MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL – 624 101

B.Sc. BOTANY

Curriculum Framework and Syllabus for

B.Sc. BOTANY

(For the candidates to be admitted from the academic year 2021-2022 onwards)

(UNDER CHOICE BASED CREDIT SYSTEM- CBCS)

Mother Teresa Women's University, Kodaikanal
Choice Based Credit System (CBCS)
(2021-2022 onwards)
B.Sc. Botany

1. About the Programme

This is a 3 year long undergraduate programme which is generally divided into six semesters. It deals with the basic principles of plant biology and related fields. It covers topics like plant kingdom, Taxonomy, microbiology, genetics and ecology etc. The course incorporates core courses, electives and practical. The delivery methods for B.Sc. Botany courses involve theoretical classes, lab work and hands-on practical training, outdoor tours etc. The students completing this programme generally go for higher education to build a career in academics, public and private sectors.

2. Programme Educational Objective

1. Develop the curriculum for fostering discovery-learning and know the importance of discipline
2. Inculcate interest in nature with its myriad living forms
3. Impart knowledge of Science as the basic objective of Education
4. Create a scientific approach to make students open-minded, critical, curious and make aware of natural sciences
5. Develop the ability to work hard and produce students to become entrepreneur who are fit for society

3. Eligibility

i. Candidate should have passed the Higher Secondary Examination conducted by the Board of Higher Secondary Examination, Govt. of Tamilnadu or any other Examination accepted by the syndicate as equivalent there to with at least one of the following subject Biology/Botany
ii. Candidate should have secured atleast 55% in the above subject and above in the aggregate.
iii. A relaxation of 10% in the total percentage will be given to SC, ST candidates

4. General Guidelines for UG Programme

i. **Duration:** The programme shall extend through a period of 6 consecutive semesters and the duration of a semester shall normally be 90 days or 450 hours. Examinations shall be conducted at the end of each semester for the respective subjects.
ii. **Medium of Instruction:** English
iii. **Evaluation:** Evaluation of the candidates shall be through Internal Assessment and External Examination.

- **Evaluation Pattern**

Evaluation Pattern	Theory		Practical	
	Min	Max	Min	Max
Internal	10	25	10	25
External	30	75	30	75

- **Internal (Theory): Test (15) + Assignment (5) + Seminar/Quiz(5) = 25**
- **External Theory: 75**

- **Question Paper Pattern for External examination for all course papers.**

Max. Marks: 75 **Time: 3 Hrs.**

S.No.	Part	Type	Marks
1	**A**	**10*1 Marks=10** Multiple Choice Questions(MCQs): 2 questions from each Unit	**10**
2	**B**	**5*4=20** Two questions from each Unit with Internal Choice (either / or)	**20**
3	**C**	**3*15=45** Open Choice: Any three questions out of 5 : one question from each unit	**45**
Total Marks			**75**

*** Minimum credits required to pass: 156**

- **Project Report**

A student should select a topic for the Project Work at the end of the third semester itself and submit the Project Report at the end of the fourth semester. The Project Report shall not exceed 75 typed pages in Times New Roman font with 1.5 line space.

- **Project Evaluation**

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25 Marks; External (Viva): 75 Marks).

5. Conversion of Marks to Grade Points and Letter Grade

(Performance in a Course/ Paper)

Range of Marks	Grade Points	Letter Grade	Description
90 – 100	9.0 – 10.0	O	Outstanding
80-89	8.0 – 8.9	D+	Excellent
75-79	7.5 – 7.9	D	Distinction
70-74	7.0 – 7.4	A+	Very Good
60-69	6.0 – 6.9	A	Good
50-59	5.0 – 5.9	B	Average
40-49	4.0 – 4.9	C	Satisfactory
00-39	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

6. Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the Prescribed Form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the Prescribed Form with the prescribed fee along with the Medical Certificate. Students with attendance less than 65% are not eligible to appear for the examination and they shall re-do the course with the prior permission of the Head of the Department, Principal and the Registrar of the University.

7. Maternity Leave

The student who avails maternity leave may be considered to appear for the examination with the approval of Staff i/c, Head of the Department, Controller of Examination and the Registrar.

8. Any Other Information

In addition to the above mentioned regulations, any other common regulations pertaining to the UG Programmes are also applicable for this Programme.

9. PROGRAMME OUTCOMES (POs)

On completion of B.Sc., Botany Programme, the students will be able to

1. enrich the fundamental concepts of botany and plant science.
2. apply the knowledge of biology to make scientific queries and enhance the comprehension potential.
3. demonstrate comprehensive knowledge about plants, current research, scholarly and professional literature of advanced learning areas of Botany
4. gain proficiency and skills in different topics of module of Botany use, principles of basic science and fundamental process to study and analyze the plant forms.
5. apply the acquired scientific knowledge to the development of Indian economy
6. pertain skills in science and apply in life for sustainable environment
7. enhance their capacity to obtain employment and higher studies in science

PROGRAMME SPECIFIC OUTCOMES (PSOs):

On completion of B.Sc., Botany Programme, the students will be able to

1. enrich knowledge on diversity, life patterns of plants and their importance to other life forms.
2. utilize the theoretic and practical knowledge of Botany in achieving a successful career.
3. impart knowledge obtained from the programme to develop their entrepreneurship skills in self supported or funded business /giving consultancy
4. communicate appropriately and effectively in botanical science and also interact productively with people from diverse background
5. impart the basic laboratory experiments and hands on training perceived will pave way to advanced research and higher studies

MOTHER TERESA WOMEN'S UNIVERSITY, KODAIKANAL
Common Course structure for UG programmes under CBCS
B.Sc., BOTANY (candidates admitted from 2021-2022 onwards)

Sl. No.	Course Code	Title of the Course	Credits	Hours		Maximum Marks		
				T	P	CIA	ESE	Total
	FIRST SEMESTER							
1.	U21LTA11	Part I-Tamil I	3	6		25	75	100
2.	U21LEN11	Part II-English I	3	6		25	75	100
3.	U21BOT11	**Core- I** - Algae, Fungi and Lichens	4	5		25	75	100
4.	U21BOP11	**Core-II**- Practical - Plant Diversity I	4		6	25	75	100
5.	U21 ZOA11	**Allied- I**-Zoology	4	5		25	75	100
6.	U21EVS11	Environmental Studies	2	2		25	75	100
7.	U21PEPS11	Professional English-I	4	6		25	75	100
		Total	**24**	**30**	**6**			**700**
	SECOND SEMESTER							
8.	U21LTA22	Part I-Tamil II	3	6		25	75	100
9.	U21LEN22	Part II-English II	3	6		25	75	100
10.	U21BOT21	**Core- III** - Bryophytes, Pteridophytes, Gymnosperm and Paleobotany	4	5		25	75	100
11.	U21BOP22	**Core- IV**-Practical - Plant Diversity-II	4		5	25	75	100
12.	U21ZOA22	**Allied-II**-Practical-Zoology	4		5	25	75	100
13.	U21VAE21	Value Education	3	3		25	75	100
14.	U21PEPS22	Professional English-II	4	6		25	75	100
		Total	**25**	**36**				**700**
	THIRD SEMESTER							
15.	U21LTA33	Part I-Tamil III	3	6		25	75	100
16.	U21LEN33	Part II-English III	3	6		25	75	100
17.	U21BOT31	**Core- V**-Cell and molecular biology	4	5		25	75	100
18.	U21CHA33	**Allied- III** –Chemistry	4	5		25	75	100
19.	U21BOE311/ U21BOE312	**Elective-I**-Bioprospecting of plants / Biodiversity conservation	3	4		25	75	100
20.	U21MSS31	**Skill Based Elective-I**-Managerial skill	2	2		25	75	100
21.		**Non Major Elective – I**	2	2		25	75	100
		Total	**21**	**31**		**-**	**-**	**700**

	FOURTH SEMESTER							
23.	U21LTA44	Part I-Tamil- IV	3	6		25	75	100
24.	U21LEN44	Part II-English- IV	3	6		25	75	100
25.	U21BOT41	**Core-VI** – Morphology and Taxonomy of Angiosperms	4	4		25	75	100
26.	U21BOP43	**Core- VIII-** Practical - Taxonomy of Angiosperms	4		4	25	75	100
27.	U21 CHA44	**Allied-IV**- Practical Chemistry	4		4	25	75	100
28.	U21BOE421/ U21BOE422	**Elective – II** - Wood Technology / Silviculture	3	3		25	75	100
29.	U21CSS42	**Skill Based Elective -II-** Computer Skills for Office Management	2	2		25	75	100
30.		**Non Major Elective –II**	2	2		25	75	100
		Total	**25**	**31**		**-**	**-**	**800**

	FIFTH SEMESTER							
32.	U21BOT51	**Core VIII- Genetics and Evolution**	4	5		25	75	100
33.	U21BOT52	**Core IX – Plant physiology**	4	5		25	75	100
34.	U21BOT53	**Core X – Plant Biochemistry**	4	5		25	75	100
35.	U21BOT54	**Core XI –Plant Anatomy and Embryology**	4	5		25	75	100
36.	U21BOP54	**Core XII-** Practical - Genetics and Evolution ,Plant physiology, Plant Biochemistry, Plant Anatomy and Embryology	4		5	25	75	100
37.	U21BOE531/ U21BOE532	**Elective –III –** Ethano Botany and Ethanopharmacognosy / Biofertiliser and Waste management	3	3		25	75	100
38.	U21BOS531/ U21BOS532	**Skill Based Elective-III-**Organic farming /Food processing & preservation	2	2		25	75	100
		Total	**25**	**30**		**-**	**-**	**700**

	SIXTH SEMESTER							
39.	U21BOT61	**Core - XIII** – Basics of Plant Biotechnology	4	5		25	75	100
40.	U21BOT62	**Core - XIV** – Environmental Biology and Phytogeography	4	5		25	75	100
41.	U21BOT63	**Core- XV**– Fundamentals of Microbiology and Plant Pathology	4	5		25	75	100

42.	U21BOT64	**Core-XVI**- Biostatistics, Bioinstrumentation and Biophysics	4	5		25	75	100
43.	U21BOP65	**Core-XVII** – Practical -Plant Biotechnology, Environmental Biology, Microbiology and Plant Pathology	4		5	25	75	100
44.	U21BOE641/ U21BOE642	**Elective –IV** –Forestry / Seed technology	3	3		25	75	100
45.	U21BOS641/ U21BOS642	**Skill Based Elective-IV**- Horticulture Techniques & Plant Breeding / Microtechnique and Histochemistry	2	2		25	75	100
46.	U21EAS61	**Extension Activities** (NSS/NCC/RRC/YRC/Physical Education)	3			100		100
		Total	**28**	**30**		**-**	**-**	**800**
		Grand Total	**148**	**193**				**4400**

Non Major Elective

The candidates, who have joined the UG programme, can also undergo Non Major Elective offered by other Departments

S.No	Code	NME Title
1	U21BON311	Forest Botany
2	U21BON312	Mushroom Cultivation
3	U21BON421	Horticulture
4	U21BON422	Pomology

Additional Credit Courses (Two credit courses)

1. **U21BOO31**: Online Course – III Semester
2. **U21BOI41** : Internship – IV Semester
3. **U21BOV51** : Value added course – V Semester (**Spirulina Cultivation)**

SEMESTER-I

COURSE CODE	U21BOT11	ALGAE, FUNGI AND LICHENS	L	T	P	C
CORE I			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To comprehend the major classes of algae, fungi and their important features. • To understand the distribution and life cycle pattern of algae, fungi and lichens • To learn in detail about the ecological and economic importance of algae, fungi and lichens • To enumerate the key points for identifying important algae and fungi
Unit I	**Algae**
Distribution and general characteristics of algae. Classification of Algae by F.E. Fritsch (1945). Thallus organization, Structure and reproduction of the Class Chlorophyceae (*Volvox)*	
Unit II	**Structure and reproduction of the Classes**
Phaeophyceae (*Sargassum*), Rhodophyceae(*Gracilaria*)andCyanophyceae (*Nostoc*). Economic Importance of algae.	
Unit III	**Fungi**
General Characteristics of the Fungi. Classification of Fungi by C.J. Alexopoulos (1962).Structure and reproduction of Myxomcetes (*Stemonites*) and Phycomycetes (*Albugo*).	
Unit IV	**Fungi**
Structure and reproduction of Ascomycetes (*Peziza*), Basidiomycetes (*Saccharomyces*) and Deuteromycetes (*Puccinia*). Economic importance of Fungi.	
Unit V	**Lichens**
General characteristics and classification of lichens. Structure and reproduction of *Usnea.* Role of Lichens in succession and monitoring pollutants. Economic importance of Lichens.	
Text books	1. Pandey, P.B. College Botany - 1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. Chand Publishing, New Delhi. 2014. 2. Bilgrami, K.S. A Textbook of Algae. CBS Publisher & Distributors, New Delhi, ISBN: 978-8123900490. 2010. 3. Johri, R.M., Smeh Lata, Kavitha Tyagi. A Text Book of Fungi, Dominant Publishers and Distributors Pvt. Ltd., New Delhi. 2011. 4. A.V.S. Sambamuty, A text book of Algae,I.K.International publishing house, Pvt. Ltd 2005.
Reference books	1. Kevin K. Fungi biology and Application, 3rd Edition, Wiley Blackwell. 2018 2. Vashista B.R.Algae, S.Chand & Co.Ltd, New Delhi. 2012. 3. Power and Dagainwala. General Microbiology, Himalayan publishing House,New Delhi.2012 4. Sharma, P. D. Microbiology, Rastogi & Co., Meerut. 2011. 5. Alexopoulos, C.J., C.M. Mims and M. BlackMell. Introductory Mycology. IV Edition. Miley India (P) Ltd., Daryaganj, New Delhi. 2007

E-References	1. http://deskuenvis.nic.in/pdf/PhycologyLee.pdf 2. http://deskuenvis.nic.in/pdf/WEBSTER30521807395.pdf 3. http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvMmpzQ2loYjQvamQxTUhmT2lQTE1JT3BVeUVjTUtIdGEySlVIRzlrMjdpUkRNR3hUeQ		
Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	understand the general features and classification of algae	**K2**
	CO2	enumerate the life cycle of major classes of algae and their economic importance	**K2**
	CO3	acquire a deep knowledge on principles of fungi classification to apply in the field	**K3**
	CO4	know the life cycle of major classes of fungi and their economic importance	**K2**
	CO5	have clear idea about lichens including their economic importance	**K1**

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	M	S	S	M	S	S
CO2	S	S	S	M	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	M	S	S	M	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	S	M	S	M	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

COURSE CODE	U21BOP11	ALGAE, FUNGI AND LICHENS	L	T	P	C
CORE II			-	-	6	4

Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Evaluate
Learning objective	• To observe the vegetative structures of algae, fungi and lichens through microscope and study it's structure • To learn thallus structure of lower plants • To develop skills on identification of lower plants through morphological characters
	Observation on 1. Microscopic observation of thallus structure and reproductive organs in selected group of microalgae 2. Analysis of thallus structure, anatomical features and reproductive structure of selected macro algae 3. Mycelial morphology, organization, fruiting bodies and structure of spores in selected group of fungi 4. Morphology, anatomy and reproductive parts of crustose, foliose and fruticose lichen. Biochemical test to determine the genus or species of various lichens. 5. Two to three days field trip to collect of algae/fungi/lichen specimen 6. Submission of 10 algae/fungi/lichen herbarium specimens and maintenance of record book
Text books	1. Sivakumar, K. Algae- A Practical Approach. MJP Publishers, Chennai, India. 2016. 2. Gupta, V.K., Tuohy, M.G., Ayyachamy, M., Turner, K.M. and O'Donovan, A. Laboratory Protocols in Fungal Biology: Current Methods in Fungal Biology. Springer, London, UK. 2013. 3. Chmielewski, J. G. and Krayesky, D. General Botany laboratory Manual. AuthorHouse, Bloomington, USA. 2013.
Reference books	1. Bendre, A. M. A Text Book Of Practical Botany – 1. Rastogi Publications, Meerut, India. 2010. 2. McMahon, K., Levetin, E. and Reinsvold, R. Laboratory Manual for Applied Botany. McGraw-Hill Education, New York, USA. 2001.
E-References	1. http://assets.vmou.ac.in/MBO10.pdf 2. http://ndl.iitkgp.ac.in/document/NXpzbzZQcHVvTFUrTGdYcTF0VlQxczVoUDhzOE9FOXg2MnN1bHhjSUNmOD0 3. https://WWW.researchgate.net/profile/Barry-Rosen/publication/235654691_Aquaculture_Manual/links/02bfe512518c53a0de000000/Aquaculture-Manual.pdf

	Upon completion of this course, the students will be able to		
Course outcome	**CO**	**Course Outcomes**	**Knowledge Level**
	CO1	perform microscopic examination of algae and fungi	**K3**
	CO2	understand the thallus structure and anatomical structure of macro algae	**K1**
	CO3	examine the fruiting bodies and structure of spores of selected fungi	**K4**
	CO4	identify the genus or species of various lichens through biochemical test	**K3**
	CO5	have a clear idea on morphological characters of lower plants	**K2**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	M	S	S	S	S	S	S	S
CO2	S	S	M	S	S	S	S	M	S	S	S	M	S
CO3	S	S	M	S	S	M	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

