description, morphology of the useful part and economic importance-- Coconut and Paddy.

Cereals and millets - Wheat and Ragi

Pulses - Black gram and Bengal gram

Sugar yielding Plants - Sugar cane

Spices - Pepper and Cardamom

Beverages - Coffee

Fibre yielding plant - Cotton

Dye Yielding plants - Henna and *Bixa orellana*

Resins - Asafoetida

Tuber crops - Tapioca

Oil yielding Plants - Sesame and Ground nut

Latex yielding plant - Rubber

Medicinal plants - *Sida*, *Zingiber officinalis*, *Aloe vera* and *Vinca rosea*

Insecticides - Neem

Practical **06 hrs**

Identify the economic products obtained from the plants mentioned under Economic Botany

b) Ethnobotany **06 hrs**

1. Definition — importance, scope, categories and significance.
2. Study of various methods to collect Ethno botanical data.
3. Plant parts used by tribes in their daily life as food, clothing, shelter, agriculture and medicine.
4. Study of common plants used by tribes. *Aegle marmelos*, *Ficus religiosa*, *Cynadon dactylon*, *Ocimum sanctum* and *Trichopus zeylanicus*

c) Pharmacognosy **06 hrs**

1. Definition and scope of Pharmacognosy
2. Sources of crude drugs – roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds

Practical **03 hrs**

1. Visit a tribal area and collect information on their traditional method of treatment using crude drugs
2. Observe the plants of ethno botanical importance

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2. Pandey SN and Misra SP, 2008 Taxonomy of Angiosperous; Ane Books Pvt. Ltd.
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SEMESTER-V

ENVIRONMENTAL STUDIES AND PHYTOGEOGRAPHY

Course code: BO1542

Number of credits: 4

Number of contact hours : Lecture: 90 hrs; Practical: 36 hrs; Total: 126 hrs

Distribution of Hours	Theory	Practical
Environmental Studies	81 hrs	36 hrs
Phytogeography	09 hrs	00 hrs
Total	90 hrs	36 hrs

MODULE- I

14 hrs

1. Definition- Scope and relevance to society and human environment. Need for public awareness
2. Natural Resources - Renewable and Non renewable - Land & Soil, Water, Energy, Minerals, Food and agriculture , Forests, Plants & Wild life resources
Degradation of natural resources - Land degradation, degradation of water resources, Loss of flora and fauna
Causes – population explosion, over exploitation, deforestation, agriculture mismanagement, desertification, overgrazing, soil erosion, mining, urbanization and industrialization- change in land use, depletion of water resources
3. Conservation of Natural resources
Land and soil- afforestation, regeneration of wasteland
Water - Rain water harvesting, ground water dams
Energy - Promoting use of renewable resources-solar, hydel, tidal and wind; biodiesel, biofuels.
Forests- Reforestation, Community forestry programmes
4. Role of an individual in conservation of natural resources, sustainable life styles.

MODULE II

Ecosystems

22 hr

1. Ecosystems - Concept, definition, structure and function; components- biotic and abiotic; energy flow
2. Food chains -Food web & ecological Pyramids, biogeochemical cycles - Carbon and Phosphorous cycle
3. Ecological succession-Definition, primary and secondary succession, climax concept, hydrosere and xerosere.
4. Plant adaptations- Morphological, anatomical& physiological adaptations of – Hydrophytes, Xerophytes, Halophytes, Epiphytes, Parasites
5. Introduction- types, characteristic features, structure and functions of the following ecosystems.

1. Forest ecosystem
2. Grassland ecosystem
3. Desert ecosystem
4. Aquatic ecosystems- Ponds, Streams, Rivers, Oceans, Estuaries (brief account only)

MODULE-III

Biodiversity and its conservation

24 hrs

1. Introduction
2. Definition- genetic, species and ecosystem diversity.
3. Terrestrial (Tropical rain forest) and Aquatic Biomes(mangroves).
4. Hot-spots of biodiversity; India as mega-diversity nation.
5. Threats to biodiversity: land use changes & habitat destruction, poaching of wild life- hunting & export, Overuse of pesticides, invasive species.
6. IUCN, Red data Book; Extinct and Threatened species- endangered & Rare; Endemic species of Western Ghats.
7. Conservation of biodiversity: *In-situ* (National parks and Wild life sanctuaries) and *Ex-situ* conservation (botanical gardens); Biosphere Reserves & World Heritage Sites in India-Ramsar sites.
8. Global initiatives in biodiversity conservation- Stockholm Conference, Montreal Protocol, Convention on Biological diversity Regional initiatives- *Chipko* movement, A brief account on conservation efforts in Kerala- People Biodiversity Register.

