ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF LIFE SCIENCES (RSLSC)

DEPARTMENT OF BOTANY

COURSE STRUCTURE & SYLLABUS

(BASED ON NATIONAL EDUCATION POLICY 2020)

FOR

B.Sc. IN BOTANY
(4 YEARS SINGLE MAJOR)

W.E.F
AY - 2025 – 26

STRUCTURE OF THE SYLLABUS FOR 4 YEAR UG PROGRAMME
B.Sc. BOTANY

1st SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BOT142M101	Cryptogamic botany (Algae, Bryophytes & Pteridophytes)	100	3	3-0-0
Major (Core)	BOT142M112	Cryptogamic botany practical	100	3	0-0-6
Minor	BOT142N141	Diversity in Plants	100	3	2-0-2
Interdisciplinary (IDC)	IKS1	Indian Knowledge System – I	100	3	3-0-0
Ability Enhancement course (AEC)	AEC982A101	Communicative English I	100	1	1-0-0
Ability Enhancement course (AEC)	Behavioural Science-I	Behavioural Science – I	100	1	1-0-0
Skill Enhancement Course (SEC)	BOT142S121	Plant disease identification and control	100	3	0-0-6
Value Added Course (VAC)	VAC1	Course from available basket	100	3	3-0-0
MOOCs	MOOCs	*MOOCs/online course will be identified by the dept from the list of courses available on MOOC online platform/SWAYAM Platform	100	3	
TOTAL CREDIT FOR 1st SEMESTER				23	
2nd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BOT142M201	Phanerogams – Gymnosperms & Angiosperms	100	3	3-0-0
Major (Core)	BOT142M212	Phanerogams Practical	100	3	0-0-6
Minor	BOT142N201	Economic Botany	100	3	3-0-0
IDC	IKS2	Indian Knowledge System – II	100	3	3-0-0
AEC	AEC982A201	Communicative English and Behavioural Science – II	100	2	2-0-0
SEC	BOT142S221	Plant Identification and Herbarium Techniques	100	3	0-0-6
VAC	VAC2	Course from available basket	100	3	3-0-0
MOOCs	MOOCs	*MOOCs/online course will be identified by the dept from the list of courses available on MOOC online platform/SWAYAM Platform	100	3	
TOTAL CREDIT FOR 2nd SEMESTER				23	

3rd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BOT142M301	Plant morphology, Anatomy & Taxonomy	200	4	4-0-0
Major (Core)	BOT142M312	Plant Morphology, Anatomy & Taxonomy – Practical	200	4	0-0-8
Minor	BOT42N301	Ethno-botany	200	4	4-0-0
IDC	IDC3	Basket Course	200	3	3-0-0
AEC	AEC982A301	Communicative English and Behavioural Science – III	200	2	2-0-0
SEC	BOT142S321	Floriculture	200	3	0-0-6
MOOCs	MOOCs	*MOOCs/online course will be identified by the dept from the list of courses available on MOOC online platform/SWAYAM Platfor	100	3	
TOTAL CREDIT FOR 3rd SEMESTER				23	
4th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BOT142M401	Microbiology & Mycology	200	3	3-0-0
Major (Core)	BOT142M402	Genetics & Plant breeding	200	3	3-0-0
Major (Core)	BOT142M403	Traditional medicinal plants of India	200	3	3-0-0
Major (Core)	BOT142M414	Practical: Microbiology, Genetics & Plant breeding	200	3	0-0-6
Minor	BOT142N401	Ecology, Environment and Biodiversity conservation	200	3	3-0-0
Minor	BOT142N402	Bio resource Management	200	3	3-0-0
AEC	AEC982A401	Communicative English and Behavioural Science – IV	200	2	2-0-0
MOOCs	MOOCs	*MOOCs/online course to be identified by the dept from the list of courses available on MOOC online platform/SWAYAM Platform	100	3	
TOTAL CREDIT FOR 4th SEMESTER				23	
5th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BOT142M501	Plant Physiology & Biochemistry	300	4	4-0-0
Major (Core)	BOT142M502	Reproductive Biology of Angiosperms	300	4	4-0-0
Major (Core)	BOT142M513	Practical: Plant Physiology, Biochemistry, & Reproductive Biology	300	4	0-0-8
Minor	BOT142N501	Environmental & Industrial Microbiology	300	4	4-0-0

Internship/Project	BOT142M521	Internship/In- Plant Training/Project After 4th semester exam	300	4	
TOTAL CREDIT FOR 5th SEMESTER				20	
6th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BOT142M601	Cell & Molecular Biology	300	4	4-0-0
Major (Core)	BOT142M602	Plant Ecology & Ecosystem Analysis	300	4	4-0-0
Major (Core)	BOT142M603	Farming Systems and Sustainable Agriculture	300	4	4-0-0
Major (Core)	BOT142M614	Practical: Cell, Molecular Biology, Ecology, & Agronomy	300	4	0-0-8
Minor	BOT142N641	Agronomy & Sustainable Development	300	4	3-0-1
TOTAL CREDIT FOR 6th SEMESTER				20	
7th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BOT142M701	Biostatistics & Bioinformatics	400	4	4-0-0
Major (Core)	BOT142M702	Applied Microbiology	400	4	4-0-0
Major (Core)	BOT142M703	Plant Biotechnology	400	4	4-0-0
Major (Core)	BOT142M714	Practical: Biostatistics, Biotechnology, Microbiology	400	4	
Minor	BOT42N701	Plant Biotechnology	400	4	4-0-0
TOTAL CREDIT FOR 7th SEMESTER				20	
8th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BOT142M801	Genetic Engineering in Plants	400	4	4-0-0
Minor	BOT142N801	Research Methodology	400	4	4-0-0
Project / Dissertation	BOT142M821	Dissertation	400	12	
IN LIU OF DISSERTATION					
Major (Core)	BOT142M802	Advanced plant systematics	400	4	4-0-0
Major (Core)	BOT142M803	Advanced plant physiology and biochemistry	400	4	4-0-0
Major (Core)	BOT142M804	Environmental Pollution and conservation	400	4	4-0-0
TOTAL CREDIT FOR 8th SEMESTER				20	

DETAILED SYLLABUS OF 1ST SEMESTER

MAJOR SUBJECT: CRYPTOGAMIC BOTANY (ALGAE, BRYOPHYTES & PTERIDOPHYTES)
SUBJECT CODE: BOT142M101, COURSE LEVEL: 100
L-T-P-C = 3-0-0-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: THEORY (T)

Prerequisite: Basic knowledge of biology and chemistry up to class 12

Course objective: To introduce the students to the diversity and type study of Cryptogams, their economic importance, and their evolution to present times.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	The course shall **infer** the students with an understanding of the wide diversity ofcryptogams, their economical, ecological & evolutionary variations and roles.	**BT -2**
CO2	The learners shall **develop** an understanding of the transition of early land plants fromaquatic to terrestrial habitats.	**BT-3**
CO3	The students shall be able to **outline** the applications of phycology, bryology & pteridology.	**BT -3**

Module Structure & Course Content

Module	Course content	Lecture hours
I	**Major Groups of Algae I: Cyanophyta, Chlorophyta and Charophyta**: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction.Type study of *Nostoc, Volvox and Chara* **Major Groups of Algae II: Xanthophyta, Pheophyta and Rhodophyta**: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Type study of *Vaucheria, Ectocarpus* and *Polysiphonia*	**15**
II	**Introduction to Archegoniates**: Unifying features of archegoniates. Transition to landhabit and its evolutionary significance. Alternation of generations. **Bryophytes:** General characteristics, Origin and evolution of bryophytes, Type Studies: Classification (up to family), morphology, anatomy and reproduction, in *Riccia, Marchantia, Anthoceros, Sphagnum and Funaria (development stages not included).* Ecological and economic importance of Bryophytes	**15**
III	**Pteridophytes:** General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*). Type Studies: Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum, Marsilea* and *Pteris*.	**15**
IV	Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution.Ecological and economic importance of pteridophytes. Recent studies and development in Cryptogamic Botany	**15**
TOTAL		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Text Books:

1. Bhattacharya K., Ghosh A. K., & Hait G. (2017). A Textbook of Botany. Vol I & II. NCBA Kolkatta.
2. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
3. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

Reference books:

1. Lee, R.E. Phycology. 2018. Cambridge University Press, Cambridge
2. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
3. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
4. R.S. Chopra. Taxonomy of Indian mosses: an introduction. 2009. Publications & Information Directorate, CSIR, New Delhi.
5. A Manual Of Cryptogamic Botany: Adapted To The Requirements Of The Science And Art Department(Classic Reprint). 2018. Charlotte M. W. Ross. Forgotten Books Publisher.