COURSE CODE	U21ZOA11	ZOOLOGY	L	T	P	C
ALLIED-I			5	-	-	4

Cognitive Level	K2: Understand K3: Apply
Learning objective	• To know the diagnostic characters of phyla • To understand the classification of chordates with their diagnostic characters • To acquire knowledge on cell division and cell cycle • To understand the origin of life and cell
Unit I	**Invertebrata**
Study of the following types with their diagnostic characters of the phyla and classes to which they belong. a) Paramecium b) Ascaris c) Starfish Life history, transmission and control measures of plasmodium, Morphology and appendages f prawn	
Unit II	**Chordata**
Classification of chordates up to classes with their diagnostic characters with few examples from each class. Mammalian representative – Rabbit. Digestive, Respiratory, structure of Heart, Brain and Reproductive system. Identification and significance of any 5 edible fishes. Snakes- Identification of poisonous and non-poisonous Snakes-Mechanism of bite-venom and action, first aid for snake bite.	
Unit III	**Cyto genetics**
Mitosis, Meiosis cell division, cell cycle and control Laws of Mendel and common Mendelian traits in man.	
Unit IV	**Physiology & Embryology**
Endocrine glands – Pituitary and thyroid. Excretion-Structure of nephron-Physiology of excretion. Development of frog upto gastrulation. Test tube babies-Birth control-Aritificial insemination-IVF.	
Unit V	**Evolution**
Introduction to evolution, A Short History of Evolutionary Thought , Origin of Life and Cells, Theories of Lamarck, Darwinism and Neo-Darwinism.	
Text books	1. Ayyar, E.K. and T.N. Ananthakrishnan, Manual of Zoology Vol. I (Invertebrata). Parts I & II.S. Viswanathan (Printers and Publishers) Pvt Ltd. Madras. 1992. 2. Power, C.B. Cell Biology Himalayan Publishing House, New Delhi.2009 3. A Text Book of Genetics Rastogi V.B, Kedar Nath Ram Nath. Meerut.1997. 4. Animal Physiology. S.Chand & Co.,New Delhi. Verma, P.S., Agarwal, 1980, 5. Chordate Embryology -P.S .Verma & V.K.Agarwal---S. Chand & Co.1995. 6. Organic Evolution, Rastogi. V.B. - Kadar Nath & RaNath, 7th edtion, 1988 – 89, Meerut

Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	identify the classes of different phyla by analysing its diagnostic characters	**K3**
	CO2	differentiate poisonous and non-poisonous snakes	**K3**
	CO3	enumerate the identification characters of fishes	**K2**
	CO4	understand the Mendelian traits in man	**K2**
	CO5	Learn the techniques of artificial insemination	**K2**

Mapping of COs with POs & PSOs:

CO	**PROGRAMME OUTCOMES (PO)**								**PROGRAMME SPECIFIC OUTCOMES (PSO)**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	S	S	S	S	M	M	M	S
CO2	S	S	S	S	M	S	S	S	S	M	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	S	S	M	S	M	S	S	M	S
CO5	S	S	M	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) -1 mark No Correlation (N) - 0 mark

SEMESTER-II

Course Code	U21BOT21	BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERM AND PALEOBOTANY	L	T	P	C
CORE III			5	-	-	4

Cognitive Level	K1: Recall K2: Understand
Learning objective	• To understand the general characters of major groups of plants such as Bryophytes, Pteridophytes and Gymnosperms • To have knowledge on classification, structure, reproduction and economic importance of Bryophytes, Pteridophytes and Gymnosperms • To find the significance of these plant groups to human welfare • To acquire knowledge and interest in the study of fossil plants
Unit I	**Bryophytes**
General Characteristics, classification by Reimers (1954). Morphology, occurrence, structure and reproduction of *Riccia*, *Marchantia* and *Polytrichum* (Need not study developmental aspects). Economic importance of Bryophytes.	
Unit II	**Pteridophytes**
General characteristics and classification by Smith (1955). Morphology, structure, reproduction and life-cycle of *Lycopodium* and *Selaginella.*	
Unit III	**Pteridophytes**
Structure, reproduction and life-cycle of *Equisetum* and *Marselia.* Stelar evolution in Pteridophytes. Economic importance of Pteridophytes.	
Unit IV	**Gymnosperms**
General characteristics and classification of Gymnosperms by Sporne (1965). Morphology, structure, reproduction and life-cycle of the following: *Cycas* and *Pinus*. Economic importance of Gymnosperms.	
Unit V	**Paleobotany**
Brief study of geological time scale. Methods of fossilization. A brief study on *Rhynia*, *Lepidodendron*, *Lyginopteris* and *Williamsoniella*	
Text books	1. Parihar, N.S. An Introduction to Embryophyta Pteridophytes. 5th Edition, Surjeet Publication, Delhi.2019. 2. Sharma, O.P. Pteridophyta. Tata McGraw-Hill Education, Delhi. 2017. 3. Johri , RM, Lata S , Tyagi K, A text book of Gymnosperms , Dominate pub and Distributer, New Delhi. 2005.
Reference books	1. Sharma, O.P. Bryophyta. MacGraM Hill Education (Pvt) Limited, New Delhi. 2017. 2. Vasishta, P.C., Sinha, A.K. and Anil Kumar. Botany for Degree Students, Pteridophyta. S.Chand &Company ltd., New Delhi. 2016. 3. Vashishta, Sinha A.K, Adarsh Kumar. Bryophytes, S.Chand &Company ltd., New Delhi. 2011. 4. Pandey B.P.A textbook of Botany (Bryophyta, Pteridophyta and Gymnosperms) S.Chand & Co., P.Ltd., Ram Nagar, New Delhi. 2010.

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<tr><td>E-References</td><td colspan="3">1. http://ndl.iitkgp.ac.in/document/OEYMeXpIRmlkYURkM3JkbUdtKy9UU3NFQ1BtNlk5dURFdUo2TM9Ec2V0aGJxRXJlNTdmTnBScMJlSmkrYk5ZQmxsUmJyMGYxUDY4MXFoOXlTV0hxaFE9PQ
2. https://WWW.ias.ac.in/article/fulltext/reso/009/06/0056-0065
3. http://ndl.iitkgp.ac.in/document/Z3dSNXd5OEtFblFDcMRPUk9LNVZIRElXaHQycVRlbkM4TnJvU2hDRDgxMD0
4. http://ndl.iitkgp.ac.in/document/RDB5OXNIdXBlRTBmUTNpODk4OS9zT3lId0tTQlI3YnBudE96OG9MMzRMUT0
5. http://ndl.iitkgp.ac.in/document/eVZ0Ky92RFRRc29LVDBqM1ZGZ1NLV2Q1blFNN2pUbUFMY2JDNUc4OTI5TT0</td></tr>
<tr><td rowspan="7">Course outcome</td><td colspan="3">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>have a clear idea about the characters and life cycle of Bryophytes and their economic importance</td><td>K1</td></tr>
<tr><td>CO2</td><td>describe the features and life cycle of Pteridophytes</td><td>K2</td></tr>
<tr><td>CO3</td><td>understand the stellar evolution and economic potential of Pteridophytes</td><td>K2</td></tr>
<tr><td>CO4</td><td>gain knowledge on features, classification, life cycle and economic importance of Gymnosperms</td><td>K2</td></tr>
<tr><td>CO5</td><td>have better understanding on fossilization process and fossil plants</td><td>K2</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	S	M	S	S	S	M	S	S
CO2	S	S	S	M	S	M	S	M	S	S	M	S	S
CO3	S	S	S	M	S	S	S	S	S	S	M	S	S
CO4	S	S	S	M	S	M	M	S	S	S	M	S	S
CO5	S	S	S	S	S	S	M	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

<table>
<tr><td>Course Code</td><td>U21BOP22</td><td rowspan="2">BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERM</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">CORE IV</td><td>-</td><td>-</td><td>5</td><td>4</td></tr>
<tr><td>Cognitive Level</td><td colspan="6">K1: Recall K2: Understand K3: Apply K6: Create</td></tr>
<tr><td>Learning objective</td><td colspan="6">• To observe the thallus structure of microscopic lower plants
• To understand the vegetative structure of Bryophytes
• To learn morphology and anatomical features of Pteridophytes
• To analyze the anatomical characters of Gymnosperms</td></tr>
<tr><td></td><td colspan="6"><u>Observation on</u>
1. Morphology and anatomy of thallus and reproductive parts of various groups of Bryophytes; Riccia, Marchantia, Funaria, Polytrichum, Anthoceros
2. Morphology and anatomy of sporophytes and spore producing organs of selected Pteridophytes; Psilotum, Lycopodium, Selaginella, Equisetum, Adiantum, Pteris, Marselia
3.Morphology and anatomy of vegetative parts and reproductive structure of selected Gymnosperms; Cycas, Pinus, Gnetum
4. Microscopic observation on various plant fossils
5.Two to three days field trip to collect of Bryophytes/Pteridophytes/Gymnosperms specimen
6. Submission of 10 Bryophytes/Pteridophytes/Gymnosperms herbarium specimens and maintenance of record book</td></tr>
<tr><td>Text books</td><td colspan="6">1. Sivakumar, K. Algae- A Practical Approach. MJP Publishers, Chennai, India. 2016.
2. Gupta, V.K., Tuohy, M.G., Ayyachamy, M., Turner, K.M. and O'Donovan, A. Laboratory Protocols in Fungal Biology: Current Methods in Fungal Biology. Springer, London, UK. 2013.
3. Chmielewski, J. G. and Krayesky, D. General Botany laboratory Manual. AuthorHouse, Bloomington, USA. 2013.</td></tr>
<tr><td>Reference books</td><td colspan="6">1. Bendre, A. M. A Text Book of Practical Botany – 1. Rastogi Publications, Meerut, India. 2010.
2. McMahon, K., Levetin, E. and Reinsvold, R. Laboratory Manual for Applied Botany. McGraw-Hill Education, New York, USA. 2001.</td></tr>
<tr><td>E-References</td><td colspan="6">1. http://assets.vmou.ac.in/MBO10.pdf
2. http://ndl.iitkgp.ac.in/document/NXpzbzZQcHVvTFUrTGdYcTF0VlQxczVoUDhzOE9FOXg2MnN1bHhjSUNmOD0
3. https://WWW.researchgate.net/profile/Barry-Rosen/publication/235654691_Aquaculture_Manual/links/02bfe512518c53a0de000000/Aquaculture-Manual.pdf</td></tr>
</table>

	Upon completion of this course, the students will be able to		
Course outcome	**CO**	**Course Outcomes**	**Knowledge Level**
	CO1	perform microscopic examination of thallus structure	**K3**
	CO2	understand the sporophytic character of Pteridophytes	**K2**
	CO3	examine the internal features of typical Gymnosperms	**K2**
	CO4	identify species of bryophytes based on morphological characters	**K1**
	CO5	prepare wet specimen as herbarium	**K6**

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	M	S	S	S	S	S	S	S
CO2	S	S	M	S	S	S	S	M	S	S	S	M	S
CO3	S	S	M	S	S	M	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21ZOA22	PRACTICAL ZOOLOGY	L	T	P	C
ALLIED-II			-	-	5	4
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To understand the mounting method • To acquire knowledge on virtual dissection • To know the preparation of blood smear • To identify specimen based on their characteristics					

Mounting

Paramecium - Whole Mount
Earthworm - Body and Penial setae
Prawn - Appendages
Fish - Cycloid scale or Placoid scale

Virtual dissection.

Cockroach - Nervous system
Starfish - Water vascular system .
Rabbit - Heart and Brain.

Spotters and specimen

Amoeba
Plasmodium
Ascaris Entire (male & female)
Prawn
Starfish oral and aboral view
Amphioxus.
Narcine.
Clarius.
Rhacophorus.
Chamaeleon.
Poisonous snakes.- Naja naja, Krait
Non poisonous snakes-Water snake, Wolf snake
Pigeon and parrot -beak and feet
Rabbit

Physiology

Mitosis in Onion root tip cells
Observation of simple mendelian traits
Human blood smear
Demonstration of blood pressure using Sphygmomanometer.
Examination of excretory products of fish, bird and mammal
Endocrine glands – Pituitary and thyroid

Embryology - Frog cleavage, blastula and gastrula.
Evolution - **Vestigial Organs- Pinna.**
Fossils: Peripatus, Limulus
Analysis of variation - Finger prints.

Reference Books	1. Sinha, J., Chatterjeee A.K., Chattopadhyay P Advanced Practical Zoology , Arunabha Sen Publishers 2011 2. H.S. Bhamrah Practical Zoology Invertebrate, Dominant Publishers. 2003. 3. Preeti Guptha and Mridula Chaturvedi, Modern Experimental Zoology,. 2000 4. Verma, Manual of Practical Zoology: Chordates, S. Chand Publishing 2000.		
Course outcome	Upon completion of this course, the students will be able to		
	CO1	prepare specimens of different organism	**K1**
	CO2	check blood pressure by Sphygmomanometer	**K1**
	CO3	understand variations occur in finger prints	**K2**
	CO4	explain the dissection and identification of organs in specimens	**K3**
	CO5	describe the stages in mitosis	**K2**

Mapping of COs with POs & PSOs:

CO	**PROGRAMME OUTCOMES (PO)**								**PROGRAMME SPECIFIC OUTCOMES (PSO)**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	M	S	M	M	M	S
CO2	S	S	S	S	S	S	S	S	S	M	S	S	S
CO3	S	S	S	S	S	M	S	S	S	S	S	M	S
CO4	S	S	S	S	S	S	M	S	M	S	S	M	S
CO5	S	S	S	S	S	S	S	M	S	S	S	S	M
CO5	S	S	S	S	S	S	S	M	S	S	S	S	M

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) -1 mark No Correlation (N) - 0 mark

SEMESTER III

Course Code	U21BOT31	CELL AND MOLECULAR BIOLOGY	L	T	P	C
CORE –V			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To learn the basic structure and function of cell and cell organelles • To understand different stages of cell division • To figure out the structure and organization of DNA • To improve the knowledge of Genetics and Molecular basis of life
Unit I	**Basic structure of Plant cell:**
Structure and function of cell wall and cell membrane. Membrane models (Unit membrane model, Fluid Mosaic Model and Davson–Danielli Model)	
Unit II	**Structure and function of cell organelles**
Chloroplast, mitochondria, ribosomes, peroxisomes, golgi apparatus, nucleus and endoplasmic reticulum.	
Unit III	**Non –living cell inclusions**
Raphides, cystolith and granules. Cell divisions; Mitosis and meiosis, Cell cycle and cytokinesis.	
Unit IV	**Chromosomes**
Morphology, chromatin organization. Watson and crick model of DNA. DNA synthesis and replication. Transposons and plasmids. C- Value paradox. Central dogma of Molecular Biology - Protein synthesis.	
Unit V	**General principles of gene regulation**
Gene regulation in prokaryotes, Operon concepts; *lac* Operon, *trp* Operon. Eukaryotic gene regulation. PCR- Sanger's DNA Sequencing Method.	
Text books	1. Pawar, Cell Biology, Himalaya Publishing House, Mumbai. 2019. 2. Rastogi, S.C. Cell and Molecular Biology. New Age International Publishers, New Delhi. 2016.
Reference books	1. Derobertis E.D. and De Robertis E.M.F. Cell and Molecular Biology 8th Edition. Lee and Fab International edition, Philadelphia.2017. 2. Verma P.S.and Agarwal V.K.Cell Biology(Cytology,Biomolecules,Molecular biology),Paper back,S.chand and Company .Ltd. 2016. 3. Buchanan B.B. Gruissem M., Jones R.L. Biochemistry and Molecular Biology. American Society of Plant Physiologist, Maryland, USA. 2015. 4. Cooper G. The cell – A molecular approach. ASM Press, Washington.2015. 5. Sheeler P and Binachi D. Cell and Moecular Biology, Third edition, Miley New York, USA. 2009.
E-References	1. http://ndl.iitkgp.ac.in/document/eXF1YzdhQ2RxM3hPUm8ra0k0NHZGUT09 2. http://ndl.iitkgp.ac.in/document/SFBhRUg0cDg3MTJyRXE0OVB5RkpLZz09 3. https://epgp.inflibnet.ac.in/Home/VieMSubject?catid=4 4. http://ndl.iitkgp.ac.in/document/OEYMeXpIRmlkYURkM3JkbUdtKy9UZXgvY1pnaUtMUG4vNUhiMnZ5R2NkaWWWZ3FVNTFkeVhtRkUzd1JGSmNJMEgxOTNJSXlyQ2ZnT3pHZMtmVE5LRGc9PQ

	Upon completion of this course, the students will be able to		
Course outcome	**CO**	**Course Outcomes**	**Knowledge Level**
	CO1	understand the organization of Plant cell, cell wall and its Membrane	K2
	CO2	describe the structure and role of cell organelles	K3
	CO3	know the stages and types of cell divisions K2	K1
	CO4	know the organization and structure of plant genetic material	K2
	CO5	differentiate the prokaryotic and eukaryotic gene regulation	K3

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	M	S	S	S	S	M	S	S	S	M	S
CO2	S	S	M	S	S	M	M	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S	M	S	S	S	M	S
CO4	S	S	M	S	S	M	S	S	S	S	S	M	S
CO5	S	S	M	S	S	S	S	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21CHA33	CHEMISTRY	L	T	P	C
ALLIED-III			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To understand the handling of chemicals and errors in chemical analysis • To get knowledge in chemical bonding and hybridization • To acquire knowledge in volumetric analysis • To understand the basic concept of chemistry of thermodynamics and kinetics
Unit I	**Handling of chemicals and Data analysis**

a) Storage and handling of chemicals: Handling of acids, ethers, toxic and poisonous chemicals. Antidotes, threshold vapour concentration and first aid procedure.
b)Errors in chemical analysis: Accuracy, precision. Types of error-absolute and relative errors.Methods of eliminating and minimizing errors.
c) Separation techniques–Solvent extraction. Principle of adsorption and partition chromatography, column chromatography, thin layer chromatography (TLC), paper chromatography and their applications.