MODULE-IV

Environmental pollution & Issues

21 hrs

1. Definition causes, effects and control measures of – 1. Air pollution 2. Water pollution 3. Soil pollution 4. Marine pollution 5. Noise pollution 6. Thermal pollution 7. Nuclear hazards.
2. Solid Waste Management- waste minimization, Recycling and Reuse, Consuming environment friendly products. E-waste management.
3. Environmental Issues - Climate change, Global warming, Acid rain, Ozone layer depletion.
4. Environmental Legislations - Environment protection Act (1986); Air [prevention and control of pollution] Act (1981; Amended 1987); Water [prevention and control of pollution] Act (1974; Amended 1988); Wildlife Protection Act (1972); Forest conservation Act (1980). (Scope and relevance only)
5. Environmental Organisations –UNEP, IPCC, WWF, Central Pollution Control Board

MODULE-V

Phytogeography- concept & definition

09 hr

Vegetation in India – Forests- tropical, temperate, sholas, sub alpine, alpine, mangroves & Grass lands.

Phytogeographical regions of India - Western and eastern Himalayas, Dessert, Western Ghats, Deccan Peninsula, Gangetic Plain, North East India, Coasts & Islands.

Practical

36 hrs

1. Visit a local polluted site and report major pollutants.
2. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes, Halophytes, Epiphytes and Parasites.
3. Observation and study of different ecosystems mentioned in the syllabus.
4. Phytogeographical regions of India- Photos/ Diagrams

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14. The Geography of Flowering Plants - Good
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SEMESTER-V

CELL BIOLOGY, GENETICS AND EVOLUTIONARY BIOLOGY

Course code : BO-1543

Number of credits : 3

Number of contact hours : Lecture: 72 hrs; Practical: 36 hrs; Total: 108 hrs

Distribution of Hours	Theory	Practical
Cell biology	25 hrs	12 hrs
Genetics	36 hrs	24 hrs
Evolutionary biology	11 hrs	00 hrs
Total	72 hrs	36 hrs

MODULE-I

Cell biology

25 hrs

1. History and progress of cell biology
2. Ultra structure and functions of the cell components and organelles Cell wall; The cell membrane, Endoplasmic reticulum, Ribosomes, Golgi apparatus, Lysosomes, Peroxisomes, Vacuole, Mitochondria, Chloroplast & Nucleus.
3. The chromosomes- Chromosome morphology- Eukaryotic chromosomes and its organization. Chromatin - composition and structure; hetero chromatin and euchromatin; Chemical organization. Nucleoproteins – histones and non –histones. Nucleosome model of DNA organization.
4. Special types of chromosomes- Salivary gland, Lamp brush and B chromosomes
5. Variation in Chromosome number (Numerical aberrations)- aneuploidy and Euploidy- haploidy, polyploidy- significance
6. Variation in Chromosome structure (Structural aberrations) - deletion, duplication, inversion and translocation; significance
7. Mitosis and Meiosis. cell cycle : Significance of mitosis and meiosis

Practical

12 hrs

Make acetocarmine squash preparation of onion root tip and to identify different stages of mitosis.

Make squash preparation of the flower buds of any of the following plants. *Rhoeo, Capsicum* (To identify Meiosis)

MODULE-II

Classical Genetics

36 hrs

1. Mendelian Genetics- Mendel and his experiments, Mendel's success, Mendelian principles, Mendelian ratios, monohybrid and dihybrid crosses, back cross and test cross

2. Genetics after Mendel- Modified Mendelian ratios; Incomplete dominance –Flower color in *Mirabilis* ; Interaction of genes- Comb pattern in poultry. 9:3:3:1. Epistasis - Recessive. Coat color in mice. 9:3:4; Dominant epistasis. Fruit colour in summer squash. 12:3:1; Complementary genes. Flower color in *Lathyrus* 9:7; Duplicate gene with cumulative effect. Fruit shape in summer squash. 9:6:1; Duplicate dominant genes in shepherd's purse. 15:1; Inhibitory factor. Leaf color in Paddy. 13:3
3. Multiple alleles-General account. ABO blood group in man. Rh factor.
4. Quantitative characters- General characters of quantitative inheritance, polygenic inheritance; Skin color in man, ear size in Maize.
5. Linkage and crossing over- Linkage and its importance, linkage and independent assortment. Complete and incomplete linkage. Crossing over – a general account, two point, three point cross. Determination of gene sequence. Interference and coincidence. Mapping of chromosomes.
6. Sex determination- Sex chromosomes, chromosomal basis of sex determination XX- XY, XX-XO mechanism. Sex determination in higher plants (*Melandrium album*) Sex chromosomal abnormalities in man. Klinefelter's syndrome, Turner's syndrome. Sex linked inheritance. Eye color in *Drosophila*, Hemophilia in man.
7. Extra nuclear inheritance General account, maternal influence. Plastid inheritance in *Mirabilis*. Shell coiling in snails, kappa particle in *Paramecium*.

Practical

24 hrs

Work out problems in

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

MODULE-III

Evolutionary Biology

11 hrs

1. Progressive and Retrogressive evolution.
2. Parallel and Convergent evolution.
3. Micro and Macro evolution.
4. Theory of Lamarck, Wiesman and De Vries, Darwinism, Neo- Darwinism
5. Isolation, Mutation, Genetic drift, Speciation
6. Variation and Evolution – Hybridization and Evolution – Polyploidy and evolution– Mutation and evolution.