MAJOR SUBJECT: CRYPTOGAMIC BOTANY - PRACTICAL
SUBJECT CODE: BOT142M112 COURSE LEVEL: 100
L-T-P-C = 0-0-6-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: PRACTICAL (P)

Prerequisite: Basic knowledge of biology and chemistry up to class 12

Course objective: To introduce the students to the world of algae, mosses and ferns by showing them live specimens and photographs and enable the students to have a hands-on experience of observing of the first landplants and their diversity

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Employ** practical knowledge of lower plants	**BT - 2**
CO2	**Discover** early land plants and their diversity	**BT - 3**
CO3	**Examine** the morphology, anatomy and reproductive structures of the lower plants	**BT - 4**

Module Structure & Course Content

Module	Course content	Lecture hours
I	**1. Algae:** ***2.*** Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas*, Volvox, *Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus andPolysiphonia***,** 3. Temporary preparations and permanent slides (subject to availability, a 4. minimum of 5 genera to be studied).	**15**
II	**5. Bryophytes:** 6. Study of *Riccia & Marchantia*- Morphology of thallus, vertical section of thallusthrough Gemma cup. 7. *Anthoceros, Sphagnum, Funaria* (as per availability) - Morphology of thallus, L.S of sporophyte (temporary slide). temporary slides showing	**15**

	antheridial and archegonial heads, longitudinal section of capsule and protonema.	
III	**8. Pteridophytes:** 9. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section ofstem, mount of strobilus, mount of microsporophyll and megasporophyll (temporary slides). 10. *Equisetum*- Morphology, transverse section of internode, longitudinal section ofstrobilus, transverse section of strobilus, mount of sporangiophore, mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide). 11. *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll,mount of sporangium, mount of spores (temporary slides), transverse section of rhizome, mount of prothallus with sex organs and young sporophyte (permanent slide).	**15**
IV	12. 8. Field study, sample collection and diversity study of cryptogams	**15**
	Total	**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 FIELD VISITS SAMPLE COLLECTION SUBMISSION

Text books:

1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.

Reference Books:

1. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
2. Pandey.B.P. Modern Practical Botany Vol. 1, 2, 3. 2011. S.Chand Publication.

MINOR SUBJECT: DIVERSITY IN PLANTS
SUBJECT CODE: BOT142N141, COURSE LEVEL: 100
CREDIT UNITS: 03, L-T-P-C: 2-0-2-3
SCHEME OF EVALUATION: COMBINED THEORY & PRACTICAL (TP)

Course objective: Develop an understanding of the various groups of Plant kingdom and Acquire knowledge about the evolution from lower plants to higher plants in the Plant kingdom.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Recognize** various plant groups of plants from primitive to highly evolved	**BT 1**
CO2	**Infer** foundation for further studies in Botany	**BT 2**

Module Structure & Course Content

Module	**Topic and Course content**	**Lecture hours**
I	**Microbes:** Discovery, general characteristics and economic importance of viruses andbacteria. **Fungi:** General characteristics, range of thallus organization, reproduction, ecologicaland economic importance of fungi. General account and significance of symbiotic associations: Lichens and Mycorrhiza.	**11**
II	**Algae:** General characteristics, range of thallus organization, reproduction,	**11**

	ecologicaland economic importance of algae.	
III	**Archegoniates:** Unifying features, Alternation of generations. **Bryohytes:** General characteristics, range of thallus organization, reproduction,ecological and economic importance, adaptation to land habit. **Pteridophytes:** General characteristics, ecological and economic importance.	**11**
IV	**Gymnosperms:** General characteristics, ecological and economic importance. **Angiosperms:** General characteristics, ecological and economic importance	**11**
Total		**44**

Practical		
1	Study of preserved botanical specimens, different instruments used in a laboratoryand Microscopy; handling of microscope, preparation ofslides by sectioning different plant materials for microscopic study.	**1**
2	Study of different staining procedures (single, double and Gram staining), Preparationof Gram stain and other important stains used in laboratory.	**1**
3	Study of different types of bacteria through photographs and permanent slides	**1**
4	Study of various structures of *Nostoc* and *Fucus* through temporary preparations and permanent slides	**2**
5	Study of various structures of *Rhizopus* and *Agaricus* through temporary preparations and permanent slides	**2**
6	Study of various growth forms of lichen and different types of mycorrhiza through photographs	**1**
7	Study of vegetative and reproductive structures of *Marchantia* through temporary preparations andpermanent slides	**2**
8	Study of vegetative and reproductive structures of *Selaginella* and *Equisetum* through temporarypreparations and permanent slides	**2**
9	Study of vegetative and reproductive structures of *Cycas* and *Pinus* through temporary preparations andpermanent slides	**2**
10	Study of floral structures of *Hibiscus* sp. and *Tagetes* sp. (Marigold).	**1**
Total		**15**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
44	30	16 • HOME ASSIGNMENTS • SEMINARS • VIVAVOCE • FIELD VISITS

Text Books:

1. Bhattacharya K., Ghosh A. K., & Hait G. (2017). A Textbook of Botany. Vol I & II. NCBA Kolkata.
2. B. P. Pandey . Botany for Degree students – Biodiversity. 2010. S. Chand Publishers.

Reference Books:

1. Gangopadhyay A. Plant Biodiversity. 2007. Gene-Tech Books.
2. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
3. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.
4. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
5. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.

SEC 1: PLANT DISEASE IDENTIFICATION AND CONTROL
SUBJECT CODE: BOT142S121, COURSE LEVEL 100
L-T-P-C: 0-0-6-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: PRACTICAL (P)

Course objective: To introduce and develop basic concepts to the world of plant disease focusing on the management and control of pathogens and epidemics.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	To **describe and identify** the physical dimensions, forms, functions and habitats ofpathogens	**BT2 BT3**
CO2	To **experiment with different** plant diseases in different crops	**BT 3**
CO3	To **examine and infer** from the studied specimen the type and its management of thedisease in the plant kingdom	**BT 4**

Detailed Syllabus

Module	Course content	Lecture Hours
I	Plant disease introduction**:** Terms and concepts; Symptomology and identification of fungal, viral and bacterial plant diseases. Host-Pathogen relationships; Disease cycle and role of environment in disease development; prevention and control of plant diseases. Quarantine and its significance in control of plant diseases.	**15**
II	Major epidemics and their social impacts. Legislative, cultural, and biological protection measures of plant diseases. Koch's postulates. Factors influencing infection,colonization, and development of symptoms.	**15**
III	**Laboratory and Analytical Techniques** Preparation and sterilization of common media. Methods of isolation of plant pathogens andtheir identification. Preservation of microorganisms by pure culture method. Methods of inoculation. Detection and Diagnosis of pathogens in seeds and other planting materials.	**15**
IV	Collection and study of Fungal, Bacterial and Viral Diseases of Crop Plants Project on Management and control of Plant diseases	**15**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 FIELD VISITS SAMPLE COLLECTION SUBMISSION