Unit II	**Chemical bonding**

a) Ionic Bond: Nature of Ionic bond. Structure of NaCl, KCl and CsCl. Factors influencing the formation of ionic bond.
b) Covalent Bond: Nature of covalent bond. Structure of CH_4, NH_3, H_2O based on hybridization.
c) Coordinate Bond: Nature of coordinate bond. Coordination complexes. Werner's theory. Geometrical and optical isomerism in square planar and octahedral complexes. Mention of structure and functions of chlorophyll and hemoglobin.
d) Hydrogen Bond: Theory and importance of hydrogen bonding. Types of hydrogen bonding. Hydrogen bonding in carboxylic acids, alcohol, amides, polyamides, DNA and RNA.
e) van der Waal's forces: Dipole – dipole and dipole - induced dipole interactions.

Unit III	**Volumetric analysis**

a) Methods of expressing concentration: normality, molarity, molality, ppm.
b)Primary and secondary standards: preparation of standard solutions
c)Principle of volumetric analysis: end point and equivalence points.
d)Strong and weak acids and bases - Ionic product of water , pH, pKa, pKb. Buffer solutions - pH of buffer solutions. Mention of Henderson equation & its significance.

Unit IV	**Kinetics & Thermodynamics**

Chemical Kinetics: Rate, rate law, order and molecularity. Derivation of rate expressions for I and II order reactions.
Catalysis-Homogeneous and heterogeneous catalysis. Enzyme catalysis, enzymes in biological system and in industry.
Thermodynamics: Introduction, scope and importance of thermodynamics- system and surrounding-isolated, closed and open systems- state of the system- intensive and extensive variables. Thermodynamic process- reversible and irreversible, isothermal and adiabatic process- First law of thermodynamics- statement- definition of internal energy (E),enthalpy (H), applications of first law of thermodynamics.

Unit V	**Chemistry of biomolecules**

<table>
<tr><td colspan="4">a) Fats – Occurrence and composition. Hydrolysis of fats.
b) Vitamins – Source, provitamin, properties and classification. Structure and functionof vitamin A, C, D, K and E
c) Hormones – Thyroxin, adrenaline and sex hormones (structure and functions only)</td></tr>
<tr><td>Text books</td><td colspan="3">1. R. Gopalan, S. Sundaram, Allied Chemistry, Sultan Chand and Sons, 1995.</td></tr>
<tr><td>Reference books</td><td colspan="3">1. U. Sathyanarayana, Biochemistry, Books and Allied (p) Ltd, 1999.
2. B.R.Puri and L.R.Sharma, Principles of physical chemistry, Shoban Lal Nagin Chand and Co. 33rd ed., 1992.</td></tr>
<tr><td rowspan="6">Course outcome</td><td colspan="3">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>gain the knowledge on the handling of chemicals and errors in chemical analysis</td><td>K1</td></tr>
<tr><td>CO2</td><td>learn chemical bonding and hybridization</td><td>K2</td></tr>
<tr><td>CO3</td><td>learn the calculations of preparing standard solutions</td><td>K2</td></tr>
<tr><td>CO4</td><td>understand and appreciate the advanced concepts and rate equations in chemical kinetics.</td><td>K2</td></tr>
<tr><td>CO5</td><td>calculate the change in thermodynamic properties, equilibrium constants, partial molar quantities, chemical potential.</td><td>K3</td></tr>
</table>

Mapping of Cos with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	M	S	S	M	S	S
CO2	S	S	S	M	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	M	S	S	M	S	M	S	S	S
CO4	S	M	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	S	M	S	M	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOE311	BIOPROSPECTING OF PLANTS	L	T	P	C
ELECTIVE –I			4	-	-	3
Cognitive Level	K1: Recall K2: Understand					
Learning objective	• To understand the current practices in bioprospecting for conservation of biodiversity and genetic resources. • To know the basics and concepts of medicinal plants bioprospecting/ pharmaceutical bioprospecting. • To be familiar with the isolation and cultivation and bioactive compounds and their applications of marine bioresources • To learn the isolation of microbial metabolites products and its applications					
Unit I	**Bioprospecting**					
Definition, introduction, current practices in bioprospecting for conservation of Biodiversity and Genetic resources. Bioprospecting Act: Introduction, phases of bioprospecting, exemption to Act. Fields of bioprospecting						
Unit II	**Medicinal plants bioprospecting / pharmaceutical bioprospecting**					
for new drugs, assays in bioprospecting. Antioxidant assay – NO free radical scavenging assay, antigenotoxicity assay – MTT assay, antiviral activities of plants – SRB assay						
Unit III	**Marine bioprospecting**					
Sources of marine planktons and their bioprospecting, Isolation and cultivation of marine bioresources, isolation of marine yeast and its industrial applications, Bioactive chemicals from seaweeds and their applications						
Unit IV	**Microbial bioprospecting**					
Isolation of microbial metabolites and their bio-activity. Endophytic microbial products as antibiotics						
Unit V	**Economic crops**					
Origin, evolution, botany, cultivation and uses of food, fodder, fibers, oil yielding crops, wood and timber, non-wood forest products(NWFPS): Bamboos, gums, dyes, resins, fruits etc						
Text books	1. Arora, R.K. and Nayar, E.R. Wild relatives of crop plants in India, NBPGR Science MonographNo.7. 1984. 2. Baker, H.G. Plants and civilization. Ill Ed. (A. Wadsworth, Belmount). 1978. 3. Thakur, R.S., Puri, H.S. and Husain, A. Major medicinal plants of India, Central Institute of medicinal and aromatic plants, Lucknow. 1969. 4. Swaminathan, M.S. and Kocchar, S.L. (Es.) Plants and Society, MacMillan Publication Ltd., 1989.					
Reference books	1. Bole, P.V. and Vaghani, Y. Field guide to common Indian trees, Oxford University Press, Mumbai. 1986. 2. Kocchar, S.L. Economic Botany of the tropics, II Edn. MacMillan India Ltd.1998. 3. CSIR. The useful plants of India Publication and Information directorate, CSIR, New Delhi. 1986.					

E-References	1. https://www.researchgate.net/publication/264238213_Bioprospecting 2. https://www.researchgate.net/publication/266948374_Bioprospecting_medicinal_plants_for_antioxidant_components 3. https://www.researchgate.net/publication/335714642_Biodiversity_Bioprospection_with_Respect_to_Medicinal_Plants		
Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	comprehend the basic concepts of bioprospecting	**K2**
	CO2	understand the basics of medicinal plant bioprospecting	**K2**
	CO3	know the basics of marine bioprospecting and their applications	**K2**
	CO4	learn about the basics of microbial bioprospecting	**K2**
	CO5	Gain knowledge on the basics of forest products	**K1**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	M	S	S	M	S	S
CO2	S	S	S	M	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	M	S	S	M	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	S	M	S	M	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BOE312	BIODIVERSITY CONSERVATION	L	T	P	C
ELECTIVE –I			4	-	-	3

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To learn the biodiversity and geographical regions of India. • To know the conservation strategies of Biodiversity. • To learn the origin of crop plants. • To understand international agreements like MTO and GATT.
Unit I	**Biodiversity and conservation**
Categories of biodiversity – species concepts: keystone, flagship, dominant and co-dominant species. Biogeography: major terrestrial biomes, theory of island biogeography, biogeographical zones of India. Principles and approaches of conservation – *In situ*conservation: National parks, wildlife sanctuaries and biosphere reserves – *Ex situ* conservation: Botanical and herbal gardens, zoological parks and gene banks etc.	
Unit II	**Values of biodiversity**
Ecosystem services, screening plants for medicines, New agricultural and industrial products from the tropics. Origin of agricultural crops. Centres for origin of domesticated crops. Speciation- species area relationship and productivity- diversity relationship. Biodiversity hotspots	
Unit III	**Extinction and conservation**
Effect of global climatic change on natural communities. Causes for species extinction. IUCN Red list categories. Red data book. Impact of exotic species on native vegetation. GMOs and biosafety – Intellectual property rights- GATT,MTO, farmers and breeders rights. Biodiversity act -2002	
Unit IV	**Remote sensing**
Introduction-Analysis techniques-Digital image processing, role of remote sensing in biodiversity management, GIS and biodiversity, water security. Environment assessment and monitoring	
Unit V	**Information management for the conservation of biodiversity**
cryobiology, agro-ecology and *in situ* conservation of native crop diversity- International and indian initiatives of biodiversity conservation. Role of biotechnology in biodiversity conservation	
Text books	1. Gillson, L. Biodiversity Conservation and Environmental Change, Oxford University Press, Oxford.2015. 2. Poul V.I. Biodiversity: Issues, Impact, Remediations and Significance 1st Edition. V L Media Solution.2013. 3. Bawa K.S., Primack, R.V. and Oommen, M.A. Conservation biology: A Primer for South Asia, ATREE, Bangalore.2011.
Reference books	1. Smith T M Smith R L. Elements of ecology, 8th edition, Benjamin Cummins.2012 2. Sharma.B.K. Environmental Chemistry,Krishna Prakash Media (P) Ltd.2019. 3. Cunningham, M.P. and Cunningham, M.A. Principals of environmental

<table>
<tr><td></td><td colspan="3">science. Tata McGraw-Hill Publishing Company Ltd., New Delhi.2002.
4. Jeffries, M.J. and M.J. Jeffries. Biodiversity and Conservation, Routledge Taylor & Francis Group, UK.2005.</td></tr>
<tr><td><u>E-References</u></td><td colspan="3">1. http://ndl.iitkgp.ac.in/document/N2tzeE1aMMpUMm04b2l1VVZEdSsvKzNKdEtyMHI2RkVFQko0ak42amJMRT0
2. https://ncert.nic.in/textbook/pdf/lebo115.pdf
3. https://WWW.researchgate.net/publication/277124537_Biodiversity_Conservation_in_India</td></tr>
<tr><td rowspan="7">Course outcome</td><td colspan="3">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>gain knowledge on categories of biodiversity and conservation methods of biodiversity</td><td>K2</td></tr>
<tr><td>CO2</td><td>understand the centre’s of origin of crop plants and biodiversity hotspots</td><td>K2</td></tr>
<tr><td>CO3</td><td>find the causes of species extinction and the value of IUCN categories</td><td>K3</td></tr>
<tr><td>CO4</td><td>gain knowledge on the role of remote sensing in biodiversity management</td><td>K2</td></tr>
<tr><td>CO5</td><td>have idea about cryobiology and role of biotechnology in conservation</td><td>K1</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	POs					PSOs				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S	S	M	S
CO4	S	S	M	S	S	S	S	S	M	S
CO5	S	S	M	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BON311	FOREST BOTANY	L	T	P	C
NME - I			2	-	-	2

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objectives	• To understand the benefits of forest on mankind • To comprehend the forest resources and utilization • To know the role of forestry in Indian economy • To understand about forest law
Unit I	**Forest laws**
Necessity, general principles, Indian forest act 1927 and their amendment. Forest types of India-world. Forest influences and Protection-Social and community forestry - Role of forestry in Indian economy.	
Unit II	**Biodiversity conservation strategies**
Rare and endangered species - conservation strategies - exotics and its significance - tropical, temperate, evergreen, semi-evergreen, deciduous forests.	
Unit III	**Regeneration of forest**
Concept, scope and study of natural and artificial regeneration of forests. Social forest-Avenue plantation-Sacred plants-definition, importance of sacred trees.	
Unit IV	**Forest resources and utilization**
Forest products - timber, pulp wood, secondary timbers, non-timber forest products(NTFPs); Gums, resins, fibres, oil seeds, nuts, rubber, canes, bamboos, medicinal plants.	
Unit V	**Social and Agro forestry**
policy on Agro forestry and Social forestry-Tree production: seed orchards; Remote sensing and GIS in forestry.	
Text books	1. Mehta,T. A handbook of forest utilization, Periodical Expert book Agency, New Delhi.1981, 2. Dhiman, A.K, Sacred plants and their medicinal uses. Daya Publishing house, New Delhi.2003 3. Sagreiya, K.P. Forest and Forestry (Revised by S.S.Negi), National Book Trust, New Delhi.1994
Reference books	1.Tiwari, K.M, Social Forestry in India. Nataraj Publishers, Dehra Dun. 1983. 2. De Vere Burton L. Introduction to Forestry Science, Delmar Publishers, New York.2000
E-References	1.http://www.westbengalforest.gov.in/upload/development/cm4.pdf 2.http://herba.msu.ru/shipunov/school/biol_154/textbook/intro_botany.pdf

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	understand the importance of forest law and necessity	**K1**
CO2	know the different aspects of forestry	**K2**
CO3	learn about the forest resources and its	**K2**

		utilization	
	CO4	gain knowledge about the benefits of forest products to use health of human	**K3**
	CO5	learn and evaluate the tree production methods	**K2**

Mapping of COs with POs & PSOs:

CO	**POs**					**PSOs**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	S	M	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BON312	MUSHROOM CULTIVATION	L	T	P	C
NME - II			2	-	-	2

Cognitive Level	K2: Understand K3: Apply
Learning objective	• To have knowledge on general identification characteristics of mushroom • To know about the types of edible mushroom • To know about the mushroom cultivation techniques • To learn the skills of mushroom cultivation • To understand the medicinal value of mushroom
Unit I	**Introduction to mushrooms**
History and Scope of mushroom cultivation - classification of mushrooms - Edible and Poisonous Mushrooms-Vegetative characters	
Unit II	**Nutritional Values of Mushroom**
Nutritional and dietary values of mushrooms as source such as protein, carbohydrates, fibre, vitamins and minerals, therapeutic properties.Mushroom cultivation techniques- Spawn production - culture media preparation- production of pure culture, harvesting. Sterilization of substrates- composting technology, mushroom bed preparation.	
Unit III	**Cultivation of edible mushrooms**
Substrate preparation, growth, packing, and maintenance of suitable environmental conditions for Button mushroom (*Agaricus bisporus*) and Oyster mushroom (*Pleurotus sajorcaju*). Factors influencing mushroom cultivation and harvesting.	
Unit IV	**Pest Management**
Pest management and problems in cultivation - diseases, pests and nematodes, weed moulds and their management strategies. Post harvest technology- Preservation of mushrooms - freezing, dry freezing, drying, canning, quality assurance and entrepreneurship.	
Unit V	**Value added products**
Value added products of mushrooms and mushrooms recipes- mushroom Soup, mushroom omelet, mushroom biryani, mushroom pickle. Medicinal values of mushrooms.	
Text books	1. C.D.Thapa Dr. V. Prakasam Sh. Mohinder Singh. Mushroom culture. College of Horticulture, YSPUH&F Nauni, Solan (HP). https://www.agrimoon.com/wp-content/uploads/Mashroom-culture.pdf.2016. 2. Tripathi. Mushroom Cultivation, D.P Oxford & IBH Publishing Co. PVT.LTD, New Delhi. .2005 3. Pathak Yadav Gour. Mushroom Production and Processing Technology, Published by Agrobios (India). 2010 4. V.N. Pathak, Nagendra Yadav and Maneesha Gaur.Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi.· 2000.
Reference books	1.Singh, M., Vijay, B., and Kamal, S., and Wakchaure, G.C. Mushrooms:Cultivation, Marketing and Consumption. Directorate of Mushroom Research,Indian Council of Agricultural Research, Solan, India. 2011. 2.S.Kannaiyan and K.Ramasamy.A hand book of edible mushroom. Today &Tomorrows printers & publishers, New Delhi.1980.

E-References	1.https://www.researchgate.net/publication/316967767_Mushroom_Cultivation_Book_Preprint_version 2.https://content.kopykitab.com/ebooks/2013/11/2269/sample/sample_2269.pdf
Course outcome	Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	differentiate edible and poisonous mushrooms	**K3**
CO2	know about the production methods of Spawn	**K2**
CO3	explain the culturing methods of Mushrooms	**K3**
CO4	know the value added products of mushrooms and mushroom recipes	**K2**
CO5	uunderstand the medicinal values of mushrooms	**K2**

Mapping of COs with POs & PSOs:

CO	POs					PSOs				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	M
CO5	M	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark
No Correlation (N) - 0 mark

SEMESTER IV

Course Code	U21BOT41	MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS	L	T	P	C
CORE-VI			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply K6: Create
Learning objective	• To know the general morphological characters of Angiosperms • To know the different system of classification • To have knowledge on various aspects of plant nomenclature • To improve their skills to identify selected flowering plants with their salient features • To understand the economic importance of various groups of Angiosperms
Unit I	**General morphology of Angiosperms**
Stem, root, leaf and inflorescences. Modifications of stem, root, leaf and inflorescence.	
Unit II	**Taxonomy**
Scope and importance; Various Systems of Classification of Angiosperms – Artificial System (Linnaeus), Natural System (Bentham and Hooker), Phylogenetic System (Engler and Prantle) and Modern system (Taktajan's 1980).	
Unit III	**Botanical Nomenclature**
ICBN Principles, rules and recommendations, citation of names. Typification. Herbarium techniques and its uses. Cytotaxonomy, Chemotaxonomy, Numerical taxonomy and Molecular taxonomy.	
Unit IV	**Angiosperm Families**
General, vegetative and sexual characteristics of Rutaceace, Leguminosae, Cucurbitaceae, Apiaceae, Rubiaceae, Solanaceae, Amaranthaceae, Euphorbiaceae and their economic importance.	
Unit V	**Angiosperm Families**
General, vegetative and sexual characteristics of Asteraceae, Apcoynaceae, Acanthaceae, Verbenaceae, Orchidaceae, Liliaceae, Zingiberaceae, Poaceae and their economic importance.	
Text books	1. Parihar, N.S. An Introduction to Embryophyta, Pteridophytes. 5th Edition, Surjeet Publication, Delhi. 2019. 2. Sharma, O.P., Plant Taxonomy. Tata McGraw-Hill Education (Pvt) Limited, New Delhi. 2017. 3. Sharma, O.P. Pteridophyta. Tata McGraw-Hill Education, Delhi. 2012
Reference books	1. Vasishta, P.C., Sinha, A.K. and Anil Kumar. Botany for Degree Students, Pteridophyta. S. Chand &Company ltd., New Delhi. 2016. 2. Singh V and D.K.Jain, Taxonomy of angiosperms, Rastogi Publication, Meerut.2012. 3. Panday, B.P.Taxonomy of angiosperms, S. Chand & Co., (P) Ltd.2011. 4. Vasudevan Nair R. Taxonomy of Angiosperms, APH Publishing Corporation.2011. 5. Vardhana, R. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd., New Delhi.2010.