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SEMESTER-VI

PLANT PHYSIOLOGY AND BIOCHEMISTRY

Course code : BO1641

Number of credits : 4

Number of contact hours: Lecture: 90 hrs; Practical: 36 hrs; Total: 126 hrs

Distribution of Hours	Theory	Practical
Plant Physiology	60 hrs	20 hrs
Biochemistry	30 hrs	16 hrs
Total	90 hrs	36 hrs

MODULE-I

20 hrs

1. General introduction: physiological processes, their significance and applications.
2. Water relations of plants: Importance of water to plant life.
 - a. Absorption of water- organs of absorption, root and root hair. Physical aspects of absorption- imbibition, diffusion and osmosis. Plant cell as an osmotic system; water potential and osmotic potential. Plasmolysis and its significance, practical applications. Mechanism of water absorption – active and passive absorption, root pressure. Pathway of water across root cells.
 - b. Ascent of sap- vital and physical theories.
 - c. Loss of water from plants: transpiration - cuticular, lenticular and stomatal mechanism - theories – starch sugar hypothesis, potassium - ion theory. Significance of transpiration - guttation, anti-transpirants, factors affecting transpiration.
3. Mineral nutrition: Gross chemical analysis of the plant body, ash analysis, criteria for essentiality of elements, macro and micro elements, role of essential elements and their deficiency symptoms. Culture methods - sand culture, hydroponics and aeroponics. Mechanism of mineral absorption (a) passive absorption- ion exchange and Donnan equilibrium (b) active absorption- carrier concept, Lundegardh hypothesis.

MODULE-II

20 hrs

4. Photosynthesis: Introduction, significance and general equation; Photosynthetic apparatus, structure and function of chloroplast, quantasomes - solar spectrum and its importance - Fluorescence and phosphorescence; Red drop, Emerson effect; Two pigment systems; raw material for photosynthesis; Mechanism of photosynthesis- Light reaction - cyclic and non cyclic photophosphorylation; Hill reaction - Dark reaction: Calvin cycle; Comparative study of C3, C4,

and CAM plants; Photorespiration Bacterial photosynthesis and chemosynthesis (Brief account only)

5. Factors affecting photosynthesis - Law of limiting factor.

6. Respiration: Introduction, definition and significance and general equation. Respiratory substances, types of respiration- aerobic and anaerobic. Aerobic respiration - glycolysis, Krebs's cycle, terminal oxidation. Anaerobic respiration – fermentation: alcoholic and lactic acid fermentation. Energy relation of respiration - R .Q and its significance - Factors affecting respiration.

MODULE-III

20 hrs

1. Translocation of solutes: Path way of movement, phloem transport, mechanism of transport - Munch hypothesis, protoplasmic streaming theory - activated diffusion hypothesis, electro osmotic theory.
2. Nitrogen metabolism: Source of nitrogen - Biological nitrogen fixation – symbiotic and asymbiotic. Nitrogen fixation by blue green algae - rotation of crops. Nif genes - Leghaemoglobin.
3. Growth: Phases of growth - vegetative and reproductive growth - growth curve - plant growth regulators - Auxins, Gibberellins, Cytokinins, Ethylene, Abscissic acid - synthetic plant hormones - practical applications. Senescence and abscission. Photoperiodism
4. Vernalization - phytochrome and its significance. Physiology of bud and seed dormancy, germination.
5. Plant movements: Tropic and nastic movements. Circadian rhythm and biological clock.
6. Stress physiology: water stress, salt stress.

Practical

20hrs

1. Water potential of onion peel / *Rhoeo* peel by plasmolytic method.
2. Imbibition of water by different types of seeds.
3. Effect of temperature on permeability.
4. Papaya petiole osmoscope.
5. Determination of stomatal index.
6. Determination of water absorption and transpiration ratio.
7. Measurement of rate of transpiration using Ganong's potometer or Farmer's potometer.
8. Evolution of oxygen during photosynthesis.
9. Measurement of photosynthesis by Wilmot's bubbler.
10. Evolution of CO₂ during respiration.
11. Ganong's respirometer and measurement of R .Q.
12. Simple respiroscope.
13. Alcoholic fermentation using Kuhn's fermentation vessel.
14. Geotropism using clinostat.
15. Measurement of growth using Arc auxanometer.

Biochemistry

MODULE-IV

15 hrs

1. Molecules and life.
2. Carbohydrates - Classification, occurrence, structure and functions of monosaccharides (glucose and fructose), oligosaccharides (sucrose and maltose), polysaccharides (starch and cellulose), synthesis of glycosidic bonds – Enzymatic hydrolysis of glycosidic bonds – amylases and invertases.
3. Amino acids- classification based on polarity, structure - Amphoteric property of Amino acids - peptide formation – Amino acid metabolism – reductive amination and transamination
4. Proteins – Structure, classification, properties and function; Role of bonds in stabilizing protein structure - hydrolysis of proteins.