TEXT BOOKS:

1. Paul Khurana, S. M. 2009: Pathological Problems of Economic crop plants and their management.
2. Dubey, R.C. and Maheshwari, D.K. (1999). A text book of Microbiology, S. Chand & Company Ltd.,New Delhi, India

REFERENCE BOOKS:

1. Pelczar, M.J. Microbiology. 2005.Tata McGraw-Hill Co, New Delhi
2. Planke, J. E. Vander. (2013) Plant Diseases Epidemics and control.
3. Sinclair W.A. and H.H. Lyon. Diseases of Trees and Shrubs. 2005. Cornell University Press.
4. Webster J and Weber R.W.S. Introduction to Fungi. 2007. Cambridge University Press.
5. Lucas J.A. Plant Pathology and Plant Pathogens. 2011. John Wiley and Sons Ltd.
6. Williamson VM, Kumar A (2006) Nematode resistance in plants: the battle underground. Trends inGenetics 22: 396–403.

DETAILED SYLLABUS OF 2ND SEMESTER

MAJOR SUBJECT: PHANEROGAMS: GYMNOSPERMS & ANGIOSPERMS
SUBJECT CODE: BOT142M201, COURSE LEVEL: 100
L-T-P-C=3-0-0-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: THEORY ONLY (T)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: To introduce the students to the world of phanerogams and their evolutionary significance, their detailed taxonomy, and their life cycles.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Identify** the phanerogams, their vegetative and reproductive structures and their importance.	**BT 1**
CO2	**Explain** evolutionary lines in each group of gymnosperms and angiosperms	**BT 2**
CO3	**Relate** the differences and the affinities between the Gymnosperms & Angiosperms.	**BT 3**

Detailed Syllabus

Modules	Course content	Lecture Hours
I	**Gymnosperms I:** History and recent systems of classification of gymnosperms; origin and evolution of gymnosperms; affinities of gymnosperms with pteridophytes and angiosperms; distribution of gymnosperms in India; Ecological and economic importance of gymnosperms **Gymnosperms II:** Gymnosperms: General characteristics. Classification Morphology and reproduction of Cycas, Pinus and Gnetum	**15**
II	**Angiosperms**: General characteristics; Classification, Basic concept of APG; Basal angiosperms and Magnoliids; Basal monocots; Petaloid monocots; Commelinids; Basal eudicots and Caryophyllids; Rosids; Asterids. Evolutionary trend in angiosperms. Origin and evolution of stamen, and carpel.	**15**
III	**Angiosperm Morphology** (stems, roots, leaves & flowers, inflorescence): morphology and modification of stems, roots, leaves, and buds. Types of inflorescence, Flower: parts of a typical flower, fruits and type of placentations, definition and types of seeds. **Palynology:** Pollen morphology; basic concepts of applied palynology. Role in taxonomic studies	**15**
IV	**Origin and evolution of Plants**: Origin and evolution of plants through Geological Time scale. **Paleobotany**- Paleobotanical records, fossil plants, process of fossilization- impressions, compressions, petrification, moulds and casts, pith casts. Radiocarbon dating. **Fossil taxa**- Rhynia, Lepidodendron, Lepidocarpon, Lyginopteris and Cycadeoidea. Significance of paleobotany in exploration of fossil fuels.	**15**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Text Books:

1. C. J. Chamberlain. Gymnosperms: Structure And Evolution. 2009. Andesite Press.
2. Bhattacharya K., Ghosh A. K., & Hait G. (2017). A Textbook of Botany. Vol I & II. NCBA Kolkatt

Reference Books:

1. A.V.S.S. Sambamurty. A Textbook Of Bryophytes, Pteridophytes, Gymnosperms And Paleobotany. 2006. I.K. International Publishing House Pvt. Ltd.
2. J. M. Coulter, C.J. Chamberlain. Morphology Of Gymnosperms. 2016. Wentworth Publishers.
3. W.N. Stewart and G.W. Rothwell. Paleobotany and the evolution of plants. 2010. Cambridge University Press
4. Charlotte M. W. Ross (2018) A Manual Of Cryptogamic Botany: Adapted To The Requirements Of TheScience And Art Department (Classic Reprint).. Forgotten Books Publisher.

MAJOR SUBJECT: PHANEROGAMS - PRACTICAL
COURSE LEVEL: 100, SUBJECT CODE: BOT142M212,
L-T-P-C: 0-0-6-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: PRACTICAL (P)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: To impart practical knowledge on various group of phanerogams, their diversity, morphology, anatomy and their fossil counterparts.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	The course will help the students to **gain** practical knowledge of vascular plants	**BT2**
CO2	They will be equipped to identify various anatomical structures of plant body	BT3
CO3	They will be able to identify economic importance of various plants	BT3

Detailed Syllabus

Module	Course content	Lecture hours
I	**Gymnosperms:** 1. Study of morphological, anatomical, and reproductive features of gymnosperms available in the region. 2. Types of pollen and germination in available gymnosperms species.	**15**
II	**Angiosperms:** 3. Study of morphological, anatomical, features of modified organs of angiosperms. 4. Study of types of inflorescence, and fruits. study of dicotyledonous angiospermic flower showing various parts by analytical drawing and identify up to genus. 5. Study of types of placentation and types of seeds of angiosperms.	**15**
	Paleo botany and palynology: 6. Study of fossil gymnosperms from photographs and museum specimens.	

III	7. Preparation of pollen grain slides by following different techniques.	**15**
IV	**8.** Study of various modified structures of angiosperms from available sources. 9. Field visit and collection 10. Mounting of properly dried and pressed specimen of gymnosperms and angiosperms with herbarium label (to be submitted along with the record book) (atleast two specimens for each group)	**15**
TotaL		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 FIELD VISITS SAMPLE COLLECTION SUBMISSION

Text books:

1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.

Reference Books:

1. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
2. Pandey.B.P. Modern Practical Botany Vol. 1, 2, 3. 2011. S.Chand Publication.

MINOR SUBJECT: ECONOMIC BOTANY
SUBJECT CODE: BOT142N201, COURSE LEVEL: 100
L-T-P-C=3-0-0-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: THEORY (T)

Course objective: To enable the students to have an understanding on how cultivated plants originated and how they are introduced across the world.

Course outcomes:

CO1:	**Explain** a brief idea on various methods used for extraction of various plant products like rubber etc., and **outline** the industrial applications of different plant parts for economic purposes	**[BT2]**
CO2:	**Experiment with** various uses of plants in day-to-day life.	**[BT3]**
CO3:	**Discover** an understanding of the economic aspects of various plants**.**	**[BT4]**

Detailed Syllabus

Modules	Course content	Periods
I	Introduction, origin, cereals and legumes: Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity. Cereals: Wheat and Rice (origin, morphology, processing & uses). Brief account of millets. Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.	12
II	Sugars, starches, spices and beverages: Sources of sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses. Spices: Listing	12

	of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper. Beverages: Tea, Coffee (morphology, processing & uses)	
III	**Oils and fats and rubber:** **Sources of oils and fats:** General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). **Essential Oils:** General account, extraction methods, comparison with fatty oils & their uses. Natural Rubber: Para-rubber: tapping, processing and uses.	12
IV	**Medicinal, timber and fiber plants**: Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver, Swvertia, Andrographis and Cannabis; Tobacco (Morphology, processing, uses and health hazards). Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).	12
Total		48

Text Book:

1. Kochhar, S.L. Economic Botany in Tropics, 2012. MacMillan & Co. New Delhi, India.
2. Kochhar, S.L. Economic Botany: a comprehensive study. 2016. Cambridge University Press.
3. Prasad, R.L. Essentials of Economic Botany. 2016. Medtech.