E-References	1. https://WWW.researchgate.net/publication/267510854_The_Flowering_Plants_Handbook 2. http://ndl.iitkgp.ac.in/document/ZTVLVjRMQ01OV01qNkVJcUx4V2xnTTJJSDhBMkJMU3RONnArZEZ4UHMMdz0 3. http://ndl.iitkgp.ac.in/document/QkszM1UzbMVYMDZtVG44VXE0OUtrVjQMek94UU5sTVpnUUhTQ0dGeVhVUT0		
Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	learn the general morphology of flowering plants	**K2**
	CO2	know different systems of classification of angiosperm plants	**K1**
	CO3	understand the nomenclatural rules and herbarium techniques	**K2**
	CO4	identify plant species with specific key characters	**K3**
	CO5	establish the skills to prepare description of plant species	**K6**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	M	M	S	S	S	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S
CO3	S	S	S	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	M	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Code</td><td>U21BOP43</td><td rowspan="2">TAXONOMY OF ANGIOSPERMS-</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">CORE VII</td><td>-</td><td>-</td><td>4</td><td>4</td></tr>
<tr><td>Cognitive Level</td><td colspan="6">K1: Recall K2: Understand K3: Apply</td></tr>
<tr><td>Learning objective</td><td colspan="6">• To learn the technical terms of Angiosperms
• To develop skills on identification of angiosperm plants through morphological characters
• To learn herbarium technique
• To have knowledge on sexual characters of selected species</td></tr>
<tr><td></td><td colspan="6">1. Detailed study on vegetative and sexual features of selected plant families;
Rutaceace, Leguminosae, Cucurbitaceae, Apiaceae, Rubiaceae, Solanaceae, Amaranthaceae, Euphorbiaceae, Asteraceae, Apcoynaceae, Acanthaceae, Verbenaceae, Orchidaceae, Liliaceae, Zingiberaceae, Poaceae
2.Two to three days to collect various angiosperm specimen
3.Visit to various botanical research institutes handling plant taxonomy research (BSI, JNTBGRI, IFGTB etc.)
4.Submission of 15 herbarium specimen and maintenance of record</td></tr>
<tr><td>Text books</td><td colspan="6">1. Sivakumar, K. Algae- A Practical Approach. MJP Publishers, Chennai, India. 2016.
2. Gupta, V.K., Tuohy, M.G., Ayyachamy, M., Turner, K.M. and O'Donovan, A. Laboratory Protocols in Fungal Biology: Current Methods in Fungal Biology. Springer, London, UK. 2013.
3. Chmielewski, J. G. and Krayesky, D. General Botany laboratory Manual. AuthorHouse, Bloomington, USA. 2013.</td></tr>
<tr><td>Reference books</td><td colspan="6">1. Bendre, A. M. A Text Book Of Practical Botany – 1. Rastogi Publications, Meerut, India. 2010.
2. McMahon, K., Levetin, E. and Reinsvold, R. Laboratory Manual for Applied Botany. McGraw-Hill Education, New York, USA. 2001.</td></tr>
<tr><td><u>E-References</u></td><td colspan="6">1.http://assets.vmou.ac.in/MBO10.pdf
2.http://ndl.iitkgp.ac.in/document/NXpzbzZQcHVvTFUrTGdYcTF0VlQxczVoUDhzOE9FOXg2MnN1bHhjSUNmOD0
3.https://WWW.researchgate.net/profile/Barry-Rosen/publication/235654691_Aquaculture_Manual/links/02bfe512518c53a0de000000/Aquaculture-Manual.pdf</td></tr>
<tr><td>Course outcome</td><td colspan="6">Upon completion of this course, the students will be able to
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>comprehend the morphological characters of angiosperm species</td><td>K1</td></tr>
<tr><td>CO2</td><td>understand the technique for the preparation of herbarium</td><td>K2</td></tr>
<tr><td>CO3</td><td>identify plant families by observing key characters</td><td>K3</td></tr>
</table></td></tr>
</table>

	CO4	understand the economic uses of selected families	**K2**
	CO5	illustrate species by analyzing the characteristic features	**K3**

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	M	S	S	S	S	S	S	S
CO2	S	S	M	S	S	S	S	M	S	S	S	M	S
CO3	S	S	M	S	S	M	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Code</td><td>U21CHA44</td><td rowspan="2">PRACTICAL CHEMISTRY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">ALLIED–IV</td><td>-</td><td>-</td><td>4</td><td>4</td></tr>
<tr><td>Cognitive Level</td><td colspan="6">K1: Recall K2: Understand K3: Apply</td></tr>
<tr><td>Learning objective</td><td colspan="6">• To enable the students to acquire knowledge in Organic Estimation
• To understand the basics of the course and gain knowledge in organic analysis</td></tr>
<tr><td></td><td colspan="6">Acidimetry and alkalimetry: Titration acids used: hydrochloric acid, sulphuric Standard solutions prepared: sodium carbonate, sodiumbicarbonate, oxalic acid.
Oxidation and reduction titration: Oxidising agents: Potassium permanganate (permanganimetry). Reducing agents: Ferrous sulphate, ferrous ammonium Sulphate, oxalic acid .
Standard solutions prepared: Ferrous Sulphate, ferrous ammonium Sulphate and oxalic acid.
Iodometry titrations: titrations of liberated iodine against sodium thiosulphate using acidified potassium permanganate, potassium dichromate and copper Sulphate solutions.
Standard solutions: potassium dichromate, copper sulphate.</td></tr>
<tr><td>Text books</td><td colspan="6">1. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
2. B.S. Furniss, A.J. Hannaford, P.W. G. Smith, A.R. Tatchell, Vogel’s Text Book of Practical Organic Chemistry. 5th Edn., Pearson Education, 2005.</td></tr>
<tr><td>Reference books</td><td colspan="6">1. N.S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Lab manual, S. Viswanathan Co. Pvt., 1998.
2. Practical Chemistry by A.O. Thomas, Scientific Book Centre, Cannanore, 2003.
3. Basic Principles of Practical Chemistry, V. Venkateswaran, R. Veeraswamy, A. R. Kulandaivelu, Sultan Chand & Sons, New Delhi, 2nd Edn., 2004.</td></tr>
<tr><td>Course outcome</td><td colspan="6">Upon completion of this course, the students will be able to
<table><tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr><tr><td>CO1</td><td>learn the concept of Titration methods and various titrations.</td><td>K1</td></tr><tr><td>CO2</td><td>understand the acidimetry and alkalimetry titrations</td><td>K2</td></tr><tr><td>CO3</td><td>learn the preparation of standard solutions</td><td>K2</td></tr><tr><td>CO4</td><td>learn the calculations of molarity, molality and normality of the solutions</td><td>K2</td></tr><tr><td>CO5</td><td>understand the concept of iodometry titrations</td><td>K3</td></tr></table></td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	M	S	M	S	S	M	S	S
CO2	S	S	S	M	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	M	S	S	M	S	S	S	S	S
CO4	S	M	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	S	M	M	M	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

COURSE CODE	U21BOE421	WOOD TECHNOLOGY	L	T	P	C
CORE I			3	-	-	3

Cognitive Level	K2: Understand K3: Apply
Learning objective	• To comprehend the basic concepts and principles of wood technology • To understand the Microscopic structure of wood, chemical composition of wood. • To learn in detail about the Mechanical properties of wood and Wood preservation • To understand the use and scope of improved wood-Compressed wood, Chemically modified wood and densified wood
Unit I	**Microscopic structure of wood**
Vessels, Tyloses, Tracheids, Fibres, Wood parenchyma - Wood rays, Grain and Texture. Organization of the cell wall - Microfibrils - Orientation, cell wall pit – structure. Detailed anatomical structure of a few Indian hard woods, bamboos and canes.	
Unit II	**Chemical Composition of Wood**
Chemical composition of wood, structure and properties of Cellulose - Hemicellulose - Wood polysaccharides and Lignin. Distribution of chemical constituents in wood. Physical properties of wood - Colour - Lustre - Fluorescence - Odour and Weight	
Unit III	**Mechanical properties of wood**
Bending properties - Composition - Hardness - Shear. Properties of Dicot and monocot wood. Growth rings in wood - Annual rings, early wood and late wood, soft wood and hard wood, pycnoxylic and manoxylic wood. Dendro - chronology	
Unit IV	**Wood Preservation**
Wood preservation - Non-pressure processes - Pressure process - Chemical processing of wood - Commercial wood species and identification, Synthetic woods, Marine plywood, Fuel wood, pulp and paper making woods, matchstick wood. Economic importance of pulp and wood	
Unit V	**Wood Preservation**
Compressed wood, Impregnated wood, Compregnated wood, Heat stabilized wood, Chemically modified wood, densified wood. Uses and scope.	
Text books	1. Vaux, H. J. 1952. Textbook of Wood Technology. Vol. II. McGraw Hill, New York. 2. Brown .1981. Textbook of Wood Technology. Tata McGraw-Hill, New Delhi. 3. Brown, H. P. (1985). Manual of Indian Wood Technology. International Books and Periodicals Supply Service, New Delhi.

<table>
<tr><td>Reference books</td><td>1. Chowdhury, K. A. and Ghose, S. S. (1958). Indian Woods. Publication Division, Government of India, New Delhi
2. Franz, F. P., Kollmann and Wilfred A. Cote, Jr. 1968. Principles of Wood Science and Technology. Vol. I: Solid Wood. Springer-Verlag, New York.
3. Franz, F. P. Kollmann .1988. Wood Science and Technology. Vol. I and II. Springer Verlag, New York.
4. Pearson and Brown .1984. Commercial Timbers of India. Government of India Publication, New Delhi.
5. Wadoo MS. 1992. Utilization of Forest Resources. IDRIS Publ.
6. Wilson, K and White, D.J.B.1986. The Anatomy of Wood: Its Diversity and Variability. Stobart and son Ltd</td></tr>
<tr><td><u>E-References</u></td><td>1. https://is.muni.cz/th/gdxwb/Textbook_glossary_final.pdf
2. https://files.eric.ed.gov/fulltext/ED099473.pdf</td></tr>
<tr><td>Course outcome</td><td>Upon completion of this course, the students will be able to
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>understand the general anatomical features of wood</td><td>K2</td></tr>
<tr><td>CO2</td><td>enumerate the physical and chemical properties of wood</td><td>K2</td></tr>
<tr><td>CO3</td><td>acquire a deep knowledge on mechanical properties of wood</td><td>K2</td></tr>
<tr><td>CO4</td><td>learn and apply the wood preservation techniques</td><td>K3</td></tr>
<tr><td>CO5</td><td>have a clear idea about uses and scope of various wood</td><td>K2</td></tr>
</table></td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	PROGRAMME OUTCOMES (PO)								PROGRAMME SPECIFIC OUTCOMES (PSO)				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	S	S	S	S	M	M	M	S
CO2	S	S	S	S	M	S	S	S	S	M	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	S	S	M	S	M	S	S	M	S
CO5	S	S	M	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) -1 mark No Correlation (N) - 0 mark

COURSE CODE	U21BOE422	SILVI CULTURE	L	T	P	C
CORE I			3	-	-	3

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To acquire knowledge on composition and structure of forest. • To know the techniques in establishment, growth and quality of forest vegetation. • To understand the role of forests in environmental sustenance. • To learn about the manipulations in management and establishment of forest vegetation.
Unit I	**Principles of silviculture**
Definition, objectives and scope of Silviculture. Status of forests in India and their role. General Silvicultural Principles : methods of propagation, grafting techniques; site factors; nursery and planting techniques-nursery beds, polybags and maintenance, water budgeting, grading and hardening of seedlings; special approaches; establishment and tending.	
Unit II	**Types of Trees**
Introduction to trees and their general classification under different forest types. Important tree families and their peculiar characters. Types of trees and canopy structure. Coniferous and broad leaved tree species. Trees in tropical, sub-tropica, temperate and alpine regions	
Unit III	**Forest soils**
Forests Soils, classification, factors affecting soil formation; physical, chemical and biological properties. Soil conservation - definition, causes for erosion; types - wind and water erosion; conservation and management of eroded soils/areas, wind breaks, shelter belts; sand dunes; Role of forests in conserving soils.	
Unit IV	**Forest Management**
Forest Management and Management Systems : Objective and principles; techniques; stand structure and dynamics, sustained yield relation; rotation, normal forest, growing stock; regulation of yield; management of forest plantations, commercial forests, forest cover monitoring. Approaches viz., (i) site-specific planning, (ii) strategic planning, (iii) Approval, sanction and expenditure, (iv) Monitoring (v) Reporting and governance.	
Unit V	**Injuries and Pest**
Injuries to forest - abiotic and biotic, destructive agencies, insect-pests and disease. Role of afforestation and forest regeneration in absorption of CO2. effect of wild animals on forest regeneration, human impacts; encroachment, poaching, grazing, live fencing, shifting cultivation and control.	
Text books	1. Aranya Bhavan, Basu Ray Chaudhuri, N K Pandey**,** Chairman, SPMU, Forest Department. General silviculture, 2016. Published by Development Circle,Directorate of Forests, Government of West Bengal. 2. Shiva, M.P. A Handbook of Systematic Botany, 1986.IBD Publisher, Dehradun. Sagreiya, K.P. Forests and Forestry, 1997. National Book Trust India. 3. Stephen F, Textbook of silviculture, Copy Right 2021, Austin state university, Nacogdoches, Texes.

<table>
<tr><td>Reference books</td><td>1. Dwivedi, A. P. 1992. Principles and Practice of Indian Silviculture, Surya Publication, 420p.
2. Khanna, L. S. 1984.Principles and Practice of Silviculture, Khanna Bhandu, Dehra Dun. P. 476.
3. Ram Prakash and L.S. Khanna. 1991. Theory and Practice of Silvicultural systems. International Book Distributors, Dehra Dun. 298p.
4. Dwivedi, A.P. 1993. A Text Book of Silviculture, International Book Distributors, Dehradun.</td></tr>
<tr><td><u>E-References</u></td><td>https://www.uou.ac.in/sites/default/files/slm/FR-01.pdf
https://www.ggu.ac.in/download/Syllabus/B.Sc.%20Forestry%20New%20CBCS%2023.09.19.pdf
https://goalclaw.xyz/?asin=1119270952
https://royalvidslog.blogspot.com/2019/01/download-ecology-and-silviculture-of.html</td></tr>
<tr><td>Course outcome</td><td>Upon completion of this course, the students will be able to
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>understand the general features and classification of algae</td><td>K2</td></tr>
<tr><td>CO2</td><td>enumerate the life cycle of major classes of algae and their economic importance</td><td>K2</td></tr>
<tr><td>CO3</td><td>acquire a deep knowledge on principles of fungi classification to apply in the field</td><td>K3</td></tr>
<tr><td>CO4</td><td>know the life cycle of major classes of fungi and their economic importance</td><td>K2</td></tr>
<tr><td>CO5</td><td>have a clear idea about lichens including their economic importance</td><td>K1</td></tr>
</table></td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	PROGRAMME OUTCOMES (PO)								PROGRAMME SPECIFIC OUTCOMES (PSO)				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	S	S	S	S	M	M	M	S
CO2	S	S	S	S	M	S	S	S	S	M	S	S	S
CO3	M	S	S	S	S	S	S	S	S	S	S	M	M
CO4	S	S	S	M	S	S	M	S	M	S	S	M	S
CO5	S	S	M	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) -1 mark No Correlation (N) - 0 mark

Course Code	U21BON421	HORTICULTURE	L	T	P	C
NME - II			2	-	-	2

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To learn the basic of horticulture technique • To know the commercial importance of horticulture • To understand the different composting methods • To know the role of bonsai in plant propagation
Unit I	**Objectives**
Introduction to horticulture; nature and scope. Objectives of horticulture.	
Unit II	**Principles of Horticulture**
Principles of land scape gardening. Gardening: ornamental and indoor- Gardens kids gardens and vertical and roof top- gardens. Garden adornments. Role of orchids in gardening.	
Unit III	**Composting**
aerobic, anaerobic and vermicomposting; Mist chamber, green house and glass house. Effect of pollution on indoor plants. Commercial products of horticulture. Olericulture: Home and market - gardening and truck farming.	
Unit IV	**Floriculture**
Introduction, nature and scope. Fresh and dry flower arrangements. production of cut flowers, foliage potted plants and bedding plants. Future prospects of floriculture.	
Unit V	**Bonsai**
making and selection of plants for bonsai. Physical control of plant growth in bonsai preparation. Preparation of terrarium, Aquaponics and arbori culture. Components of high-tech farming	
Text books	1. Adams, C.R. and M. P. Early. Principles of horticulture. Butterworth – Heinemam, Oxford University Press. 2004. 2. Bansil. P.C. Horticulture in India. CBS Publishers and Distributors, New Delhi. 2008.
Reference books	1. Kumar, N. Introduction to Horticulture, Rajalakshmi Publication, Nagercoil. 2001. 2. Bhattacharjee.S.K. Amenity Horticulture, Biotechnology and Postharvest technology. Pointer publishers. Jaipur. 2006.
E-References	1. https://agrimoon.com/fundamentals-of-horticultur-pdf-book/ 2. https://www.iaritoppers.com/2019/06/Principles-Of-Plant-Breeding-ICAR-Ecourse-Free-PDF-Book-Download-e-krishi-shiksha.html