MODULE-V

15 hrs

5. Lipids- classification – Simple lipids- fats & oils, waxes; Compound lipids- phospholipids, spingolipids and glycolipids; Derived lipids- Cholesterol and terpenes; Fatty acids – Alpha-oxidation and Beta-oxidation; Synthesis of ester bonds.
6. Enzymes - general account - structure, classification and nomenclature (recommended by Commission on Enzymes); Mechanism of enzyme action - inhibition of enzymes - regulation of enzymes - allosteric inhibition - Isoenzymes, coenzymes and cofactors
7. Secondary Plant Products – Introduction – classification and function [General account]

Practical

16 hrs

1. Qualitative test for carbohydrates - Molisch's test, Benedict's test (for reducing sugar)
2. Iodine test for starch/Seliwanoff's test.
3. Test for proteins - Biuret test

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2. Devlin & Witham – Plant Physiology (C B S publishers).
3. Kochhar P. L. & Krishnamoorthy H. N. – Plant Physiology. (Atmaram & Sons-Delhi,Lucknow)
4. Richard F Venn 2004, Principles and Practice of Bioanalysis, Taylor & Francis, Ane Books Pvt. Ltd
5. Kumar & Purohit – Plant Physiology - Fundamentals and Applications (Agrobotanical Publications)
6. Malic C. P. & Srivastava A. K. – Textbook of Plant Physiology (Kalyani Publishers-New Delhi).
7. Noggle G R & Fritz G J – Introductory Plant physiology (Prentice Hall of India).
8. Pandey S.N. & Sinha B. K. – Plant physiology (Vikas publishing House- New Delhi).
9. Salisbury F. B. & Ross C. W. - Plant physiology. (Wadsworth publishing company).
10. Sundara Rajan S. – College Botany Vol.IV (Himalaya publishing House).
11. William G. Hopkins – Introduction to Plant Physiology (John Wiley & Sons, New York).
12. Keith Wilson and John Walker (2008) Principles and techniques of Biochemistry and Molecular Biology, 6th Edition, Cambridge University Press, India Pvt. Ltd.

13. Verma V 2007 ,Text Book of Plant Physiology.Ane Books Pvt Ltd
14. Jain J. L. – Fundamentals of Biochemistry (S. Chand & Company).
15. Lehninger - Principles of Biochemistry (CBS publishers).
16. Plummer D. T. – An introduction to Plant Biochemistry (Tata Mc Graw Hill).

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SEMESTER-VI

MOLECULAR BIOLOGY, GENERAL INFORMATICS & BIOINFORMATICS

Course code : BO1642

Number of credits : 4

Number of contact hours: Lecture: 72 hrs; Practical: 36 hrs; Total: 108 hrs

Distribution of Hours	Theory	Practical
Molecular Biology	28 hrs	12 hrs
General informatics & Bioinformatics	44 hrs	24 hrs
Total	72 hrs	36 hrs

MODULE-I

Molecular Biology

28 hrs

1. **DNA as genetic material**- experimental evidence- Griffith's experiment on Bacterial transformation, Avery's experiment, Hershey-Chase Experiment.

2. **DNA**- Chemical Composition, Chargaff's rules, molecular structure of DNA-Watson & Crick's Double Helical Model of DNA, Salient features of double helix, Biological Significance of Double Helical Model of DNA; Forms of DNA - A, B and Z forms; Satellite and repetitive DNA

3. **Replication of DNA**- An overview, General principles and features, Semi conservative model- Meselson and Stahl experiment; Leading strand and lagging strand synthesis, okazaki fragments, replication fork and origin of replication; Unidirectional and Bidirectional replication; Enzymology of replication: topoisomerase, helicase, primase, polymerase and ligase; DNA repairing mechanism- photoreactivation.

4. **RNA structure**- Structure, Properties and functions of tRNA, mRNA and rRNA; Genetic code.

5. **Synthesis of protein**: Transcription; RNA modifications- introns, exons, removal of introns, spliceosome; Translation -Central dogma-reverse transcription

6. **Regulation of gene expression in prokaryotes and eukaryotes**- *lac* operon; transcriptional gene regulation in eukaryotes-promoters, enhancers, transcription factors; RNA interference.

7. **Concept of gene**-Units of a gene, cistron, recon, muton; Types of genes- House keeping genes (constitutive genes), Luxury genes (non constitutive genes), overlapping genes.

8. **Transposable genetic elements**- General account, Characteristic, Transposons (jumping genes), Cellular oncogenes (general account only).

Practical

12 hrs

1. Study of semiconservative replication of DNA through micrographs/schematic representations.

2. Practice problems in molecular biology based on DNA structure and replication

Module- II

22 hrs

General Informatics

- 1. Overview of Information Technology:** Features of the modern personal Computer and peripherals, computer network and internet, overview of operating systems- Windows & Linux, and major application softwares-Excel, Power point, MS word.
- 2. Knowledge skill for Higher Education:** Data information and knowledge, knowledge management- Internet as a knowledge repository, academic search techniques, creating your cyber presence, open access initiatives, open access publishing models, basic concepts of IPR, copy rights and patents, plagiarism, introduction to use of IT in teaching and learning, case study of educational software, Academic services-INFLIBNET, NICNET and BRNET.
- 3. Social Informatics:** IT and Society- issues and concerns- digital divide, IT and development, new opportunities and new threats, Cyber ethics, Cyber crime, Security, privacy issues, cyber addictions, Information overload, Health issues, guidelines for proper usage of computers, internet and mobile phones. Localization issues-IT and Regional languages-IT for the disabled, the free software debate.