Reference Books:

1. Harlan, J.R. Crops and Man. 2nd ed. 1992.Madison W D: American Society of Agronomy.
2. Chrispeels, M.J. and Sadava, D.E. Plants, Genes and Agriculture. 1994. Jones & Bartlett Publishers.
3. A.V.S.S. Sambamurty and N.S. Subrahmanyam. A Textbook of Modern Economic Botany. 2008. CBS Publisher.
4. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

SEC II: PLANT IDENTIFICATION AND HERBARIUM TECHNIQUES
SUBJECT CODE: BOT142S221, COURSE LEVEL: 100
L-T-P-C: 0-0-6-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: PRCTICAL (P)

Course objective: To impart practical knowledge on various plant identification systems, their preservation and utilization.

Learning Outcomes: At the end of the course the student will be:

CO1	**Identify, describe,** and practice different methods of plant identification Systems	BT2 & BT3
CO2	**Categorize** different techniques used in preservation and utilize its knowledge in various field of application	BT 4

Detailed Syllabus:

Module	Course content	Lecture hours
I	**Plant identification:** Introduction, importance of plant identification. **Tools of identification:** Expert determination, Herbarium, taxonomic literature (Floras, Manuals, Monographs, Icons, Journals, Supporting literature), taxonomic keys, interactive keys/ visual keys, Computers in identification, molecular plant identification.	**22**
	Plant nomenclature: History of organized nomenclature, International Code of	

II	Nomenclature for Algae, Fungi and Plants (ICN)- ranks of taxa, valid and effective publications, principle of priority, changes of names, rejection of names, name ofhybrids, and cultivated plants.	**22**
III	**Herbarium:** Introduction, definition, history, objective, types of herbaria, importance, major herbaria in the world and India. **Herbarium techniques:** Preparation for collection; field equipment, kinds of field work, Ethical guidelines for field works. Maintenance of Herbarium.	**22**
IV	**Herbarium Techniques for special types of plants:** Aquatic plants, cane, bamboo, succulents, rhizomatous plants, resinous plants, algae, Lichens, wild mushrooms, and bryophytes. **Digital/virtual herbarium**: Introduction and importance of digital herbaria. **Practical/ Project based on the syllabus.**	**24**
Total		**90**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 FIELD VISITS SAMPLE COLLECTION HERBARIUM PREPARATION &SUBMISSION

Textbooks:

1. Simpson, M. G. 2006. Plant Systematics. Elsevier, Amsterdam
2. Rao and Jain 1976. A Handbook of Field and Herbarium methods
3. Singh, G. 2012. Plant Systematics- Theory and Practice. Oxford and IBH Publishing Co Pvt Ltd,
4. Sharma and Sharma 2007. Taxonomy. Pragati Prakashan, Meerut

Reference Books:

1. Anderson, N. O., and J. D. Walker. 2003. Effectiveness of Web-based versus live plant identification tests. Horttechnology 13:199-205.
2. Dirr, M. A. 1998. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics,Culture, Propagation and Uses. Stipes Publishing, Champaign, IL
3. Kahtz, A. W. 2000. Can computer assisted instruction be used by students for woody plant identification. Hort. technology 10:381-384.

DETAILED SYLLABUS OF 3RD SEMESTER

MAJOR SUBJECT: PLANT MORPHOLOGY, ANATOMY & TAXONOMY
Subject Code: BOT142M301, COURSE LEVEL: 200
L-T-P-C=4-0-0-4, Credit Units: 04
SCHEME OF EVALUATION: Theory (T)

Prerequisite: Basic knowledge of biology of class XII.
Course objective: To introduce the students to the different tissue systems in angiosperms and their morphology, how they function and the theories of root and shoot development.
Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Recognize** the various tissue organization of the plant body	**BT1**
CO2	**Describe** the development and functions of various tissue systems inside the plant body.	**BT2**
CO3	**Analyze** special types of anatomical adaptations in xerophytes and hydrophytes.	**BT4**

Detailed Syllabus

Module	Course content	Lect. hours
I	**Introduction and organization of plant body: Tissues**: Classification of tissues; Simple and complex tissues; Tissue system. **Stem:** Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory. Types of vascular bundles; Structure of dicot and monocot stem anatomy. **Leaf:** Structure of dicot and monocot leaf anatomy, Kranz anatomy. **Morphology**: Inflorescence, stamens, carpel and fruit morphology; Telome theory, phyllode theory.	**15**
II	**Root:** Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root. **Vascular Cambium**: Structure, function and seasonal activity of cambium; Secondary growth in root and stem **Wood:** Axially and radially oriented elements; Types of rays and axial parenchyma; Sapwood and heartwood; Ring and diffuse porous wood. **Adaptive anatomy:** Hydrophytes and xerophytes.	**15**
III	**Angiosperm Taxonomy:** Aims of taxonomy, History of classification- Artificial, Natural (Bentham and Hooker), Phylogenetic (Englar & Prantl, Hutchinson, Takhtajan), APG system- a brief idea; Role of Morphology, anatomy, embryology, cytology, phytochemistry, and palynology in relation to taxonomy; Botanical Survey of India- Organization and activities, Botanical Garden and its importance.	**15**
IV	**Botanical nomenclature**: Principles and rules (ICN); Typification, valid and effective publication, rejection of names, principle of priority and its limitations. **Family studies**: Affinities, phylogeny, economic importance and comparative studies of the following families: Magnoliaceae, Brassicaceae, Fabaceae, Malvaceae, Cucurbitaceae, Euphorbiaceae, Apiaceae, Rubiaceae, Solanaceae, Acanthaceae, Verbenaceae, Lamiaceae, Asteraceae. Arecaceae, Musaceae, Zingiberaceae, Orchidaceae, Poaceae.	**15**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Textbook:

1. Evert, R.F. Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. 2006. John Wiley and Sons, Inc.
2. Katherine Esau. Anatomy Of Seed Plants.2006. Wiley Publications.
3. B.P. Pandey. Plant Anatomy. 2001. S. Chand Publication.
4. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
5. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.

Reference Books:

1. Charles B. Beck. An introduction to plant structure and development (plant anatomy for 21st century). (2nd edition). 2010. Cambridge University Press.
2. James D. Mauseth. Plant Anatomy.2008. The Blackburn Press.
3. William Chase Stevens. Plant Anatomy from The Standpoint of The Development and Functions of The Tissues: And Handbook of Micro-Technic.2012. Wentworth Press.
4. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row, New York.
5. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
6. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. 2002. Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.