	Upon completion of this course, the students will be able to		
Course outcome	**CO**	**Course Outcomes**	**Knowledge Level**
	CO1	understand the importance of horticulture technique for commercial production	**K2**
	CO2	describe the importance of gardening and types of gardens	**K3**
	CO3	know indoor and outdoor plants and their propagation	**K1**
	CO4	know the economic value of floriculture	**K1**
	CO5	make and selection of plants for bonsai	**K3**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	M	S	S	S	S	M	S	S	S	M	S
CO2	S	S	M	S	S	M	M	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S	M	S	S	S	M	S
CO4	S	S	M	S	S	M	S	S	S	S	S	M	S
CO5	S	S	M	S	S	S	S	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BON422	POMOLOGY	L	T	P	C
NME-II			2	-	-	2

Cognitive Level	K1: Recall K2: Understand
Learning objective	• To gain knowledge on basics of pomology • To learn the cultivation techniques of fruit bearing plants • To acquire knowledge to establish commercial orchards thereby become successful entrepreneur
Unit I	**Introduction**
Importance, history, origin, area and distribution of fruit varieties and their classification. Climatic and soil requirements, propagation, root stocks and problem of multiplication	
Unit II	**Establishment of commercial orchards**
planting and aftercare. Nutrition management, nutritional disorders, training, pruning, irrigation, weed control and intercropping. Vegetative and reproductive phases, fruit set and fruiting.	
Unit III	**Disease Management**
Techniques for high productivity, Physiological disorders causes and remedies, Pest, diseases and their management, Post-harvest handling.	
Unit IV	**Classification of fruit species**
Description, classification and identification of fruit species and varieties with special reference to important fruits grown in India. Botanical description of families, genera and species covering various tropical, sub-tropical and temperate fruits and nuts upto varietal level; Cultivation fruit crops– Pineapple, Grapes and Guva - spacing, irrigation, field disease control.	
Unit V	**Systematic Pomology and its significance**
Industrial and export potential, Agri. Export Zones (AEZ) and industrial supports of the following crops Mango, Banana, Papaya, Sapota, Pineapple, Jackfruit, Annonaceous crops, Jamun, Tamarind, Avacado, Passion fruit, Mangosteen, Carambola, Bilimbi.	
Text Books	1. Bal, J.S. Fruit Production, Kalyani Pubulishers, New Delhi Bose. 1977. 2. Singh, Amar, Fruit Physiology land Production, Kalyani Publishers, New Delhi.1980. 3. Chattopadhyay, T.K. (ed). A Textbook on Pomology vol. II & III, Kalyani Publishers, Calcutta.1998.
Reference Books	1. Production Technology Of Fruit Crops,Tamil Nadu Agricultural University,2017, 2. Mitra, S.K., Rathore D.S., and Bose, T.K, Temperate fruits, Horticulture and Aallied Publishers, Kolkatta.1991. 3. TS.K.Mitra and D. Sanyal (Ed). Fruits-Tropical and SubTropical, Naya Udyog, Calcutta. 2001.
E-References	1. http://fvzqvwfwtbhuy.servehttp.com/pomology-book-pdf.html 2. http://cbseacademic.nic.in/web_material/publication/cbse/19Pomology-pdf 3. https://agrimoon.com/production-technology-of-fruit-crops-pdf-book/

	Upon completion of this course, the students will be able to		
Course outcome	**CO**	**Course Outcomes**	**Knowledge Level**
	CO1	understand the scope and importance of Indian medicinal system	**K2**
	CO2	know the uses of traditional medicinal plants	**K1**
	CO3	learn the processing and preparation of Indian drugs	**K2**
	CO4	know the value added products obtained from medicinal plants K3	**K1**
	CO5	understand the preparation of herbal formulations	**K2**

Mapping of COs with POs & PSOs:

CO	**POs**					**PSOs**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

SEMESTER V

Course Code	U21BOT51	GENETICS AND EVOLUTION	L	T	P	C
CORE -VIII			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To understand the basics of Mendelian genetics • To learn the genetic recombination and its effects • To learn the significance of plant genetic recombination • To comprehend the evolution and equilibrium concepts
Unit I	**Mendelian inheritance**
Laws of dominance, segregation and independent assortment. Monohybrid and Dihybrid Ratios. Incomplete dominance and co-dominance, lethal factor, complementary factor and epistasis (dominant), multiple alleles with reference to ABO blood group in man.	
Unit II	**Recombination**
Linkage and crossing over. Mapping of genes on the chromosomes. Cytoplasmic inheritance. Sex linked inheritance and diseases.	
Unit III	**Sex determination**
Mechanism of sex determination and sex determination in plants. Chromosomal aberrations; changes in chromosome structure, number, behavior and their genetic effects. Polyploidy and its types.	
Unit IV	**Gene Transfer & Microbial genetics**
Structure of Ti plasmid and applications of plant genetic recombination. Human Genome Project. Microbial genetics with reference to bacterial recombination: Transformation, transduction and conjugation**.**	
Unit V	**Evolution**
Introduction, evidences of evolution, Brief account of theories of evolution. Species concept, Speciation; population genetics and Hardy-Weinberg Equilibrium	
Text books	1. Fundamentals of Genetics by B.D.Singh - kalyani Publishers .January 2014. 2. Genetics By Veer Bala Rastogi –March 2019 MEDTECK 3. Boston. 3 Pierce, B. A. Genetics: A conceptual approach. 4 th ed. W H Freeman and Company Ltd. 2008.
Reference books	1. Verma, P.S. and Agarwal, V.K. Genetics. S.Chand Publications, New Delhi. 2012. 2. Pankaj Kumar. A textbook of Genetics. Lalitha Publishers, India. 2021. 3. Veer Bala Rastogi . Genetics, Medtech Publishers. Delhi. 2019. 4. Gardner, E. J., Simmons, M.J. and D. P. Snustad, Principles of Genetics. Miley India (Pvt.) Ltd. New Delhi. 2018. 5. Hartl, D.L and Jones E. W. Genetic analysis of Genes and Genomes. 2nd ed. Jones and Bartlett Pub, 2017. 6. Neil Ingram, Sylvia Hixson Andrews and Jane still, Evolution, Oxford Biology Primers, Paperback, 2021.

<table>
<tr><td>E-References</td><td colspan="3">1. http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvMmpzQ2loMHQvQUpTNDZXM2pZS1l6bFFuR0tnR0F6TE14RFJFYlNMNFI1c3ZYMMgrMg
2. http://ndl.iitkgp.ac.in/document/cGlkTnFCS2ZRN09ONGxmVjN4QUMyUT09
3. http://ndl.iitkgp.ac.in/document/K2F6YjJpSGxxVMx0MmxoM25GOUJXQzRnY2hqS1p2Mmg4Yi9QL2ZDRzBNaz0
4. https://epgp.inflibnet.ac.in/Home/VieMSubject?catid=4
5. https://teach.genetics.utah.edu/content/dna/tx-tl_teacher-guide.pdf
6. https://global.oup.com/ukhe/disciplines/bioscience/evolution/?cc=in&lang=en&</td></tr>
<tr><td rowspan="7">Course outcome</td><td colspan="3">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>have a thorough understanding on Mendelian genetics and expression of alleles</td><td>K1</td></tr>
<tr><td>CO2</td><td>comprehend the recombination of eukaryotic genome and diseases linked with sex chromosomes</td><td>K2</td></tr>
<tr><td>CO3</td><td>attain knowledge on determination of sex and abnormalities of chromosomes K2</td><td>K2</td></tr>
<tr><td>CO4</td><td>depict and explain plasmids and recombination phenomenon</td><td>K2</td></tr>
<tr><td>CO5</td><td>relate population genetics with process of evolution</td><td>K3</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	S	S	S	S	M	S
CO2	S	S	M	S	S	M	S	S	S	S	S	M	S
CO3	S	S	M	S	S	S	M	S	S	S	S	M	S
CO4	S	S	M	S	S	M	S	S	S	S	S	M	S
CO5	S	S	M	S	S	S	M	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOT52	PLANT PHYSIOLOGY	L	T	P	C
CORE-IX			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To learn the plant water absorption process • To obtain basic knowledge on photosynthetic and respiratory process • To study the importance of plant growth hormone, seed germination and fruiting physiological process
Unit I	**Absorption of water and minerals, transpiration**
Types, mechanism of stomatal movement. Factors affecting transpiration. Gas exchange, guttation. Mineral nutrients: Role of macro elements (N, P, K, Mg, Ca) and micro elements (Zn, Mo, B).	
Unit II	**Photosynthesis**
Photosynthetic pigments-red drop phenomena, Emerson's enhancement effect and electron transport system (Cyclic and Non-cyclic) and photophosporylation. Calvin cycle (C_3) and C_4 (Hatch and Slack Pathway) and Crassulacean acid metabolism (CAM).	
Unit III	**Respiration**
Aerobic and anaerobic respiration. Glycolysis, Kreb's cycle, electron transport system, oxidative phosporylation.	
Unit IV	**Nitrogen fixation**
Biological nitrogen fixation; symbiotic and asymbiotic N_2 fixation, symbionts, mechanism of biological N_2 fixation. Plant growth regulators; practical applications, physiological role of auxins, gibberellins, cytokinins, ethylene and abscissic acid.	
Unit V	**Seed dormancy**
Causes and methods to break seed dormancy - Physiology of seed germination. Fruiting- mechanism of fruiting – hormonal control of fruiting – climacteric rise .	
Text books	1. Arunkumar.V. Plant Biochemistry, A.P.H Publisheing, New Delhi,2010. 2. Jain, V.K. Fundamentals of Plant Physiology. S.Chand and co., New Delhi. 2017. 3. S.K.Sinha.A Textbook of Plant Physiology.Centrum Press.2013. 4. S.N.Pandey & B.K.Sinha, Plant Physiology. Vikas Publishing.2010 5. Gill, D.S. Plant Physiology, S.Chand and co., New Delhi. 2000.
Reference books	1. R.K. urray, D.K. Granner and V.M,Rodwell. Harper's Illustrated Biochemistry, 27th Edition. The McGraw-Hill companies, Inc.2009. 2. hilip stewart and Sabine Globig, Plant Physiology, Apple Academic Press.2021. 3. Lambers**,** Hans, Oliveira**,** Rafael S. Plant Physiological Ecology, Springer. 2019. 4. Lincoln Taiz, Eduardo Zeiger , Ian Max Møller, Angus Murphy .Fundamentals of Plant Physiology Paperback. Sinauer Associates Inc. 2018.

E-References	1. http://ndl.iitkgp.ac.in/document/djN4cHJoaFBISzk4NXpiOHZ3ckE4Zz09 2. http://ndl.iitkgp.ac.in/document/djN4cHJoaFBISzk4NXpiOHZ3ckE4Zz09 3. http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvMmpzQ2loVUhyU29EcE5jMMVNMUh1Mm13MXp6MUhHNGpFMjlMK2FJNmdNNlYMS1I1Tg 4. http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvMmpzQ2loMkNPL1RGQjdEVkorcjJaU0dkTkJqU0VYbEJZUnlvRDQxU2EMdVdoSMZpMQ 5. http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvMmpzQ2loVm9lMXVCL1g4MFdpakIrUnQyUmVRZVpiNTRnMnFaUTRBcHl0MkREM1BkZM

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	understand the concepts of water and mineral absorption	**K2**
CO2	describe the mechanism of photosynthesis	**K3**
CO3	know the plant respiratory process and energy metabolism for respiration	**K3**
CO4	find the importance of nitrogen to plant and fixation of nitrogen and role of growth hormone	**K1**
CO5	get clear understanding of seed germination and fruiting mechanism	**K2**

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	S	S	S	S	M	S
CO2	S	S	M	S	S	S	M	S	S	S	S	M	S
CO3	S	S	M	S	S	M	S	M	S	S	S	M	S
CO4	S	S	M	S	S	S	S	S	S	S	S	M	S
CO5	S	S	M	S	S	M	M	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOT53	PLANT BIOCHEMISTRY	L	T	P	C
CORE X			5	-	-	4
Cognitive Level	K1: Recall K2: Understand					
Learning objective	• To understand the basic fundamentals of biochemistry. • To learn about the general properties of carbohydrates, proteins and lipids its role in the living beings. • To understand the major role of nucleic acids in life processes. • To understand the chemistry of biomolecules and its significance					
Unit I	**Chemical Bonds & carbohydrate**					
Basic concepts of atoms and molecules. Isomerism. Primary chemical bonds – covalent bond and hydrogen bond. Acid-base theories, pH, Buffers, oxidation –reduction. Carbohydrates: Classification, structure and properties of monosaccharides, disaccharides, oligosaccharides and polysaccharides.						
Unit II	**Amino acids and Proteins**					
classification amino acids, physical properties of amino acids - Solubility, electrochemical properties, fundamental role of proteins in life - Composition of proteins - General properties of proteins - classification of the proteins on the basis of their biological functions- Criteria for the purity of proteins.						
Unit III	**Lipids**					
Fatty acids - Classification, Hydroxy and keto derivatives and cyclic fatty acids - physical properties of fatty Acids - solubility, boiling point, absorption, Fats - Fatty acids esters of glycerol - Chemical structures. Physical and chemical properties of fats – Waxes, phospholipids, non-phosphorylated lipids and steroids.						
Unit IV	**Nucleic Acids**					
fundamental role of nucleic acids in life processes- DNA and its types, RNA – types, functions. Structure of bases, nucleosides and nucleotides - bond linking the various bases. Isolation, separation and purification of plant DNA						
Unit V	**Vitamins**					
Discovery and physico- chemical properties of vitamins, fat-soluble vitamins, vitamin A, D, E and K - Water soluble vitamins, vitamin B complex, vitamin C – Brief mention of source and physiological role.						
TextBooks	1. T. Devasena, Biomolecules by MJP Publishers,2011 2. Arihant, Experts Handbook of Chemistry, Arihant Publications,2020 3. P.K.Gupta , Biomolecules and cell Biology, Rastogi Publication, 2018					
References	1. Lehninger, A.L , Biochemistry, 6th edition, Kalyani publisher, 2012. 2. Lubert Stryer, Biochemistry, 7th edition, W.H. Freeman and Company, New York, 2012 3. J.M. Berg, J.L. Tymoczko and L. Stryer, Biochemistry, W.H. Freeman, 2015 4. Mohan P Arora, Biomolecules, Himalaya publishing House, 2012 5. S. Azhagu Madhavan, P. Vinotha, V. Uma, Chemistry of Biomolecules, Notion Press, 2020					
E-References Link	1.https://www.mdpi.com/journal/biomolecules 2.https://ncert.nic.in/textbook/pdf/lech205.pdf					

	3. https://www2.nau.edu/lrm22/lessons/biomolecules/biomolecules.html 4. https://opentextbc.ca/biology/chapter/2-3-biological-molecules/

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	understand the foundation of life and structure and functions of carbohydrates	K1
CO2	attain knowledge in structure, properties, role and classification of amino acids and proteins	K2
CO3	know the structure, properties, role and classification of Lipids and fatty acids	K2
CO4	learn the types of nucleic acids and its structure and biological importance.	K2
CO5	gain knowledge on various types , functions, requirements and deficiency diseases of vitamins	K2

Mapping of CO with PO & PSO:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	M	M	S	S	S	M	S
CO2	S	M	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course Code	U21BOT54	PLANT ANATOMY AND EMBRYOLOGY	L	T	P	C
CORE XI			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To develop skill to distinguish monocot and dicot plants • To understand the structure of simple and complex tissues • To learn the internal organization of different parts of plants • To know the process of fertilization in plants
Unit I	**Simple tissue**
Structure, occurrence and function of Parenchyma, Collenchyma, Sclerenchyma. Complex tissues; Definition, Structure, Origin and function of Xylem & Phloem, Tracheary elements and Sieve elements.	
Unit II	**Secretory tissues**
Glandular trichomes, nectaries, hydathodes, schizogenous and lysigenous cavity, laticifers. Types of Vascular bundles (Conjoint, Collateral, Bi-collateral, Open, Closed, Radial, Concentric, amphicribal and amphivasal.) Stomatal types.	
Unit III	**Meristems**
Classification, distribution, structure, function. Meristerm Theories: Tunica – Corpus and Quiescent Centre. Root apex: Histogen theory & Korper-Kappe theory.	
Unit IV	**Anatomy of stem and Root**
Primary structure of monocot stem and root. Primary and secondary structure of dicot stem and root. Anomalous secondary growth in dicot stems *Boerhavia* and *Nyctanthes* and monocot stem; *Dracaena*. Structure of Monocot and dicot leaves. Brief account on Nodal anatomy	
Unit V	**Embryo Anatomy**
Structure of mature anther and ovule - double fertilization: Embryo: types of embryogenesis in monocot and dicot embryos. Polyembryony. Structure and types of Endosperm	
Text books	1. Singh.V.Text Book of Botany: Anatomy and Embryology of Angiosperms .Rastogi Publication.2017. 2. Pandey, B.P. Plant Anatomy. Chand & Co Ltd.2012. 3. Singh,Pande and Jain.Text Book of Botany:Angiosperms, Rajpal and sons Publishing. 2010 4. Vashista, P.C.. A text Book of plant Anatomy, S.Negin & Co.2001.
Reference books	1. Dr. K. N. Dhumal, Dr. H. S. Patil , Dr. B. N. Zaware , Dr. B. P. Shinde /,Dr. K. S. Bhosale.A Book of Plant Anatomy & Embryology and Plant Biotechnology. Edition Paperback. Nirali Prakashan.2019. 2. Bhojwani, S..S and Bhatnagar, S.P. The Embryology of Angiosperms,6th Edition Vikas Publishing House Pvt. Ltd., New Delhi. 2015. 3. Vimala singh and Alok Abhisek, **,**Plant Embryology and Experimental Biology**,** Educational Publishers and Distributors 291, Bank Enclave, Laxmi Nagar, Delhi – 2019 4. Esau, K. Plant Anatomy, Miley Eastern Private Limited. New Delhi.2006