Module-III

Bioinformatics

22 hrs

1. Introduction: Definition, Origin of concept of Bioinformatics; Brief history, Importance of bioinformatics, Wet lab and Web lab.
2. Basics of Genomics, Proteomics & Comparative genomics
3. Biological databases:
 - Nucleic acid databases (Eg: EMBL, Gen Bank, DDBJ)
 - Protein sequence databases. Eg: PIR, SWISS PROT, UNIPROT
 - Brief account on Model/organism databases, Biodiversity databases
 - Protein structure databank- PDB
4. Sequence analysis and alignment (brief account only), Pair wise sequence alignment, multiple sequence alignment, Sequence Alignment Tools: BLAST, CLUSTAL X
5. Bioinformatics in relation to Biomolecular structure
 - Molecular visualization- use of Ras mol
6. Molecular Phylogeny and Phylogenetic trees- Advantages of Molecular phylogeny and phylogenetic analysis- PHYLIP

Practical

24 hrs

1. Create, Copy and Save a document with Header, Footer, Page Number, Date and Time using Word processing
2. Insert a table in the above Document
3. Prepare the mark list of students in a class using Excel
4. Prepare five slides each using power point with different design templates

5. Students are expected to work with at least any one of the commercial / scientific packages, to explore the WEB and able to find, recognize, download, install and use software in various areas useful to the research in Biology.

6. Blast Search

7. Molecular visualization using Rasmol

REFERENCE

1. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P and Robertis, E.M.P (1991) Cell and molecular biology. Scientific American books.
3. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd
4. Darnel, J.Lodish, Hand Baltimore, D. (1991) Cell and molecular biology. Lea and Fibiger, Washington.
5. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd
6. Sandhya mitra,(1998)Elements of molecular biology. Macmillan, India Ltd.
7. Twymann, R.M. (1998) Advanced molecular biology Viva books New Delhi.
8. Selzer PM, Marhofer RJ, Rohwer A (2009) Applied Bioinformatics. Springer- Verlag Berlin Heidelberg, Germany
9. Ingvar Eidhammer, Inge Jonassen,William R Tailor 2009, Protein Bioinformatics, Wiley India Edition
10. Venkatarajan S Mathura and Pandjassarame Kanguane (2009) Bioinformatics- a concept based introduction. Springer-Verlag Berlin Heidelberg, Germany
11. Agrawal S (2009) Bioinformatics for Beginners: Introduction to Bioinformatics. Ane Books India Pvt. Ltd
12. Niel C Jones and Pavela Pevzner (2009) An introduction to Bioinformatics Algorithms. Ane Books India Pvt. Ltd
13. Selzer (2008) Applied Bioinformatics: An Introduction, Ane Books India Pvt. Ltd
14. Kolchanov (2008) Bioinformatics of Genome regulation and Structure. Ane Books India Pvt. Ltd.
15. Rubin (2007) The Avenues in Bioinformatics. Ane Books India Pvt. Ltd.
16. Joseph Seckback and Eitan Rubin (2007) Springer, Kluwer Academic publishers
17. Jin Xiong (2007) Essential Bioinformatics. Cambridge University Press India Pvt. Ltd
18. Higgs (2005), Bioinformatics and Molecular evolution. Ane Books India Pvt. Ltd
19. Ethan Cerami (2005) XML for Bioinformatics. Springer International Edition
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21. Mukerjee DP (2000) Fundamentals of Computer Graphics and Multimedia. Prentice Hall of India Pvt. Ltd.

WEB RESOURCES

- ✓ www.fgc.edu/support/office2000
- ✓ www.openoffice.org *Open office official website*
- ✓ www.microsoft.com/office *MS Office website*
- ✓ www.lgta.org *Office online lessons*
- ✓ www.learntheneth.com *Web Primer*

- ✓ www.computer.org/history/timeline
- ✓ www.computerhistory.org
- ✓ <http://computer.howstuffworks.com>
- ✓ <http://vmoc.museophile.org> *Computer history*
- ✓ www.dell.com *Dell Computers*
- ✓ www.intel.com *Intel*
- ✓ www.ibm.com *IBM*
- ✓ www.keralaitmission.org *Kerala Govt. IT Dept.*
- ✓ www.technopark.org
- ✓ www.studentworkzone.com/question.php?ID=139

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SEMESTER-VI

HORTICULTURE, PLANT BREEDING & RESEARCH METHODOLOGY

Course code : BO1643

Number of credits : 4

Number of contact hours: Lecture: 72 hrs; Practical: 36 hrs; Total: 108 hrs

Distribution of Hours	Theory	Practical
Horticulture	35 hrs	20 hrs
Plant breeding	20 hrs	16 hrs
Research methodology	17 hrs	00 hrs
Total	72 hrs	36 hrs