MAJOR SUBJECT: PLANT MORPHOLOGY, ANATOMY & TAXONOMY - PRACTICAL
Subject Code: BOT142M312, COURSE LEVEL: 200
L-T-P-C=0-0-8-4, Credit Units: 04
SCHEME OF EVALUATION: Practical (P)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: To impart practical knowledge on various group of archegoniates, have a clear concept on cellular structure of plants by microscopic observation, have a hands-on experience on economically important plant parts used, and do microchemical tests to observe the molecules present there.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	The course will help the students to **gain** practical knowledge of vascular plants.	**BT1**
CO2	They will be equipped to **identify** various anatomical structures of plant bodies.	**BT2**
CO3	They will be able to **describe** the economic importance of various plants.	**BT2**

Detailed Syllabus

Module	**Course content**	**Lecture hours**
I	**Plant anatomy**: 1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/museum specimens/microphotographs with the help of suitable examples. 2. Apical meristem of root, shoot and vascular cambium.	**22**

	3. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres. 4. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood. 5. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.	
II	6. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular. 7. Root: monocot, dicot, secondary growth. 8. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels. 9. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy). 10. Adaptive Anatomy: xerophytes, hydrophytes. 11. Secretory tissues: cavities, lithocysts and laticifers.	**22**
III	12. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): • Ranunculaceae –*Ranunculus/Delphinium* • Brassicaceae –*Brassica/Rorippa* • Apiaceae - *Coriandrum / Foeniculum* • Rubiaceae – *Ixora/Hedyotis* • Asteraceae - *Vernonia/Ageratum/ Eclipta/Mikania* • Solanaceae - *Solanum nigrum/Solanum indicum* • Lamiaceae - *Salvia/Ocimum* • Acanthaceae – *Justicia/Phlogocanthus* • Euphorbiaceae - *Euphorbia hirta/E.milii/E. pulcherrima* • Musaceae - *Musa* • Liliaceae - Lilium/Allium • Poaceae - *Triticum/Avena/Oryza*	**24**
IV	13. Field visit (local) – Subject to grant of funds from the university. 14. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).	**22**
Total		**90**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 FIELD VISITS SAMPLE COLLECTION HERBARIUM SUBMISSION

Textbook:

1. Evert, R.F. Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. 2006. John Wiley and Sons, Inc.
2. Katherine Esau. Anatomy Of Seed Plants.2006. Wiley Publications.

Reference Books:

1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
3. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
4. Pandey B.P. Modern Practical Botany Vol. 1, 2, 3. 2011. S. Chand Publication.

MINOR SUBJECT: ETHNOBOTANY
Subject Code: BOT142N301, COURSE LEVEL: 200
L-T-P-C=4-0-0-4, Credit Units: 04
SCHEME OF EVALUATION: Theory (T)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: To introduce the students to the various ways plants are used in a particular culture and region, to present its scope as an interdisciplinary science and its relevance in modern times.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Describe** various traditional methods of medical treatments in various communities of India	**BT2**
CO2	**Compute** the traditional knowledge of prominent tribes of Assam	**BT3**
CO3	**Infer** the applications of the ethnomedicine in modern pharmaceutical systems	**BT4**

Detailed syllabus:

Module	**Topic/ Course content**	**Lecture hours**
Theory		
I	Basic concept of society, community and groups, Characteristics and of rural communities, Scope and Importance of botany in Rural Economy and Employment Generation, Importance in food and nutritional security, Ecotourism.	**12**
II	Ethnobotany in North -east India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany.	**12**
III	Ethnomedicine, ethnoecology, ethnic communities of NE India. Application of natural products to certain diseases - Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases	**12**
IV	Herbs used by dominant communities of Assam- Bodo, Tiwa, Karbi, Garo and Rabha in their day-to-day life.	**12**
Total		**48**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Text Books:

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.

References:

1. S.K. Jain (ed.) Glimpses of Indian Ethnobotany, Oxford and I B H, New Delhi – 1981
2. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.

SEC: FLORICULTURE
SUBJECT CODE: BOT142S321, COURSE LEVEL: 200
L-T-P-C=0-0-6-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: PRACTICALS (P)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: The student will learn the techniques of floriculture, the economic importance of different plants used in floriculture and the commercial aspect of floriculture.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Recognize** field-based application on flower cultivation and marketing.	**BT1**
CO2	**Identify** gardening techniques for different flowers	**BT2**

Detailed Syllabus:

Mod	Content	Lect. hour
I	Importance and scope of floriculture and landscape gardening, Types of gardens, garden elements, styles of gardening, famous gardens in India and abroad, principles of gardening.	**9**
II	Ornamental plants, flowering annuals, herbaceous perennials, divine vines, shade and ornamental trees, ornamental bulbous and foliage plants, cacti and succulents, palms and cycads, ferns and selaginellas, cultivation of plants in pots, indoor gardening, bonsai.	**9**
III	Methods of propagation of flowers, sexual and vegetative methods of propagation, soil sterilization, seed sowing, pricking, planting and transplanting, shading, defoliation, wintering, mulching, topiary, role of plant growth regulators, maintenance of cut flowers	**9**
IV	Commercial floriculture, factors affecting flower production, production and packaging of cut flowers, flower arrangements, methods to prolong vase life, cultivation of important cut flowers (Carnations, Asters, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Lilium, Orchids). Mode of transportation and preservation of loose and cut flowers.	**9**
Total		**36**

Projects based on the syllabus such as:

1. Digital album of world-famous gardens, 2. Development of gardens in RGU campus.
3. Exhibition of floral arrangements of both fresh and dry flowers.

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 • HOME ASSIGNMENTS • SEMINARS • VIVAVOCE • FIELD VISITS

Text Books:

1. Singh, A. K. (2014). *Floriculture: Basic Concepts and Methods*. New India Publishing Agency.
2. Reddy, S., Janakiram, T., Balaji, T., & Kulkarni, S. (2007). *Floriculture*. Kalyani Publishers.

Reference Books:

3. Randhawa, G. S., & Mukhopadhyay, A. (1986). *Floriculture in India*. Allied Publishers.
4. Sheela, V. L. (2008). *Horticulture*. MJP Publishers.
5. Arora, J. S. (2006). *Introductory Ornamental Horticulture*. Kalyani Publishers.
6. Laurie, A., Kiplinger, D. C., & Nelson, K. S. (2001). *Commercial Floriculture* (2nd ed.). CBS Publishers.

DETAILED SYLLABUS OF 4TH SEMESTER

MAJOR SUBJECT: MICROBIOLOGY & MYCOLOGY
SUBJECT CODE: BOT142M401, COURSE LEVEL: 200
L-T-P-C=3-0-0-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: THEORY (T)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: To introduce and develop basic concepts to the world of microbes focusing on the diversity and fundamental biological processes of bacteria, viruses & algae.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	To **describe** the physical dimensions, forms, functions and habitats of bacteria, plant & animal viruses, the diversity of algae, the ecological role of fungi and the biotechnological application of certain species of all the three groups	**BT2**
CO2	To **distinguish** between the micro and macro forms of life and their value-addition to the environment.	**BT2**
CO3	To **illustrate** the differences between the antagonistic and beneficial roles of bacteria, viruses & Fungi in the plant kingdom	**BT3**

Detailed Syllabus

Module	Course content	Lecture hours
I	**Introduction to microbial world**: Introduction to microbial world, microbial nutrition, growth and metabolism. **Viruses**: Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus(T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses	**12**
II	**Bacteria**: Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria.	**12**
III	**Introduction to fungi:** Introduction to true fungi, Affinities with plants and animals; Cell wall composition; Nutrition; Classification. General account of Chytridiomycetes, Zygomycota, Ascomycota Basidiomycota and Oomycota: Heterokaryosis and parasexuality. **Allied Fungi:** General characteristics; Status of Slime moulds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies. **Symbiotic associations**: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization. Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.	**12**
IV	**Applied Mycology:** Role of fungi in biotechnology, Application of fungi in industries and Agriculture (Biofertilizers); **Phytopathology:** Terms and concepts; Symptomology and identification of plant diseases with reference to fungi, bacteria, and viruses. Host-Pathogen relationships; Disease cycle and role of environment in disease development; prevention and control of plant diseases, and role of quarantine. Type study of few important diseases (eg: Citrus canker, Tobacco Mosaic viruses, Early blight of potato, Black stem rust of wheat, White rust of crucifers, etc)	**12**
Total		**48**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 • HOME ASSIGNMENTS • SEMINARS • VIVAVOCE • FIELD VISITS

SUGGESTED READINGS:

Textbooks:

1. Dubey, R.C. and Maheshwari, D.K. (1999). A textbook of Microbiology, S. Chand & Company Ltd., New Delhi, India
2. Pelczar, M.J. Microbiology. 2005.Tata McGraw-Hill Co, New Delhi
3. Tortora G.J., Funke B.R., Case C.L., Weber D and Bair W. Microbiology: An Introduction (13th Edition). 2018. Pearson Publisher.