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2. http://ndl.iitkgp.ac.in/document/ZMsMc3RMeFNtMDhVVk1vV2x1NTkMZjM4RmprYys5cHQrQ3hveDcyOHlRdz0
3. http://ndl.iitkgp.ac.in/document/MHdqSlQ2MDR4UXhKcDNQTXI0akFXdTdlY1ZuMMxER2tkV2VkREg5QTVTQT0
4. http://ndl.iitkgp.ac.in/document/Sm0rdEpQN1Y1YU1UT0pEa3VvdktzY2xIUkM0MmFQVnlhbTQMV2V4Qjd0QT0</td></tr>
<tr><td>Course outcome</td><td>Upon completion of this course, the students will be able to
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>attain knowledge on different types and functions of simple and complex tissues</td><td>K2</td></tr>
<tr><td>CO2</td><td>understand the arrangement of vascular bundles and types of stomata</td><td>K2</td></tr>
<tr><td>CO3</td><td>describe classification and theories pertaining to meristematic tissues</td><td>K1</td></tr>
<tr><td>CO4</td><td>have clear picture on the internal structure of plant parts like leaf, stem and roots.</td><td>K2</td></tr>
<tr><td>CO5</td><td>explain reproductive structures and fertilization process in flowering plants</td><td>K3</td></tr>
</table></td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	M	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	S	S	S	S	M	S
CO3	S	S	M	S	S	M	S	M	S	S	S	M	S
CO4	S	S	M	S	S	S	S	M	S	S	S	M	S
CO5	S	S	M	S	S	M	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

<table>
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<tr><td colspan="2">CORE-XII</td><td>-</td><td>-</td><td>5</td><td>4</td></tr>
<tr><td>Cognitive Level</td><td colspan="6">K1: Recall K2: Understand K3: Apply</td></tr>
<tr><td>Learning objective</td><td colspan="6">• To acquire the knowledge on mendelian traits and pedigree analysis
• To analysis the qualitative and quantitative analysis of biomolecules
• To understand the transpiration rate and osmotic potential
• To know the methods used for the sectioning and mounting of plant parts
• To differentiate monocot and dicot plants anatomically</td></tr>
<tr><td></td><td colspan="6">Genetics
1. Observation and record of simple mendelian traits
2. Pedigree analysis – chart preparation
3 Problems based on gene frequency – Hardy Weinberg Law

Plant Physiology and Biochemistry
1.Determination of osmotic potential of plant cell sap plasmolytic method
2.Demonstration of transpiration by Ganong’s photometer
3.Osmosis by potato osmoscope experiment
4.Preparation of buffers; phosphate and acetate buffer
5. Qualitative test for Carbohydrates
6.Qualitative test for lipids
7.Qualitative test for amino acids and protein
8.Separation of amino acids and sugars by thin layer chromatography or paper chromatography

Plant Anatomy and Embryology
1.Study of simple tissues-Parenchyma, chlorenchyma, collenchyma and sclerenchyma
2. Internal structure of Dicot stem, Dicot root, Monocot Stem and Monocot root.
3. Anomalous secondary structures in Boerhaavia and Nyctanthes
4. Demonstration of pollen viability test
5. Structure of Anther and Ovule
6. Structure of dicot embryo</td></tr>
<tr><td>Text books</td><td colspan="6">1. Singh, R. J. Plant Cytogenetics. CRC press, US. 2016.
2. Jackson, S. A., Kianian, S. F., Hossain, K. G., and Walling, J. G. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York, NY. 2012.
3. Maheswari, P. An introduction to the Embryology of Angiosperms. TATA McGraw-Hill Publishing Co., Ltd., New Delhi.1976
4. PatkiL.R,Bhalchandra B.L, JeevajiI.H. An introduction to Micro technique,S.Chand.1987.
5. Johansen, D.A. Plant Microtechnique, TATA McGraw Hill Book Co., Ins., New delhi.1998.</td></tr>
<tr><td>Reference books</td><td colspan="6">1. Bharadwaj, D. N. Breeding of field crops (pp. 1-23). Agrobios (India). 2012.
Bala, M., Gupta, S., Gupta, N. K., and Sangha, M. K. Practicals in plant physiology and biochemistry. Scientific Publishers (India). 2013.</td></tr>
</table>

E-References	1. https://epgp.inflibnet.ac.in/Home/VieMSubject?catid=4 2. http://ndl.iitkgp.ac.in/document/djN4cHJoaFBISzk4NXpiOHZ3ckE4Zz09 3. http://ndl.iitkgp.ac.in/document/Sm0rdEpQN1Y1YU1UT0pEa3VvdktzY2xIUkM0MmFQVnlhbTQMV2V4Qjd0QT0 4. https://WWW.researchgate.net/publication/309118583_Techniques_in_Anatomy_Cytology_and_Histochemistry_of_Plants#fullTextFileContent		
Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	explain the pedigree analysis	**K3**
	CO2	understand the osmotic potential of plant cell	**K2**
	CO3	perform qualitative and quantitative analysis of biomolecules, separate biochemical compounds by using chromatographic technique	**K3**
	CO4	practice sectioning and analyse internal part of dicot and monocot	**K3**
	CO5	learn to handle microscope ,micrometry and identify dicot and monocot embryo	**K1**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	M	S	S	S	S	M	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S
CO3	S	S	M	S	S	M	S	S	S	S	S	M	S
CO4	S	S	M	S	S	S	S	M	S	S	S	M	S
CO5	S	S	M	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

<table>
<tr><td>Course Code</td><td>U21BOE531</td><td colspan="2" rowspan="2">ETHNO BOTANY AND ETHNOPHARMACOGNOSY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">ELECTIVE- III</td><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td>Cognitive Level</td><td colspan="7">K1: Recall K2: Understand K3: Apply</td></tr>
<tr><td>Learning objective</td><td colspan="7">• To attain knowledge about ethnobotany and its significance
• To understand the concept of traditional medicinal practices by Indian tribals
• To know the value of ethnopharmacognosy
• To apply the methods to transform ethnobotanical knowledge for the preparation of value added products</td></tr>
<tr><td>Unit I</td><td colspan="7">Ethnobotany</td></tr>
<tr><td colspan="8">Concept, scope and importance of ethno botany - sub-disciplines, inter- disciplines of ethnobotany, approaches in ethnobotanical studies.</td></tr>
<tr><td>Unit II</td><td colspan="7">Ethnobotany and conservation of plants</td></tr>
<tr><td colspan="8">with special reference to India –conservation of selected plant species: sacred groves, forestry and unique ecosystems and their ethnobiolgical values.</td></tr>
<tr><td>Unit III</td><td colspan="7">Tribes</td></tr>
<tr><td colspan="8">Major tribes of South India and their ethnobotanical and ethno-biological heritage – Parayar, Kurichiar, Paniyar, Karuman, Naikas, Shola Naikas, Thodas, Kothas, Kurumbas, Irullas, Kattu Naikas.</td></tr>
<tr><td>Unit IV</td><td colspan="7">Tribal medicinal plants</td></tr>
<tr><td colspan="8">Plants used by tribals of Nilgiris, plants used by tribals of Kerala and Eastern Himalayas. Economic potential of NTFPs, Gender role in harvesting NTFPs, Good sustainable harvesting practice of some selected NTFPs.</td></tr>
<tr><td>Unit V</td><td colspan="7">Ethnopharmacognosy</td></tr>
<tr><td colspan="8">Scope and importance of ethnopharmacognosy - Natural Plant Products – values of natural plant products – History of natural drugs. Plant with anti -tumor potential – Plant with anti- HIV potential – Plants with anti- inflammatory activity – Plants with anti- diabetic activity.</td></tr>
<tr><td>Text books</td><td colspan="7">1. Gokhale, S.B., Kokate, C.K. and Gokhale, A. Pharmacognosy of Traditional Drugs. 1st ed. Nirali Prakashan, Pune. 2016.
2. Gringauz. Introduction to Medicinal Chemistry: How Drugs Act & Why? Wiley India Pvt Ltd., Noida. 2012
3. Joshi, S.G. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd.,
4. New Delhi. 2018.</td></tr>
<tr><td>Reference books</td><td colspan="7">1. Kumar, N. A Textbook of Pharmacognosy. Aitbs Publishers, India. 2018.
2. Premendra Singh Medicinal Plants: Conservation, Cultivation and Utilization. Daya Publishing House New Delhi.2013.</td></tr>
<tr><td><u>E-References</u></td><td colspan="7">1. https://www.researchgate.net/publication/310772096_Ethnobotany_Ethnopharmacology_Bioprospectingand_Patenting
2. https://www.eolss.net/sample-chapters/C06/E6-151-02.pdf</td></tr>
<tr><td rowspan="3">Course outcome</td><td colspan="7">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO</td><td colspan="4">Course Outcomes</td><td colspan="2">Knowledge Level</td></tr>
<tr><td>CO1</td><td colspan="4">comprehend the concept of ethnobotany and its related research</td><td colspan="2">K2</td></tr>
</table>

	CO2	understand the concept and importance of sacred groves	**K2**
	CO3	know about different tribes in south India	**K1**
	CO4	describe the plants which used as traditionally for various treatments	**K2**
	CO5	know the plants with different pharamacological activities	**K1**

Mapping of COs with POs & PSOs:

CO	**POs**					**PSOs**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	M	S	S	S	S	S	M	S	S	M
CO5	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOE532	BIOFERTILIZER AND WASTE MANAGEMENT	L	T	P	C
ELECTIVE –III			3	-	-	3

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To learn mass cultivation of biofertilizers • To study the production of various manures • To understand and practice solid waste management
Unit I	**Biofertilizers**
Introduction, Scope, Advantages and limitations. Types of Biofertilizers; Based on nutrients and microbes. Mechanism of Symbiotic and Non- Symbiotic (Free living) nitrogen fixation. Root nodule formation	
Unit II	**Production**
Mass production of cyanobacterial biofertilizers *Nostoc* and *Anabaena,* bacterial biofertilizers- *Azotobacter*, *Azospirillum*, *Rhizobium* and *Pseudomonas* and duck weed fern (*Azolla*).	
Unit III	**Manures**
Composts, farmyard manure, oil seed cakes (Castor and Neem), green leaf manures, vermicompost and agro-industrial wastes	
Unit IV	**Municipal solid waste**
Sources and types of solid wastes, composition and its determinants. Factors influencing its generation	
Unit V	**Disposal of solid wastes**
refuse disposal –methods of refuse disposal. Sanitary landfills- methods of operation – advantages and disadvantages of sanitary landfills	
Text books	1. Abdin M.K., Kiran U. Kamaluddin & Ali, A. Plant Biotechnology: Principles and Applications. Springer. 2017. 2. Krohne D. T. Ecology: Evolution, Application, Integration. Oxford Univ. Press. 2017. 3. Poul V.I. Biodiversity: Issues, Impact, Remediations and Significance 1st Edition. V L Media Solutions. 2013.
Reference books	**1.** Krishnendu Acharya, Surjit Sen, Manjula Rai, Biofertilizers and Biopesticides, Technoworld Publishers, Kolkatta.2019. **2.** Khosla, R. Biofertilizers and Biocontrol Agents for Organic Farming, Kojo Press, Delhi.2017 **3.** Panda. H., Manufacture of Biofertilizer and Organic Farming, Published by National Institute of Industrial Research.2011. **4.** Subba Rao, N.S., Soil Microbiology. Medtech Publishers, Delhi.2017.
E-References	1. http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvMmpzQ2loU1NPaEl6eMpVaXpnNGUMc21iQzZKbMlHL2Fxc1hFSUpPdGJVaVpXMVJ6T0pGTjNuU1NBZjdId08vQnZ1eThMQ3c9PQ 2. http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvMmpzQ2loZDl5a

	M1MOM5LNlVrNittT3pLY0pSMMZyZmU1Q0MyNMdPdDdsS3RvcGF3LM		
Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	understand microbial nitrogen fixing process for different types of microbial biofertilizers	**K1**
	CO2	know the mass production of biofertilizers	**K2**
	CO3	understand the production of manures and composts	**K2**
	CO4	describe the composition and recycling of municipal solid Waste	**K3**
	CO5	have idea about disposal of solid wastes and sanitary landfills	**K2**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	M	S	M	S	S	S	S	S
CO4	S	S	M	S	S	S	S	S	S	S	S	M	S
CO5	S	S	M	S	S	M	S	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOS531	ORGANIC FARMING	L	T	P	C
SBE - III			2	-	-	2

Cognitive Level	K1: Recall K2: Understand K5: Analyze
Learning objective	• To understand the concept of organic farming • To learn the organic farming techniques and apply to become potential entrepreneur • To create healthy people and healthy environment through organic food production
Unit I	**Types of Farming (Advantage & disadvantage of each system)**
Pure Organic Farming – Definition, Concept & Benefits Integrated Farming system (Combination of Organic and Inorganic) ,Mixed Farming, Advantages and disadvantages of Chemical fertilizer and pesticides.	
Unit II	**Organic Farming**
Introduction and Status, Organic Farming and its Components,Organic Farming Concepts and Principles,SWOT Analysis of Organic Farming, Developing organic farms, Important steps & methods	
Unit III	**Sustainable Agriculture**
Key Indicators of Sustainable Agriculture,Organic Farming and Climate Change, Principles of Compost Production , Vermicompost Production Technology, Enriched Vermicompost Production Technology,Vermicompost Quality and Marketing,Green Manure:Mulches.	
Unit IV	**Pest and Disease Management**
Pest and Disease Management in Organic Farming, level "C" Pest and Disease Management.Introduction to Organic Crop Management, Organic Vegetable Crop Management,Organic Vegetable Crop Management (Cereals)	
Unit V	**Organic Food and Human Health**
Quality of Organic Food, Natural Sources of Antioxidants for Health Defense , Antioxidant Capacity of fruits and vegetablesOrganic Standard, Organic Certification Process , Operational Structure of Organic Certification, Marketing of Organic Products	
Reference books	1. Lampkin, N. Organic Farming. Farming Press, Ipswich (ISBN 0 85236 191-1990 2. Lampkin, N & Measures, M .2004 Organic Farm Management Handbook. Organic Farming Research Unit, Aberystwyth (ISSN 1354 3768) & Organic Advisory Service, Berkshire (ISBN 1 872 064 388) .2004. 3. Younie, D & Wilkinson, J. M (eds) Organic Livestock Farming. Chalcombe Publications, Lincoln (ISBN 0 948617 45 .2001. 4. Younie, D., Taylor, B. R., Welsh, J. P & Wilkinson, J. M (eds) Organic Cereals and Pulses. Chalcombe Publications, Lincoln.2002.
E-References	1. https://drive.google.com/file/d/1vKgc32uFghQ1TUJ7OAZZo3xtJzEI2rbB/view 2. https://ecofriend.org/7-best-books-on-organic-farming-and-gardening/

	3. http://www.efrc.com/education_main.htm Henry Doubleday Research Association (HDRA) http://www.hdra.org.uk International Federation of Organic Agriculture Movements (IFOAM)		
Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	understand the disadvantages of chemical pesticides and fertilizers	**K2**
	CO2	practice organic farming methods	**K1**
	CO3	comprehend the sustainable agriculture	**K2**
	CO4	learn the pest management techniques	**K5**
	CO5	know the importance of organic food and marketing	**K2**

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S
CO3	S	S	M	S	S	M	S	S	S	S	S	M	S
CO4	S	S	M	S	S	S	S	M	S	S	S	M	S
CO5	S	S	M	S	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOS532	FOOD PROCESSING AND PRESERVATION	L	T	P	C
SBE - III			2	-	-	2

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To understand the general principles of preservation • To know the principles of food freezing • To comprehend the processing of food and its importance • To learn the large-scale food processing technology
Unit I	**Food preservation**
Introduction- principles of preservation - classification of methods used for preservation - need and importance of preservation at domestic and large scale - Causes of food spoilage.	
Unit II	**Food spoilage mechanism**
Microbial contamination; Bacteria, fungi – Control of microbial contamination - Chemical deterioration – Enzymatic reactions – preservation – Refrigeration – Freezing – The freezing process – Industrial freezers – Quality of frozen foods – Thermal processing – Canning; Presterilization procedures, Sterilization, Quality of canned food	
Unit III	**Food preservatives**
Blanching – Controlling water activity – Dehydration – Fermentation and pickling — Chemical preservation: Organic chemical preservatives, inorganic chemical preservatives – Food irradiation – Biological effects of irradiation;	
Unit IV	**Methods of food handling and storage**
Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, freezing of raw and processed foods	
Unit V	**Large-scale food processing**
Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, dehydration of fruits	
Text books	1. Subbulakshmi, G., and Shobha A. Udipi "Food Processing and Preservation".New Age Publications. 2006. 2. HUi, Y.H. "Handbook of Vegetable Preservation and Processing". Marcel Dekker. 2003. 3. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge.2003.
References Books	1. Gould, G.W. "New Methods in Food Preservation". Springer,1995. 2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice". Surbhi Publications, 2001. 3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002. 4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.
E-Reference links	1. http://www.cold.org.gr/library/downloads/Docs/Handbook%20of%20Food%20Preservation.PDF 2. https://www.researchgate.net/publication/270099729_Handbook_of_Food