Horticulture

MODULE I

18 hrs

1. Introduction - Divisions of horticulture- Importance and scope of horticulture.
2. Principles of garden making- types of pots and containers- Potting mixture and potting media – soil, sand, peat, sphagnum moss, vermiculite- Soil types, Soil preparation- Irrigation methods
3. Propagation methods- Cuttings, Layering – Air layering, Ground layering (Tip, Trench and Compound), Budding – T- budding, Grafting – Approach grafting, Bridge grafting, whip and tongue grafting.
4. Garden tools and implements- Lawn mower, hand trowel, nursery spade, spade fork, garden hoe, weeder, tillers
5. Manures and fertilizers- Farmyard manure, compost, vermicompost and biofertilizers; Chemical fertilizers – NPK; Time and application of manures and fertilizers- Foliar sprays

MODULE II

17 hrs

6. Components of Garden- Landscaping principles; Lawns, Trees, shrubs and shrubberies, climbers and creepers, Flower beds and borders, ornamental hedges, edges, Drives, roads, walks and paths, Carpet beds, topiary, trophy, rockery, Conservatory or green houses
7. Indoor garden, Roof garden (Brief account only)
8. Bonsai
9. Flower Arrangement- Containers and requirements for flower arrangements- Free style, Shallow and Mass arrangement- Japanese- Ikebana. Dry flower arrangement

Practical

20 hrs

1. Familiarise the garden tools and implements mentioned in the syllabus
2. Students must be trained to do Cutting/ layering/ grafting/ budding.
3. Visit to a Botanical garden under the guidance of the teacher is recommended

MODULE-III

20 hrs

Plant breeding

1. Introduction, objectives in plant breeding- - Important national and international plant breeding institutes
2. Plant introduction. Agencies of plant introduction in India, Procedure of introduction - Acclimatization - Achievements.
3. Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection and methods.
4. Hybridization: Procedure of hybridisation, inter generic, inter specific, inter varietal hybridisation with examples. Composite and synthetic varieties.
5. Heterosis and inbreeding depression- genetic basis; male sterility
6. Mutation breeding – method – achievements in India.
7. Polyploidy breeding
8. Breeding techniques and achievements with reference to the following crops in India: a. Rice b. Wheat c. Potato d. Coconut

Practical

16 hrs

1. Techniques of emasculation and hybridization of any bisexual flower.

MODULE-IV

17 hrs

Research Methodology

1. Introduction; Need for research; Stages of Research – Definition of problem, execution of the problem, interpretation of results
2. Characteristics of Research, Types of research-Qualitative & quantitative.
3. Experimental design, components of experimental designs- Randomized blocks, completely randomized designs.
4. Preparation of a project report : Data analysis and consolidation of photographs, illustrations, tables and graphs, Title, introduction, review of literature, materials and methods, results, discussions, summary, references, acknowledgements; Bibliography – Method of citing and arrangement of references.

REFERENCES

1. Arora J.S 1990, Introductory Ornamental Horticulture, Kalyani Publications
2. Bailey L.H 1901, The Standard Cyclopaedia of Horticulture Volume 1,2 and 3, Macmillan Publications.
3. Bose T.K and Mukerjee D 1987, Gardening in India, Oxford Book House
4. Chauhan V.S, Vegetable Production in India, RamPrasad & Sons
5. Kumar N 1989, Introduction to Horticulture, Rajalakshmi Publications
6. Manibhushan Rao K 1991, Text Book of Horticulture, Macmillan Publications
7. Shujnroto, 1982, The Essentials of Bonsai, David & Charles, Newton
8. Allard RW (1999). Principles of Plant Breeding (2nd Edition), John Wiley and Sons.
9. Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA.
10. B D Singh Plant breeding
11. N. Gurumani Research Methodology: For Biological Sciences, MJP Publishers, 2006. ISBN, 8180940160
12. C. R. Kothari, Research Methodology New Age International

OPEN COURSES

OPEN COURSE – I

Offered to the students of other disciplines choosing Botany

Semester	Course Code	Title of the Course	Contact hrs/week	Credits
V	BO1551.1	Horticulture	3	2
	BO1551.2	Mushroom Cultivation and Marketing		
	BO1551.3	Forestry		

OPEN COURSE –II

Offered to the students of Botany

Semester	Course Code	Title of the Course	Contact hrs/week	Credits
VI	BO 1651	Biotechnology&Nanobiotechnology	3	2

OPEN COURSE –I (a)

HORTICULTURE

Course code : BO1551.1

Number of credits : 2

Number of contact hours : Lecture: 54 hrs

MODULE I

10 hrs

1. Introduction
2. Divisions of horticulture
3. Importance and scope of horticulture.
4. Principles of garden making
5. Types of pots and containers
6. Potting mixture and potting media – soil, sand, peat, sphagnum moss.
7. vermiculite
8. Soil types, Soil preparation
9. Irrigation methods
10. Hydroponics

MODULE II

12 hrs

I Propagation methods

1. Cuttings
2. Layering – Air layering, Ground layering (Tip, Trench and Compound)
3. Budding – T- budding
4. Grafting – Approach grafting, Bridge grafting, whip and tongue grafting.
5. Garden tools and implements
6. Manures and fertilizers
7. Farmyard manure, compost, vermicompost and biofertilizers.
8. Chemical fertilizers – NPK.
9. Time and application of manures and fertilizers.
10. Foliar sprays