Reference books:

1. Wiley, J.M., Sherwood, L.M. and Woolverton C.J., Prescott. Microbiology. 2017. McGraw Hill International.
2. Madigan M.T., Martinko J.M., Bender K.S., Buckley D.H., Stahl D.A., Brock T. Brock Biology of Microorganisms (14th Edition). 2014. Pearson Publisher.
3. Harvey R.A. and Cornelissen C.N. Lippincott Illustrated Reviews: Microbiology (Lippincott Illustrated Reviews Series) Third, North American Edition. 2012. LWW; Third, North American edition.

MAJOR SUBJECT: GENETICS & PLANT BREEDING
Subject Code: BOT142M402, COURSE LEVEL: 200
L-T-P-C=3-0-0-3, Credit Units: 03
SCHEME OF EVALUATION: Theory (T)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: To acquaint the students with the basics of plant genetics and heredity.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Describe** Mendel as well as the chromosomal basis of inheritance.	**BT2**
CO2	**Predict** the basis of inheritance and variation caused due to mutation and aberrations.	**BT2**
CO3	**Evaluate** the techniques to create new varieties with a set of desired characteristics.	**BT3**

Detailed syllabus:

Modules	Topics / Course content	Periods
I	History, branches, and applications of genetics. Mendelism: Mendel's laws of inheritance – Law of dominance, law of segregation and law of independent assortment. Monohybrid crosses and Dihybrid crosses. Deviation from Mendel's law: Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy. Penetrance and Expressivity, Polygenic inheritance	**12**
II	Extranuclear inheritance and maternal effect. Chromosomal aberrations: Numerical and structural aberrations. Significance of chromosomal aberration in crop improvement. Mutations: types and causes: Spontaneous and induced mutation (Spontaneous lesion, tautomeric shift, biological factors, chemical and physical mutagens).	**14**
III	Fine structure of gene: Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism. Population and evolutionary genetics: Allele frequencies, Genotype	**10**

	frequencies, Hardy-Weinberg Law, role of natural selection, genetic drift. Genetic variation and Speciation.	
IV	Principles and objectives of Plant Breeding: Domestication and centers of origin of cultivated plants. Plant introduction and Selection methods: mass, pure line and clonal selection. Hybridization and its types; Methods: emasculation, bagging & tagging. Heterosis – polyploidy and its role in plant breeding. Introduction to haploidy, autopolyploidy and allopolyploidy.	**12**
Total		**48**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

SUGGESTED READINGS:

Textbooks:

1. Karp, G. 1996. Cell and Molecular Biology. John Wiley and Sons Inc. New York, Singapore.
2. Russell, P.J. and Gordey, K., 2002. *IGenetics* (No. QH430 R87). San Francisco: Benjamin Cummings.
3. Singh, B.D., 2005. Plant Breeding, principles and methods (7th Revised and enlarged edition). Kalyani publishers, New Delhi.
4. Gupta, P.K., 2007. Genetics - Classical to modern. Rastogi Publications, Meerut, India.

Reference books:

1. Sundarraj D and Thulasidas, G. 1972. Introduction to cytogenetics and Plant Breeding (III Edn.) Popular Book Depot. Madras.
2. George W. Burns, 1969. The Science of Genetics. An introduction to heredity. The Macmillan company. New York.
3. Gardener, J, Simmons, H.J and Snustad, D.P. 1991. Principles of Genetics (8th edition), John Wiley & Sons, New York.
4. Darbeshwar Roy, 2012. Plant breeding - A biometrical Approach. Narosa Publishing House, New Delhi.
5. Chahal, G.S. and Gosal, S.S. 2002. Principles and procedures of plant Breeding. Narosa Publishing House. New Delhi.
6. George M. M., 2005. Freifelder's Essentials of Molecular Biology. 4th edition. Narosa Publishing House, New Delhi.

MAJOR SUBJECT: TRADITIONAL MEDICINAL PLANTS OF INDIA
SUBJECT CODE: BOT142M403, COURSE LEVEL: 200
L-T-P-C=3-0-0-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: THEORY (T)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: To impart knowledge on the traditional methods of using medicinal plants in India and also introducing to the students the basic concept of ethnobotany.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Describe** various traditional methods of medical treatments in various communities of India	**BT2**
CO2	**Compute** the traditional knowledge of prominent tribes of Assam	**BT3**
CO3	**Infer** the various applications of ethnomedicine in modern pharmaceutical systems	**BT4**

Detailed syllabus:

Module	Topic/ Course content	Lect. hour
I	**History, Scope and Importance of Medicinal Plants**. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumours treatments/ therapy, polyherbal formulations.	**10**
II	**Conservation Of Endangered and Endemic Medicinal Plants**. Definition: endemic and endangered medicinal plants, red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.	**10**
III	**Ethnobotany and Folk medicines**. Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases.	**09**
IV	**Ethnomedicine, Ethnoecology, Ethnic Communities of NE India**. Herbs used by dominant communities of Assam- Bodo, Tiwa, Karbi, Garo and Rabha in their day-to-day life.	**07**
Total		**36**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

SUGGESTED READINGS:

Textbooks:

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
3. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
4. S.K. Jain (ed.) Glimpses of Indian Ethnobotany, Oxford and I B H, New Delhi – 1981
5. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.

MAJOR SUBJECT: MICROBIOLOGY, GENETICS & PLANT BREEDING- PRACTICAL
SUBJECT CODE: BOT142M414, COURSE LEVEL: 200
L-T-P-C=0-0-6-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: PRACTICAL (P)

Prerequisite: Basic knowledge of biology of class XII.

Course objective: To impart practical knowledge on various groups of archegoniates, have a clear concept on cellular structure of plants by microscopic observation, have a hands-on experience on economically important plant parts used, and do microchemical tests to observe the molecules present there.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Employ** practical knowledge of microns, fungi, as well as lower plants such as algae	**BT3**
CO2	**Reproduce** the different cell division techniques.	**BT1**
CO3	**Demonstrate** techniques used in plant breeding.	**BT4**

Detailed syllabus:

Module	Course content	Lecture hours
I	**Microbiology:** 1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle. 2. Types of Bacteria to be observed from temporary/permanent slides/photographs. 3. Demonstrate Gram staining: Curd and root Nodule **Lichens:** 4. Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. **Phytopathology:** 5. Herbarium specimens/ photographs of bacterial diseases, fungal diseases, viral disease in plants. Preparation and submission of disease album.	**12**
II	**Mycology:** 6. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps). 7. Study of asexual stage from temporary mounts and sexual structures through permanent slides. *Rhizopus/ Aspergillus/ Penicillium/ Alternaria* 8. *Peziza*: sectioning through ascocarp. 9. *Agaricus*: Specimens of button stage and full-grown mushroom; sectioning of gills of *Agaricus*.	**12**
III	10. Study of cell division – Mitosis in onion root tips (Squash method), meiosis in *Rheo discolour* or *Allium Cepa* or any available material/flower buds (Smear method). 11. Genetic problems based on theory syllabus – monohybrid, dihybrid, test cross and gene interaction, gene interaction viz dominant, co-dominant, supplementary gene.	**12**
IV	12. Hybridization techniques - Emasculation, Bagging and tagging. 13. Induction of polyploidy in plants.	**12**
Total		**48**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 • SAMPLE COLLECTION • VIVAVOCE • FIELD VISITS

Text Books:

1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
3. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
4. Pandey B.P. Modern Practical Botany Vol. 1, 2, 3. 2011. S. Chand Publication.