	_Preservation/link/549fe1990cf257a635fe8afe/download

	Upon completion of this course, the students will be able to		
Course outcome	**CO**	**Course Outcomes**	**Knowledge Level**
	CO1	learn the need and importance of preservation	**K1,K2**
	CO2	understand various microbial contamination in food	**K2**
	CO3	learn the deterioration of fermented and pickled food products	**K1**
	CO4	use the methods of food handling and storage	**K3**
	CO5	understand the pasteurisation of milk and yoghurt	**K2**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	S	S	S	M	S	M	S	S	S	S	S	S
CO2	M	M	S	M	S	M	S	S	S	S	S	M	S
CO3	S	S	M	S	S	M	S	M	S	S	M	S	S
CO4	S	M	S	S	M	S	S	S	S	S	S	S	M
CO5	M	S	M	M	S	M	M	M	S	M	M	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

SEMESTER VI

Course Code	U21BOT61	BASICS OF PLANT BIOTECHNOLOGY	L	T	P	C
CORE - XIII			4	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To know the scope and techniques of Plant Biotechnology • To learn the role of important plant hormones • To acquire a basic knowledge on Plant tissue culture
Unit I	**Plant genome organization**
Structure of representative plant genes and gene families in plant – Organization of Chloroplast genome and Mitochondrial genome.	
Unit II	**Molecular biology and gene rearrangement**
Mechanism of T-DNA transfer to plant – Ti plasmid vectors and its utility – plant viral vectors	
Unit III	**Genetic engineering of plants**
Construction of genome libraries and cDNA libraries. Molecular breeding – recombinant DNA – Transgenic plant and applications	
Unit IV	**Plant hormones**
Auxin, IAA, GA, Cytokinins and Abscissic acid (ABA) - molecular basis of action – Phytochrome – role in photo – morphogenesis – regulation of gene expression – stress induced promoter switches in the control of gene expression. Ethylene and fruit ripening	
Unit V	**Plant tissue culture**
Cells suspension cultures– haploid plants – cloning of hosts – micro propagation – somatic embryogenesis – protoplast isolation and applications	
Text books	1. Chawla, H.S.. Introduction to Plant Biotechnology. Oxford and IBH Publications, Delhi.2020 2. Satyanarayana, U. Biotechnology. Books and Allied Ltd. Kolkata.2020. 3. Singh, B.D. Biotechnology: Expanding Horizons, Kalyani Publishers, Delhi.2015. 4. Slater, Plant Biotechnology: Genetic Manipulation of Plants. Oxford Pub. Delhi.2008.
Reference books	1. Kojima, Lee, H. and Kun, Y. Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag. 2001 2. Trivedi, P.C. Applied Biotechnology and plant genetics, Dominant publishers and distribution. 2000. 3. Ignacimuthu. Applied plant Biotechnology. Tata McGraw – Hill. 1996. 4. Grierson and Convey, S.N. Plant molecular Biology. Backie. 1988.
E-References	1. http://ndl.iitkgp.ac.in/document/Rm5qb3lqRngwWDZ2Tnl6UXl4VU9YSWo3RFBPdTVoNlFQR3BIQ2Y0cHl4OC96NGJyc2E0MFJQLzVQVjAvNWRocTNQNG9JMWFBNFUvZTY2WjROUmFVQUE9PQ 2. https://nptel.ac.in/content/storage2/courses/102103045/download/mod1.pdf

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	understand the organization of plant genome and important genes	K2

	CO2	describe the process of T-DNA transfer and role of vectors in gene transfer	**K3**
	CO3	understand the construction of genome libraries and molecular breeding	**K2**
	CO4	know the molecular basis of plant growth hormones and phytochromes	**K1**
	CO5	know the procedure for the basic tissue culture techniques	**K2**

Mapping of COs with POs & PSOs:

CO	**POs**					**PSOs**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S	S	M	S
CO4	S	S	M	S	S	S	S	S	M	S
CO5	S	S	M	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOT62	ENVIRONMENTAL BIOLOGY AND PHYTOGEOGRAPHY	L	T	P	C
CORE - XIV			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To understand the basic components of ecosystem • To attain knowledge on different kinds of producers and consumers • To learn the importance of ecosystems and vegetation. • To understand and get awareness on causes and effects of pollution
Unit I	**Ecology**
definition, introduction and scope. Brief account on autecology and synecology. Biotic and abiotic factors. Positive and negative interactions of biotic factors	
Unit II	**Ecosystem Concept**
structure and function of ecosystem. Biomass. Ecological pyramids. Productivity: primary, secondary and gross. Food chain, food web and energy flow. Structure and functions of pond ecosystem	
Unit III	**Vegetation**
Development of vegetation. Plant succession: hydrosere and xerosere. Ecological classification of plants; hydrophytes, xerophytes, mesophytes and halophytes	
Unit IV	**Pollution**
Types of pollutants. Causes, effect and control of atmospheric, soil, industrial and agricultural pollution	
Unit V	**Phytogeography**
Vegetational types of Tamilnadu: Evergreen, deciduous, scrub and mangrove forests. Phytogeographical regions of India	
Text books	1. Dr. Namita Joshi , Dr. P. C. Joshi , A Text Book Of Ecology And Environment Paperback .Himalaya Publishing House.2011. 2. Sharma, P.D,Ecology and Environment (BC-69) Paperback-i, Rastogi Publications.2019.
Reference books	1. Eugene Odum, Fundamentals of Ecology. Cengage Learning India Private Limited, Delhi.2018. 2. Keddy, P.A. Plant Ecology: Origins, processes, consequences. 2nd ed. Cambridge University Press. ISBN. 978-1107114234.2017. 3. Brian, K.H. and Benedict, H.. Evolution. 5th ed. Jones & Bartlett Publishers. 2014 4. Shukla, R.S and Chande I.P.S Plant Ecology and Soli Science, S. Chand & Co Ltd.,2005. 5. Sharama, J.P. Environmental Studies, Laxmi Publications (P) Ltd. New Delhi.2004.
E-References	1. https://epgp.inflibnet.ac.in/Home/VieMSubject?catid=4 2. https://WWW.researchgate.net/publication/325780661_FUNDAMENTALS_OF_ECOLOGY_AND_ENVIRONMENT 3. http://Miienvis.nic.in/MriteReadData/Publication/19_Grassland%20Habitat_2016.pdf

	4. https://cdn.cseindia.org/attachments/0.81111800_1563776216_Brochure-Zanzibar-decentralised-pilot-project-report.pdf		
Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	acquire knowledge on ecology and its components.	**K2**
	CO2	describe the concepts of ecosystem and dependence of organisms in energy flow	**K3**
	CO3	have clear understanding on formation of vegetation	**K2**
	CO4	understand the causes and control of various types of pollution	**K2**
	CO5	become aware of vegetational types of Tamilnadu and geographical zones of India	**K1**

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	M	S	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	S	S	M	S
CO3	S	S	M	S	S	S	M	S	S	S	S	M	S
CO4	S	S	M	S	S	S	S	S	S	S	S	M	S
CO5	S	S	M	S	S	M	S	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOT63	FUNDAMENTALS OF MICROBIOLOGY AND PLANT PATHOLOGY	L	T	P	C
CORE-XV			5	-	-	4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To enrich the knowledge on Microorganisms • To learn different types of bacteria and fungi and their nature • To understand the processing of milk and dairy products. • To know fermentation processes and industrial products of commercial importance
Unit I	**Bacteria**
Morphology, different shapes and arrangement, ultra structure. Reproduction of bacteria: Sexual reproduction - conjugation, asexual methods of reproduction. Types of nutrition in bacteria. Viruses – general morphology and ultra structure	
Unit II	**Fungi**
life cycle of typical fungi, identification. Rhizospere organisms- mycorrhiza- types and its advantages, VAM fungi. Edible and Ppoisonous mushrooms. Fungal toxins	
Unit III	**Food Microbiology**:
Physical and chemical composition of milk. Pasteurization. Dairy products. Manufacture of cheese. Microbial flora of fruit and vegetables	
Unit IV	**Industrial microbiology**
Fermentation technology; structure of bioreactor, aerobic and anaerobic fermentation. Production of ethanol, penicillin, vitamin B12 and industrial enzymes – cellulose and lipase	
Unit V	**Plant Pathology**
Bacterial diseases: Paddy blast and citrus canker. Fungal diseases: Tikka disease of ground nut and red rot of sugarcane. Viral diseases (bunchy top of banana). Diseases control methods (physical, chemical and biological)	
Text books	1. Tortora, G.J., Funke, B.R. & Case, C.L. Microbiology an Introduction. 13th Edition. Pearson Education, Inc. 2019. 2. Cowan, M.K. & Smith H. Microbiology: A Systems Approach. 5th Edition. Mc Graw Hill Edn. 2018. 3. Bauman, R. W. Microbiology: with diseases by body system 4th Edn. Pearson Education, Inc. 2015. 4. Stanbury, P.F., Whitaker, A. & Hall, S.J. Principles of Fermentation Technology, Butterworth-Heinemann publications. 2016. 5. Singh R.S. Introduction to Principles of Plant Pathology. 5th Edition. Medtech Publisher. 2017. 6. Dube H.C. Modern Plant Pathology.3rd Edition, Agribios, New Delhi. 2014. 7. Sharma, P. D, Plant Pathology. Rastogi Publishers New Delhi.2013.
Reference books	1. Talaro, K. P. & Chess, B. Foundations in microbiology. 10th Edition. Pearson Education, Inc. 2018. 2. Pommerville, J. C. Alcamo's Fundamentals of Microbiology, 11th Edition. Jones & Bartlett Learning. 2017. 3. Madigan M. T., Bender K.S., Buckley D.H., Sattley W.M., & Stahl D.A. Brock Biology of Microorganisms. Pearson Education, Inc. 2017. 4. Mehrotra R.S. Plant Pathology. 3rd Edition. McGraw Hill Education.2017.

E-References	1. https://nptel.ac.in/courses/102/103/102103015/ 2. https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf 3. https://WWW.researchgate.net/publication/340660994_Plant_Pathology_at_a_Glance 4. https://WWW.moscmm.org/pdf/Ananthanarayan%20microbio.pdf		
Course outcome	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	have a better knowledge on structure, shapes and reproduction of bacteria and virus	**K1**
	CO2	identify and describe fungi and have knowledge on edible and poisonous mushrooms	**K2**
	CO3	know the production of dairy products and diversity of microorganisms in food products	**K2**
	CO4	understand fermentation technology and production of industrial products using microbes	**K2**
	CO5	describe causes and control measures for important plant diseases	**K3**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	M	S	S	S	M	S
CO2	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	M	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	M	S	S	M	S	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOT64	BIOSTATISTICS, BIOINSTRUMENTATION AND BIOPHYSICS	L	T	P	C
CORE-XVI			4	-	-	4
Cognitive Level	K2: Understand K3: Apply					
Learning objective	• To know basic statistical analysis • To perform preparation table and graphs which are helpful in research studies • To know the principles and application of Instruments used in the field of Biology • To understand the concepts of Photobiology					
Unit I	**Data collection & Graphical Representation**					
Data collection, sampling, classification, tabulation and graphical representation. Significance of figures. Frequency distribution: Measures of central tendency, mean, median, mode, standard deviation and variance.						
Unit II	**Correlation and Regression**					
Explanation, types of correlation – Positive and negative correlation. Methods of studying Correlation using Karl Pearson's Coefficient of Correlation. Chi-square test and student's T-test.						
Unit III	**Microscope & Centrifuge**					
Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, cytophotometry and flow cytometry. pH and buffers. Centrifugation: Basic principles and application of differential, density and ultracentrifugation.						
Unit IV	**Colorimetry**					
Parts and functions of colorimeter. Beer Lambert's Law. Spectroscopy: UV-visible, spectroscopy. Principle, methodology and applications of thin layer chromatography and HPLC. Electrophoresis: Principle and applications of Native, SDS and agarose.						
Unit V	**Photobiology**					
Electromagnetic spectrum, lLight emission, fluorescence, phosphorescence and bioluminescence. Bioenergetics - Laws of thermodynamics– High energy compounds– ATP bioenergetics.						
Text books	1. Chap T.Le. Eberly, L.E. Introductory Biostatistics, 2nd Edition, Wiley and Sons, Hoboken. 2016. 2. Veer Bala Rastogi, Biostatistics. 3rd edition. Medtech. 2015. 3. Biju Dharmapalan. Scientific Research Methodology. Narosa Publising House, New Delhi.2012. 4. Norman Bailey, T. J. Statistical methods in Biology. Cambridge University Press. 2012.					
Reference books	1. Antonisamy B, Prasanna S. Premkumar, Principles and Practices of Biostatistics, Elsevier India.2017. 2. Hanmanth Rao, P and K. Janardhan, Fundamentas of Biostatistics. DreamTech Press, Chennai 2019. 3. Veerakumari, L. Bioinstrumentation, MJP Publisher, Chennai.2011. 4. Upadhyay, A., Upadhyay, K. & Nath, N. Biophysical Chemistry –Principles and techniques. Himalaya Publishing House. 2017. 5. Yeung, E. C. T., Stasolla, C., Sumner, M.J., Huang, B.Q. Plant Microtechniques and Protocols, Springer. 2015.					

	6. Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology (Seventh Edition). Cambridge University Press, Yow York.2010.
E-References	1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3469943/ 2. https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod2.pdf 3. http://Meb.mit.edu/5.33/WWW/lec/spec1.pdf

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	perform basic statistical calculations and representation of data in the form of table and figures	**K3**
CO2	understand and do correlation and regression analysis	**K2**
CO3	know the principles and applications of different types of microscopes and centrifuges	**K2**
CO4	learn the components and procedure for the operation of spectroscopy, TLC, HPLC and SDS	**K2**
CO5	understand the electromagnetic spectrum and thermodynamic principles	**K2**

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	M	S	S	S	S	S
CO3	S	S	M	S	S	M	S	S	S	S	S	M	S
CO4	S	S	M	S	S	S	S	M	S	S	S	M	S
CO5	S	S	M	S	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

<table>
<tr><td>Course Code</td><td>U21BOP65</td><td rowspan="2">PRACTICAL -PLANT BIOTECHNOLOGY, ENVIRONMENTAL BIOLOGY,MICROBIOLOGY AND PLANT PATHOLOGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">CORE- XVII</td><td>-</td><td>-</td><td>5</td><td>4</td></tr>
<tr><td>Cognitive Level</td><td colspan="6">K2: Understand K3: Apply</td></tr>
<tr><td>Learning objective</td><td colspan="6">• To perform and understand procedure for plant tissue culture
• To learn Staining of Bacteria
• To understand different types vegetation
• To find out important plant diseases</td></tr>
<tr><td></td><td colspan="6">1. Demonstrate the procedure for plant tissue culture
2. Demonstration of sterilization technique
3. Spotters related to Plant Ecology and Phytogeography Theory Paper
4. Gram’s staining experiment
5. Plant Pathology – Citrus Canker, Red rot of Sugarcane, Paddy blast and Bunchy top of Banana
6. Spotters related to Microbiology and Plant Pathology
7. Preparation and submission of record note</td></tr>
<tr><td>Text books</td><td colspan="6">1. L.M. Prescott, J.P. Harley and D.A. Klein, Mc Graw Hill, Boston. Microbiology Sixth edition.2005.
2. A.A. Salyers and B.D.Whitt. Microbiology – Diversity, Disease and the Environment, Fitzerald Scientific Press, Maryland.2001.</td></tr>
<tr><td>Reference books</td><td colspan="6">1. Rangaswamy, G. Diseases of Crop Plants in India. Prentice Hall of India Pvt.Ltd.1972.
2. Manju Bala, Sunita Gupta and N.K. Gupta. Practicals in Plant Physiology and Biochemistry, Scientific Publishers, Delhi.2012</td></tr>
<tr><td>E-References</td><td colspan="6">1. https://www.researchgate.net/publication/306018042_Microbiology_Laboratory_Manual
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvMmpzQ2loUjc4dmd5U2dETTcrUno5d2wxwitxblN0MEt5NlNVYVpBUk8vcjNZQVlpMg
4. https://ncert.nic.in/textbook/pdf/ievs101.pdf</td></tr>
<tr><td rowspan="6">Course outcome</td><td colspan="6">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO</td><td colspan="2">Course Outcomes</td><td colspan="2">Knowledge Level</td></tr>
<tr><td>CO1</td><td colspan="2">gain knowledge on mass multiplication of tissues</td><td colspan="2">K2</td></tr>
<tr><td>CO2</td><td colspan="2">handle instruments used for sterilization</td><td colspan="2">K2</td></tr>
<tr><td>CO3</td><td colspan="2">illustrate the methods used for vegetation analysis</td><td colspan="2">K2</td></tr>
<tr><td>CO4</td><td colspan="2">differentiate gram positive and negative bacteria using staining techniques</td><td colspan="2">K3</td></tr>
<tr><td>CO5</td><td colspan="2">identify the plant diseases and pathogens</td><td colspan="2">K3</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	M	S	S	S	S	M	S	S	S	M	S
CO2	S	S	M	S	S	S	S	S	S	S	S	M	S
CO3	S	S	M	S	S	M	S	S	S	S	S	M	S
CO4	S	S	M	S	S	S	S	M	S	S	S	M	S
CO5	S	S	S	S	S	S	S	M	S	S	S	S	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

Course Code	U21BOE641	FORESTRY	L	T	P	C
ELECTIVE IV			3	-	-	3

Cognitive Level	K1:Recall K2:Understand K3:Apply
Learning objective	• To know about Silviculture in forest • To understand the technique of measuring the trees by using various parameters • To comprehend the forest management system • To understand the importance of trees and ecological balance • To obtain the knowledge about economic values of timbers in forest.
UNIT – I	**Regeneration of forest**
Factors influencing vegetation- Regeneration of forest, methods of propagation, Grafting, nursery and Planting techniques – clear felling coppice and conversion systems – Silviculture management in India	
UNIT – II	**Survey of forest trees**
Methods of measuring diameter, girth, height and volume of trees form factors volume of estimation of stand annual increment, methods of forest survey - sampling methods and sample plots.	
UNIT – III	**Forest managements in India**
Sampling method and sample plot. Forest survey - map reading management of forest plantations - commercial forests - forest cover monitoring.	
UNIT – IV	**Agro forestry**
Scope and necessity, social / urban forestry. Tribal participation in forest management Soil conservation- causes of erosion. Water shed management and environmental function of forests.	
UNIT –V	**Harvesting Practices**
Logging and Extraction, non timber forest products - wood seasoning and preservation. Anatomical structure of wood - Defects and abnormalities, Timber identification. .	
Text Books	1. Tiwari KM and Singh RV.social forestry plantations. Oxford and IBH Publishing Co., New Delhi. 1980. 2. Stebbin EP A.Manual of Elementary Forest Zoology for India International Books Distributions Dehra Dun. 1977.