MODULE III

12 hrs

- 1 Components of Garden
2. Lawns and landscaping Trees, shrubs and shrubberies, climbers and creepers
3. Flower beds and borders, ornamental hedges, edges Drives, roads, walks and paths , Carpet beds, topiary, trophy, rockery
4. Conservatory or green houses, Indoor garden, Roof garden
5. Bonsai

MODULE IV

10 hrs

1. Flower Arrangement
2. Containers and requirements for flower arrangements Free style, Shallow and Mass arrangement
3. Japanese – Ikebana
4. Bouquet and garland making
5. Dry flower arrangement
6. Harvesting Methods, Storage
7. Marketing of Fruits, vegetables and flowers
8. Preservation and processing of fruits and vegetables

MODULE V

10 hrs

1. Growth regulators in horticulture
2. Rooting hormones , Growth promoters , Flower induction , Parthenocarpy
3. Plant protection Common diseases of fruits and vegetable crops (Mango, Tomato)
4. Weedicides, Fungicides, Pesticides

Field Study: Visit to a Botanical garden under the guidance of the teacher is encouraged.

REFERENCES

1. Arora J.S 1990, Introductory Ornamental Horticulture, Kalyani Publications
2. Bailey L.H 1901, The Standard Cyclopaedia of Horticulture Volume 1,2 and 3, Macmillan Publications.
3. Bose T.K and Mukerjee D 1987, Gardening in India, Oxford Book House
4. Chauhan V.S, Vegetable Production in India, RamPrasad & Sons
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7. Shujnrnoto, 1982, The Essentials of Bonsai, David & Charles, Newton 50

OPEN COURSE -I (b)

MUSHROOM CULTIVATION AND MARKETING

Course code : BO1551.2

Number of credits : 2

Number of contact hours : Lecture: 54 hrs

MODULE I 12 hrs

- History and introduction: Edible mushrooms and Poisonous mushrooms.
- Systematic position, morphology, distribution, structure and life cycle of *Agaricus* and *Pleurotus*.

MODULE II 08hrs

Nutritional value, medicinal value and advantages- types- milky, straw, button and poisonous mushrooms

MODULE III 12 hrs

- Cultivation: Paddy straw mushroom – substrate, spawn making. Methods – bed method, polythene bag method, field cultivation.
- Oyster mushroom cultivation –Substrate, spawning, pre-treatment of substrate. Maintenance of mushroom.
- Cultivation of white button mushroom – Spawn, composting, spawning, harvesting.

MODULE IV 12hrs

- Diseases- Common pests, disease prevention and control measures.
- Processing - Blanching, steeping, sun drying, canning, pickling, freeze drying.
- Storage – short term and long term storage.

MODULE V 10hrs

- Common Indian mushrooms.
- Production level, economic return, Foreign exchange from Mushroom cultivating countries and international trade.

Field Study: Visit to a mushroom cultivating Laboratory

REFERENCES

1. Pandey B P 1996. A textbook of fungi. Chand and company N Delhi.
2. Kaul T N 2001. Biology and conservation of mushrooms. Oxford and IBH publishing company N.Delhi
3. Gupta P.K. Elements of Biotechnology. 51
4. Harander Singh. 1991. Mushrooms- The Art of Cultivation- Sterling Publishers.
5. Indian Journal of Mushrooms. Published by I.M.G.A. Mushroom Research Laboratory. College Agriculture, Solan

OPEN COURSE -I (c)

FORESTRY

Course code : BO1551.3

Number of credits : 2

Number of contact hours : Lecture: 54 hrs

MODULE I

10 hrs

General introduction to forests- Natural and Manmade; Tropical, temperate, evergreen semi-evergreen, deciduous; Monoculture, multipurpose, social and industrial. Forest and gene conservation.

MODULE II

16 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 species in India such as *Azadirachta indica*, *Tectona grandis*, *Eucalyptus*, *Mahagoni*, *Dalbergia sisso* and *Santalum album*, jack wood, Rubber.

• Wood: Homogenous and heterogenous- spring and autumn wood- Porous and non porous wood- Heart and sap wood.

• Relevance of wood anatomical studies in Kerala- Identification of wood- preparation of key and their uses

MODULE III

10 hrs

• Social and agro forestry. Selection of species and role of multipurpose trees. Food, fodder and energy.

• Social forest- Avenue plantation. Sacred plants- definition, importance of sacred trees like *Ficus religiosa*, *Emblica officinalis*, *Aegle marmelous*.

MODULE IV

09 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 their amendment.

MODULE V

09 hrs

• Forest resources and 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. Lac collection and marketing.

Field Study

1. Identification of wood using key: Teak, Jack wood, Mahogany, Rubber, *Azadirachta*, Eucalyptus.
2. Visit to a plywood factory to have knowledge of wood based industry.