MINOR SUBJECT: ECOLOGY, ENVIRONMENT AND BIODIVERSITY CONSERVATION
Subject Code: BOT142N401, COURSE LEVEL: 200
L-T-P-C=3-0-0-3, Credit Units: 03
SCHEME OF EVALUATION: Theory (T)

Prerequisite: Basic knowledge of biology of class XII.

Course Objectives: The aim of the course is to build up the knowledge among the students about the biodiversity of India and world and different conservation strategies used for preserving the biodiversity.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Describe and Classify** biodiversity, its types, status, hotspot and its conservation status.	**BT1 BT2**
CO2	**Identify and categorize** the plant under the different categories of threat**.**	**BT4**
CO3	**Evaluate** strategies for biodiversity conservation.	**BT4**

Detailed Syllabus:

Module	Course content	Lect. hours
I	**Ecology:** Definition, factors affecting ecology, types of ecology, importance of ecology. **Introduction to biodiversity**: Biodiversity – types, levels, threats, value and uses; distribution and gradients of biodiversity. Agrobiodiversity outlines, megadiverse nation. Biodiversity hotspots with special emphasis on Indian hotspots. Biodiversity and Ecosystem services (BES), status of biodiversity conservation in India.	**9**
II	**Measures of Biodiversity:** Alfa, Beta and Gamma diversities – Indices of diversity and evenness – The Simpson Index Diversity of fully censured communities – Estimating the diversity of large community – Evenness and Equitability – Hierarchical diversity. **Causes and Consequences of Biodiversity Loss:** Habitat Loss and Alteration. Exotic Species. Chemical Pollutants. Loss of Genetic Diversity in Crops	**9**
III	**Introduction to Conservation**: Types of conservation. Conservation strategies, IUCN Red list of threatened Species. Extinction of species, IUCN protected area management categories. Role of organizations in the conservation of biodiversity – IUCN, WCED, UNEP, NBPGR, CBD.	**9**
III	**Conservation Strategies**: Laws and Legal Actions. Grassroots Action Programs. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).	**9**

Total	**36**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE

Textbooks:

1. Krishnamurthy, K.V. 2017. A textbook of Biodiversity, CRC Press.
2. Sharma, P. D. (2009). Ecology and Environment, Rastogi Publications, Meerut, India

Reference Books:

1. Bharucha, F.R. A textbook of plant geography of India, Oxford University Press, 179 pages
2. Cain, S.A. 1944. Foundations of Plant Geography, Harper & Brothers, N.Y.
3. Schulze E. D., et al. 2010. Plant Ecology. Springer.
4. Chapman, J. L. and Reiss, M. J. (1992). Ecology – Principles and Applications, Cambridge University Press, Cambridge, UK

MINOR SUBJECT: BIORESOURCE MANAGEMENT
SUBJECT CODE: BOT142N402, COURSE LEVEL: 200
L-T-P-C=3-0-0-3, CREDIT UNITS: 03
SCHEME OF EVALUATION: THEORY (T) ONLY

Prerequisite: Basic knowledge of biology of class XII.

Course Objective: The course is developed with an aim to identify and apply biological agents for the production of a specific bioproduct with the desired yield and purity.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Classify** PGPM and **predict** the use of specific PGPM in different areas of agriculture.	**BT2** **BT3**
CO2	**Categorize** the different microbes and the raw materials that can be used for the production of different types of biofuels.	**BT4**
CO3	**Outline** a model that can be used be tried and applied for future perspective.	**BT4**

Detailed Syllabus:

Module	**Course content**	**Lect. hours**
I	Plant growth promoting microbes (PGPM) and their mass production for agriculture and forestry; principles and usage of bioreactors; types of bioreactors; microbial fermentation.	**9**
II	Environmental monitoring of GEMs; bioconversion of waste products by microbes with special reference to biogas and organic compost; steroid bio-transformations. **Biofuels Production process:** Various Biofuels production processes from renewable energy sources, merits and demerits of different biofuels production processes. Various microbes involved, Different biochemical routes for the Biofuels production.	**10**
III	**Introduction to biofilms and EPS** • Review of microbial lifestyle/basic concepts in microbiology, adhesion, occurrence and development of biofilms • Biofilm Development (attachment, differentiation and dispersal)	**7**
IV	**Biosafety, bioethics & IPR**: Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on	**10**

	biosafety, WTO and other international agreements related to biosafety. The WTO and other international agreements; Types, patents, copy rights, trademarks, design rights, geographical indications – importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO). Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc.; Implications of intellectual property rights on the commercialization of biotechnology products.	
Total		**36**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE

Textbooks:

1. "Biofuels from algae", 2nd edition, Elsevier (2018), Editors: Duu Jong Lee, Ashok Pandey, Jo-Shu Chang, Yusuf Chisti, Carlos Soccol, Paper back ISBN-13: 978-04446421922
2. "Process synthesis for fuel ethanol production", CRC Press (2009), C.A. Cardona, O.J. Sanchez, L.F. Gutierrez, ISBN-13: 978-1439815977Kumar, P.S.G. 2004. Research methods and statistical techniques. B.R. publishing Academy, Udaypur.

Reference Books:

1. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
2. Prescott, L. Harley, J. and Klein, D. 2017. Microbiology. Tata McGraw-Hill Co. New Delhi.
3. Crueger, W. and Crueger, A. (2000). Biotechnology: A textbook of industrial microbiology Panima Publishing Corporation, India.
4. Edward, A.B. (1992). Modern Microbiology – Principles and application, WMC Brown Publishers, USA.

DETAILED SYLLABUS OF 5th SEMESTER

MAJOR SUBJECT: PLANT PHYSIOLOGY & BIOCHEMISTRY
SUBJECT CODE: BOT142M501, COURSE LEVEL: 300
L-T-P-C=4-0-0-4 CREDIT UNITS: 04
SCHEME OF EVALUATION: THEORY (T)

Course objectives: Develop an understanding of the various physiological and biochemical processes operating in a plant system.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Recognize** the fundamental concepts of plant physiology	**BT1**
CO2	**Describe** the different processes affecting plant growth and development	**BT2**
CO3	**Discover** the roles of different plant hormones in plant growth and development	**BT3**
CO4	**Interpret** their application for crop improvement programs.	**BT4**

Module	Topic and Course content	Lecture hours
I	**Plant-water relations:** Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement. Symplast, apoplast, transmembrane pathways, root pressure, guttation, Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, anti transpirants, mechanism of stomatal movement.	15
II	**Mineral nutrition:**Macro and micronutrients and chelating agents. Mineral deficiency symptoms, roles of essential elements. Solute Transport: Passive and Active transport: transport of ions across cell membrane, passive absorption, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.	15
III	**Photosynthesis:** The Light Reaction: Organization of photosynthetic apparatus; Mechanism of Electron transport and mechanism of ATP synthesis; The Dark reaction: Calvin cycle, C4 and CAM pathways; Photorespiration. **Respiration:** Glycolysis, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway. Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.	15
IV	**Physiology of flowering:** Photoperiodism and Photomorphogenesis, flowering stimulus, florigen concept, Vernalization. Role of Phytochrome, cryptochromes and phototropins. Plant growth regulators: Discovery and role of Auxins, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids, Jasmonic acid and Strigolactones.	15
TOTAL		60

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 • HOME ASSIGNMENTS • SEMINARS • VIVAVOCE • FIELD VISITS

Text Books:

1. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
2. Lehninger Biochemistry

Reference Books:

1. Buchanan B.B, Gruissem W. and Jones R. L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland,USA.

2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Dennis D. T., Turpin, D. H. Lefebvre D. D. and Layzell D. B.(eds) (1997). Plant Metabolism (Second Edition) Longman, Essex, England.
5. Willium G Hopkins, Norman P Hunar (2009) Introduction To Plant Physiology, Wiley.