Reference Books	1. Puri GS. Meher VM Gupta RK and Puri S. Forest ecology Oxford and IBH Publishing Co., New York. 1981. 2. Sukachev V and Dlis N.Fundamentals of forest Biocenology, Oliver and Boyd Edinburgh. 1964. 3. Warning RH and schesinger WH. forest Ecosystems: concepts and Management Academic Press New York. 1985.
E-References	1. https://www.scientificpub.com/upload/pdf/486.pdf 2. http://drive.oiipdf.com/dl.php?f=487fb0d4-e754-469d-8b45-4b9929d8d58e.pdf&n=Ministry+of+Agriculture+and+Forestry:+Management+of+Biosecurity+Risks
Course out come	Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	acquire knowledge of factors influencing vegetation and its management	**K2**
CO2	know the technique of measuring the trees by using various parameters	**K2**
CO3	gain the knowledge of forest survey	**K2**
CO4	know the scope of agro forestry	**K1**
CO5	apply the harvesting practices and identification of timber	**K3**

Mapping of COs with POs & PSOs:

CO	PROGRAMME OUTCOMES (PO)								PROGRAMME SPECIFIC OUTCOMES (PSO)				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	M	M	S	S	S	M	M	M	M	S	S	M	M
CO2	S	M	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	M	S	M	S	S
CO4	M	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	M	S	S	M	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) -1 mark No Correlation (N) - 0 mark

Course Code	U21BOE642	SEED TECHNOLOGY	L	T	P	C
ELECTIVE - IV			3	-	-	3

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To know physical and mechanical seed separation. • To learn the functions of seed processing machines • To understand seed processing technology • To acquire knowledge on seed storage methods
Unit I	**Seed processing**
Importance of seed processing. Physical methods used to separate seeds. Preparing seeds for processing. Licensing of machines.	
Unit II	**Seed drying**
Importance and advantages of seed drying, methods of seed moisture measurements. Theory of seed drying (wet dry seeds). Advantages of mechanical drying equipments. Dehumidification and drying of heat sensitive seeds.	
Unit III	**Seed processing machines**
Principle, construction, working, adjustments, cleaning and uses of seed processing machines viz. i) Air screen cleaner cum grader ii) Specific gravity separator, aspirators, pneumatic aspirators, stoner iii)Roll mill iv) Magnetic separators and v) Spiral separators, dropper best separator, electrostatic separators.	
Unit IV	**Seed Treatment**
Principle, construction, working, adjustments and uses of Slurry seed treater, Mist-o- matic seed treater. Storage and labeling of treated seeds. Seed users safety. Seed conveyors and elevators.	
Unit V	**Seed storage**
Structures and their management: Packing and marketing of seeds, bagger weigher, bag closing, portable and conveyor type of bag closer. Labeling and maintaining lot identity, lot numbers, seed pellets, handling and stacking. Maintenance of seed processing record.	
Text books	1. Agarwal, L., Seed Technology.Oxford & IBH Publishing Co Pvt.Ltd, Delhi.2018. 2. S.M. Henderson & R. Perry. Agricultural process Engineering, Avi Publishing CoInc.; 3rd Revised edition.1976. 3. Carl W. Hall. Drying Farm crops, Agricultural Consulting Associates; 6th printing edition.1967. 4. A Chakravarty. Post Harvest Technology & cereals , oil seeds. pulses & Oxford &IBH Publishing Co Pvt.Ltd.1989.
Reference books	1. ICAR, Handbook of Agriculture, Directorate of Information and Publication of Agriculture (DIPA).1961. 2. Hunt D. Farm power & machinery management, Iowa State University Press. 1977. 3. Prem Singh and Arya. Vegetable breeding and seed production; Kalyani Publ.Ludhiana. 1999.
E-References	1. http://www.jnkvv.org/PDF/30032020194456Principles_of_Seed_Technology_Dr_Rudrasen_Singh.pdf 2. https://ir.library.msstate.edu/bitstream/handle/11668/13653/1960-15-CALIBRATING%20THE%20MIST-0-

	MATIC%20SEED%20TREATER%20AND%20WHY.pdf?sequence=1&isAllowed=y 3. http://www.jnkvv.org/PDF/17042020094358SEED%20TREATMENT.pdf

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	learn the physical separation of seeds and licensing of machines	**K2**
CO2	understand the seed drying process and nature of heat sensitive seeds	**K1**
CO3	learn the principles and operation procedure of major seed processing machines	**K2**
CO4	know the slurry and Mist-o-matic seed treater and seed user safety.	**K3**
CO5	attain knowledge on seed storage and packing of seeds	**K2**

Mapping of COs with POs & PSOs:

CO	POs					PSOs				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	S	M	S
CO3	S	S	M	S	S	S	S	S	M	S
CO4	S	S	M	S	S	S	S	S	M	S
CO5	S	S	M	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark

Course Title & Code	U21BOS641	HORTICULTURE TECHNIQUE AND PLANT BREEDING	L	T	P	C
SBE - IV			2	-	-	2

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning objective	• To learn the cultivation of important fruit tree • To study and practice the grafting techniques • To make students interested in gardening • To learn the commercial production of Flowers
Unit I	**Horticulture**
Importance and Scope of Horticulture, Classification of horticultural crops – fruits and vegetable crops. Basic climatic, soil, Water and nutritional requirements of horticultural crops. Cultivation of important fruit trees – Mango and Banana.	
Unit II	**Plant propagation methods**
cutting, layering, grafting, budding, stock-scion relationship. Use of plant growth regulators in Horticulture. Garden designs, types of gardens – formal, informal and kitchen garden, units of garden.	
Unit III	**Garden maintenance**
weeding, top dressing methods of pruning, topiary. hedge, border, topiary arches. Lawn making: types of lawn grasses and maintenance.	
Unit IV	**Floriculture**
Cultivation of commercial flowering plants – Rose, Jasmines and Chrysanthemum. Nursery maintenance. Cut flowers and flower decoration arrangement.	
Unit V	**Principles and objectives of plant breeding**
Selection methods, (pure line, clonal, mass) Hybridization: Types and procedure for hybridization. Somatic hybridization: Heterosis, hybrid vigor. Anther culture and its role in plant breeding.	
Text books	1. Gupta, S. N. Handbook of Horticulture, 1st Edition, Jain Brothers. 2018. 2. Shry, C. & Reiley. Introductory Horticulture; 9th Edition. Cengage Learning. 2016. 3. Singh, J. Fundamentals of Horticulture, Kalyani Publishers. 2014. 4. Chopra, V. L. Plant Breeding Theory & Practice Oxford & Ibh Publishing Co Pvt Ltd.2012.
Reference books	1. Tiwari A.K. and R. Kumar Fundamentals of Ornamentals, Horticulture and Landscape Gardening. New India Publishing Agency, New Delhi.2012. 2. Peter K. V. Basics of Horticulture. New India Publishing Agency, New Delhi. 2015. 3. Reddy, M. and A. Rao, Plant Breeding in Horticulture. Pacific Book International, NewDelhi.2010.
E-References	1. https://ncert.nic.in/textbook/pdf/ievs101.pdf 2. https://agritech.tnau.ac.in/pdf/HORTICULTURE.pdf 3. https://agriicarjrf.com/Mp-content/uploads/2018/07/Instant-horticulture.pdf

	Upon completion of this course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
Course outcome	CO1	classify fruits and vegetables and also understand the cultivation of mango and banana	**K1**
	CO2	develop skill in horticulture techniques like grafting, layering, budding and garden designing	**K2**
	CO3	maintain garden and access skills on lawn making	**K3**
	CO4	cultivate commercial flowers and flower decoration	**K3**
	CO5	know the plant breeding process and method of hybridization	**K2**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	M	S	S	S	S	M	S	S	S	S	S
CO3	S	S	S	S	S	M	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	M	S	S	M	S	M	S	S	S	M	S

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark No Correlation (N) - 0 mark

<table>
<tr><td>Course Code</td><td>U21BOS642</td><td rowspan="2">MICROTECHNIQUE AND HISTOCHEMISTRY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">SBE - IV</td><td>2</td><td>-</td><td>-</td><td>2</td></tr>
<tr><td>Cognitive Level</td><td colspan="6">K1: Recall K2: Understand K3: Apply</td></tr>
<tr><td>Learning objective</td><td colspan="6">• To know the scope of histochemistry in biological application
• To understand the technique used for killing and fixing of tissues
• To know the preparation of specimen for light microscope and electron microscope
• To understand methods used for the detection of primary and secondary metabolites</td></tr>
<tr><td>Unit I</td><td colspan="6">Histochemistry:</td></tr>
<tr><td colspan="7">Scope of histochemistry in Biology. Killing and Fixing;Principles and techniques of killing and fixing; properties of reagents; properties and composition of important fixatives - Carnoy’s Fluid, FAA, FPA, Chrome acetic acid fluids, Zirkle- Erliki fluid.</td></tr>
<tr><td>Unit II</td><td colspan="6">Tissue dehydration:</td></tr>
<tr><td colspan="7">Reagents, infiltration and embedding; hand and serial sections, squashes, smears and maceration. Mounting: Techniques, common mounting media used - DPX, Canada balsam, Glycerin jelly and Lacto phenol. Cleaning, labeling and storage of slides.</td></tr>
<tr><td>Unit III</td><td colspan="6">Microscope:</td></tr>
<tr><td colspan="7">Tissue processing technique for light microscope and electron microscope. Microtomy-Rotary, Sledge, Freezing, Cryostat and Ultratome.</td></tr>
<tr><td>Unit IV</td><td colspan="6">Stains:</td></tr>
<tr><td colspan="7">Classification and chemistry of biological stains. General and specific vital stains and flurochromes. Micrometry, camera lucida, photomicrography.</td></tr>
<tr><td>Unit V</td><td colspan="6">Detection and localization of primary metabolites:</td></tr>
<tr><td colspan="7">Carbohydrates (PARS reaction), Proteins (Coomassie brilliant blue staining), Lipids (Sudan Black method). Detection and localization of secondary metabolites- alkaloids, terpenoids, phenolics.</td></tr>
<tr><td>Text books</td><td colspan="6">1. Yeung E.C.T., Stasolla C., Sumner M. J. & Huang B. Q. Plant Microtechniques and Protocols. Springer Nature.2015.
2. Prasad M. K. & Prasad M. K. Emkay Publications 2000.
3. Kierman, J.A. Histological and Histochemical Methods. Butterworth Publ. London. 1999.</td></tr>
<tr><td>Reference books</td><td colspan="6">1. Toji Thomas Essentials of botanical microtechnique (II Edn). Apex infotech publishing company. 2005.
2. Ruzin, Z. E. Plant Microtechnique and Microscopy. Oxford Press, New York. 1999.</td></tr>
<tr><td><u>E-References</u></td><td colspan="6">1. .https://www.researchgate.net/publication/309118583_Techniques_in_Anatomy_Cytology_and_Histochemistry_of_Plants</td></tr>
<tr><td rowspan="3">Course outcome</td><td colspan="6">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO</td><td colspan="3">Course Outcomes</td><td colspan="2">Knowledge Level</td></tr>
<tr><td>CO1</td><td colspan="3">know the properties and composition of different fixatives</td><td colspan="2">K1</td></tr>
</table>

	CO2	describe the principle and working mechanism of microtome	**K2**
	CO3	prepare permanent slides for different tissues	**K3**
	CO4	understand different mounting media	**K2**
	CO5	know the different types of sectioning	**K3**

Mapping of COs with POs & PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	M	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	S	S	S	S	M	S
CO3	S	S	M	S	S	M	S	M	S	S	S	M	S
CO4	S	S	M	S	S	S	S	M	S	S	S	M	S
CO5	S	S	M	S	S	M	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (M) - 1 mark
No Correlation (N) - 0 mark

Course Code	U21BOV51	SPIRULINA CULTIVATION	L	T	P	C
VALUE ADDED COURSE			2	-	-	2
Cognitive Level	K1: Recall K2: Understand K3: Apply					
Learning objective	• To understand the need of non-conventional food • To know about the application of SCP and mass cultivation of spirulina • To become successful SCP entrepreneur					
Unit I	**Algal biomass as non- conventional food**					
Introduction, Concept and need, Advantages, disadvantages and Sources of non-conventional food						
Unit II	**Introduction to SCP production**					
Historical use and rediscovery of *Spirulina* importance – morphology, taxonomy and habitat of *Spirulina* – biochemical composition including proximate composition – amino acids – unsaturated fatty acids – minerals and vitamins. Human health benefits of *Spirulina*.						
Unit III	**Spirulina cultivation - single cell protein**					
SCP--Introduction, Systematic position, thallus structure, Merits of Spirulina cultivation, Methods of cultivation- Small scale cultivation, Mass cultivation, Harvesting of Spirulina, Flow chart of Spirulina cultivation, Limiting factors for Spirulina cultivation, Spirulina products –Powder, Biscuits, Tablets						
Unit IV	**Spirulina cultivation steps**					
Principle, Requirement, chemicals, Sample or Inoculum of Spirulina, procedure (steps involved in Spirulina cultivation), observations, Harvesting, results and records, precautions Visit to a Spirulina cultivation laboratory in nearby area (Students are expected to prepare a model of Spirulina cultivation laboratory, a visit report and to submit the same at the time of practical examination.						
Unit V	**Spirulina cultivation**					
Natural production – laboratory cultivation – small scale commercial production – commercial and mass cultivation (tank construction, culture medium, strain selection, scaling up of the process) – importance of light and pH in *Spirulina* cultivation – harvesting, drying and packing						
Textbooks	1. UmarBacha, Muhammad Nasir, Single Cell Protein: Production && Evaluation for Food Use Evaluation for Food Use,Lambert Publication,2011 2. Robert Henrikson,Spirulina - World Food: How this micro algae can transform your health and our planet,2010 3. Amos Richmond ,Qiang Hu, Handbook of Microalgal Culture: Applied Phycology and Biotechnology,Wiley,2013					
References	1. Paul M. Coates, Joseph M. Betz, Marc R. Blackman Encyclopedia of Dietary Supplements, 2010. 2. Biswas S., Datta M. and Ngachan S.V, Mushrooms: A Manual for					

<table>
<tr><td></td><td colspan="3">Cultivation, PHI, 2012.
3. Aaron Baum, Grow Your Own SpirulinaSuperfood: A Simple How-To Guide Kindle Edition, 2013.
4. Aaron Baum, Grow Your Own Spirulina Superfood: A Simple How-To Guide, 2013.
5. Selvendran D, Large Scale Algal Biomass (Spirulina) Production in India. In: D. Das Algal Biorefinery: An Integrated Approach, Springer. 2015.</td></tr>
<tr><td>E-references</td><td colspan="3">1. https://www.researchgate.net/publication/329170462_IPR_Biosafety_Bioethics
2. https://biocyclopedia.com/index/biotech_biosafety_ipr_ipp.php
3. https://link.springer.com/chapter/10.1007/978-981-10-2961-5_14</td></tr>
<tr><td rowspan="6">Course outcome</td><td colspan="3">Upon completion of this course, the students will be able to</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>understand the need of algal mass</td><td>K1</td></tr>
<tr><td>CO2</td><td>get knowledge on morphology, taxonomy biochemical aspects of spirulina</td><td>K2</td></tr>
<tr><td>CO3</td><td>understand the various methods involved in spirulina cultivation</td><td>K2</td></tr>
<tr><td>CO4</td><td>learn the techniques of of spirulina cultivation for SCP production</td><td>K3</td></tr>
<tr><td>CO5</td><td>get thorough knowledge on natural production, mass cultivation and process</td><td>K3</td></tr>
</table>

Mapping of COs with POs & PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	M	S	S	S	S	S	M
CO2	S	S	S	M	S	M	S	S	M	S	S	M	S
CO3	M	M	S	S	M	S	M	S	S	M	S	S	M
CO4	S	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	M	S	M	S	S	M	S	M	S	M

Strongly Correlating (S) - 3 marks Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark No Correlation (N) - 0 mark