REFERENCES

1. Sagreiya, K.P. 1994. Forests and Forestry (Revised by S.S. Negi). National book trust, New Delhi.
6. Tribhawan Mehta, 1981. A handbook of forest utilization. Periodical Expert Book Agency, New Delhi.
7. Kollmann and Cote 1988. Wood science and Technology. Vol.I & II Springer verlag.
8. Sharma P.D. 2004. Ecology and Environment. Rastogi publications, Meerut
9. Singh M.P. and Vinita Vishwakarma. 1997. Forest environment and Biodiversity. Daya publishing house, New Delhi.
10. Tiwari K.M. 1983. Social forestry in India.
11. Anil Kumar Dhiman. 2003. Sacred plants and their medicinal uses. Daya publishing house, New Delhi
12. B.S. Chundawat and S.K. Gautham. 1996. Text book of Agroforestry. Oxford and IBH Publishing House, New Delhi
13. A Hand book of Kerala Timbers- KFRI, Trichur.

SEMESTER-VI

OPEN COURSE-II - ELECTIVE

BIOTECHNOLOGY AND NANO BIOTECHNOLOGY

Course code : BO1651

Number of credits : 2

Number of contact hours : Lecture: 54 hrs

Biotechnology

MODULE- I

12 hours

1. Introduction – History- major achievements-Biotechnology in India.
2. Plant Tissue culture – Totipotency- definition and importance – dedifferentiation and redifferentiation. Cytodifferentiation.
Culture media, composition, preparation and sterilization.
Callus and suspension culture, meristem culture- Somaclonal variation- Somatic embryogenesis and organogenesis. Synthetic seeds – anther culture and production of haploids – protoplast culture – somatic hybrids – cybrids.

MODULE- II

12 hours

1. Recombinant DNA technology:
General account of cloning vehicles – plasmid, bacteriophages, cosmids and phagemids. Cutting and joining of DNA molecules – restriction endonucleases, ligases – Gene library.
2. Brief account of gene transfer techniques – Direct DNA uptake by protoplast –vector method Agrobacterium mediated, physical method- electroporation- shot gun method – microinjection.

MODULE III

12 hours

1. Methods in Biotechnology.
 - a. Isolation and purification of DNA from plant cells.
 - b. Agarose gel electrophoresis
 - c. PCR, RFLP, DNA sequencing-Sanger's method, Southern blotting, ELISA.
2. Application of biotechnology in
 - a. Medicine – edible vaccines from plants, gene therapy.
 - b. Agriculture – *nif* genes, GMO foods.
 - c. Industry and environment (brief account only)
3. Biosafety and ethical issues, Intellectual Property Rights (IPR)

MODULE IV

Microbial and industrial biotechnology

10 hours

1. Microbes in biotechnology.
2. Microbial culture methods of culturing, media and composition (LB and PDA)
3. Application of recombinant microbes.
4. Industrial microbiology: Production of alcohol, vinegar, bread, dairy products & single cell protein. (brief account only)

MODULE V

Nanobiotechnology

08 hours

1. Introduction-background and definition of nanotechnology
2. Nanosystems in nature
3. Nanoscaled biomolecules (nucleic acids and proteins)
4. Technologies for visualization of biological structures at the nano scale-atomic force microscope
5. Nanoparticles- Quantum dots, Paramagnetic iron Oxide Crystals, Dendrimers, Carbon nanotubes.
6. Application of nanotechnology in life sciences;

Field Study

- Visit to a well equipped biotechnology laboratory to familiar with the use of equipments and glasswares. Petri dishes, conical flasks, culture tubes, Pasteur pipettes, forceps, scalpels, hot air oven, autoclave, platform shaker, pH meter and laminar air flow system.
- Preparation of media, sterilization, inoculation and callus induction (demonstration only).

REFERENCES

1. Sobti RC and Suparna S Pachauri 2009, Essentials of Biotechnology, Ane Books Pvt. Ltd
2. Abhilasha s Muthuriya (2009) Industrial Biotechnology. Ane Books Pvt. Ltd
3. Misra SP (2009) Plant Tissue Culture. Ane Books Pvt. Ltd
4. Victoriano Valpuesta 2004, Fruit and Vegetable Biotechnology, CRC Press. New York. Ane Books Pvt. Ltd
5. Smith (2008) Biotechnology (5th Edition), Cambridge University Press India Pvt. Ltd
6. Colin Ratledge (2006) Basic Biotechnology, Cambridge University Press India Pvt. Ltd
7. Balasubramoniun D, CFA Bryce, K Dharmalingam, J Green and Kunthala
8. Jayaraman 2007, Concepts in Biotechnology, Universities Press
9. Janardhanan S and Vincent S 2007, Practical Biotechnology, Universities Press
10. Channarayappa 2008, Molecular Biotechnology, Universities Press
11. Gupta P. K. - Elements of Biotechnology (Rastogi publications).
12. Ignacimuthu S. J. – Applied Plant Biotechnology (Tata Mc Graw Hill)
13. Kumar H .D. - Molecular Biology & Biotechnology (Vikas publishing)
14. Pamela Peters – Biotechnology: A guide to genetic engineering (WC Brown Publishers)
15. Kesavachandran K and KV Peter 2008, Plant Biotechnology, Universities Press
16. Timir Baran Jha and Biswajit Ghosh 2007, Plant Tissue Culture, Universities Press
17. Ramawat K. G. – Plant Biotechnology (S. Chand & company)
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20. Bharat Bhushan , 2004 Hand book of nanotechnology. Springer- verlag, Berlin
21. Benjamin Lewin, 2004 Gene VIII Pearson Education International

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