MAJOR: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS
SUBJECT CODE: BOT142M502, COURSE LEVEL: 300
CREDIT UNITS: 04; L-T-P-C = 4-0-0-4
SCHEME OF EVALUATION: THEORY ONLY (T)

Course Objective: The course is designed to inform the student about the various bioresources and its management.

Course Outcomes: By the end of the course the students will be able to:

CO1	**Identify** the students about the development of flower, various stages of development of male and female gametophytes and the process of fertilization**.**	BT 1
CO2	**Recognize** stages of development and reproductive parts of angiosperms	BT2
CO3	**Predict** various incompatibilities and hybridization process in plants.	BT 3
CO4	**Compare** various types of embryo development and seed types in plants.	BT 4

Detailed Syllabus:

Modules	Course content	Periods
I	Flower as a modified determinate shoot; ABC model of flower development. Development of Anther. Anther wall: Structure and functions, Microsporogenesis and Micro-gametogenesis; Pollen wall structure. Pollen viability. Abnormal features of pollen.	**15**
II	**Ovule Structure, pollination, and double fertilization**: Ovule Structure; Types; Special structures. Megasporogenesis and Mega-gametogenesis (details of *Polygonum* type). Organization and ultrastructure of mature embryo sac. Pollination Pollen pistil interaction. Double fertilization.	**15**
III	**Self-incompatibility**: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic). Methods to overcome self-incompatibility reactions. Intra-ovarian and in vitro pollination. Parasexual hybridization; Cybrids, in vitro fertilization.	**15**
IV	**Embryo, Endosperm and Seed Structure and types:** Development of dicot and monocot embryo and endosperm. Suspensor: structure and functions; Embryo-endosperm relationship, Nutrition of embryo. Unusual features embryo development in *Paeonia*. Seed structure, importance, and dispersal mechanisms. Polyembryony and apomixes.	**15**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 • HOME ASSIGNMENTS • SEMINARS • VIVAVOCE • FIELD VISITS

Text Book:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2014). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Pandey B.P. Embryology of Angiosperm. 2017. Rastogi publication, Meerut.
3. Raghavan, V. Developmental Biology of Flowering plants. 2000. Springer, Netherlands.

Reference Book:

1. Haig D and Westoby M. Seed size, pollination costs and angiosperm success.1991. Springer-Verlag, Netherlands. (Research Paper).
2. Johri, B.M. Embryology of Angiosperms. 2015. Springer-Verlag, Netherlands.
3. Raghavan, V. Molecular embryology of flowering plants. 1997. Cambridge, University Press.
4. Went van J.L. Fertilization in Angiosperm plants. 1992. Springer-Verlag, Netherlands. (Research paper

MAJOR SUBJECT: PLANT PHYSIOLOGY, BIOCHEMISTRY & REPRODUCTIVE BIOLOGY - PRACTICAL
SUBJECT CODE: BOT142M513, COURSE LEVEL: 300
CREDIT UNITS: 04; L-T-P-C=0-0-8-4,
SCHEME OF EVALUATION: PRACTICAL (P)

Course objective: To impart practical knowledge on various cellular and molecular biology techniques

Learning Outcomes: At the end of the course the student will be able to:

CO1	**Identify** basic concepts of plant physiology, including water potential, transpiration, and mineral nutrition.	BT 1
CO2	**Examine** key physiological processes like photosynthesis, photoperiodism, and the role of growth regulators in plants	BT 4
CO3	**Analyze** experimental results related to plant physiology, including water potential, transpiration, and photosynthesis.	BT3
CO4	**Perform** molecular biology techniques, including DNA extraction, gel electrophoresis, and PCR, for genetic analysis.	BT4

Detailed Syllabus:

Module	Course content	Lecture hours
I	1. Determination of Water Potential and its components in plant by gravimetric and weight method. 2. Determination of rate of transpiration using potometer. 3. Identification of mineral deficiency symptoms in plants.	**15**
II	4. Measurement of the rate of photosynthesis using Hill's Reaction. 5. Effect of photoperiod on flowering in short day and long day plants. 6. Effect of plant growth regulators on seed germination and growth.	**15**
III	7. Study of Vegetative and Floral Characters 8. LS/TS of anther and ovary.	**15**
IV	9. Study of different embryo. 10. Pollen Viability Test	**15**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 • INDUSTRY/LAB VISITS • SAMPLE COLLECTION • LAB PERFORMANCE • EQUIPMENT HANDLING

Text Book:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2014). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Pandey, B.P. Embryology of Angiosperm. 2017. Rastogi publication, Meerut.
3. Plummer, D. T. An introduction to Practical Biochemistry. 2006. Tata McGrow-Hill Publishing Company Limited

MINOR SUBJECT: ENVIRONMENTAL & INDUSTRIAL MICROBIOLOGY
SUBJECT CODE: BOT142N501, COURSE LEVEL: 300
CREDIT UNITS: 04; L-T-P-C = 4-0-0-4

SCHEME OF EVALUATION: Theory (T)

Course Objective: The course is designed to impart theoretical as well as practical knowledge on the diversity of microbes in the environment and their interaction in different areas and utilization of microorganisms in different categories of industries.

Course Outcomes: By the end of the course the students shall be able to:

CO1	**Identify** different types of microorganisms found in the environment and **recognize** their contribution in the environment.	**BT1** **BT2**
CO2	**Outline** different application of microorganism in industries	**BT4**
CO3	**Distinguish different diseases caused by** microbes from different sources such as air, soil, and water.	**BT 4**

Detailed Syllabus:

Module	Topics / Course content	Lecture hours
I	Role of microorganisms in the environment: Aero-microbiology: aerosols and bioaerosols, microbial survival in the air, airborne diseases and their control, significance of microbes in air. Soil Microbiology: soil microflora and their interactions, role of microbes in biogeochemical cycles.	**15**
II	Water microbiology: microbial ecosystems – fresh water and marine. Eutrophication, water borne diseases and their control. Waste water treatment – solid liquid, aerobic and anaerobic methods.	**15**
III	Fermentation technology: Bioreactors/Fermenters and fermentation processes. Solid-state and liquid-state fermentations, Batch and continuous reactions. Types of fermented foods.	**15**
IV	Industrial Microbiology: Microorganisms growth in controlled environment; Microbial production of industrial products: Enzymes, alcohol, organic acids, antibiotics (Penicillin), biopolymers, biofuels, biosurfactants. Role of microbes in bioremediation	**15**
TOTAL		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 • HOME ASSIGNMENTS • SEMINARS • VIVAVOCE • FIELD VISITS

Text Book:

1. Whitaker and Stanbury. Principles of Fermentation Technology.
2. Casida. Industrial Microbiology. Tata McGraw Hill.
3. Adams and Moss. Food Microbiology. Cambridge.

Reference Books:

1. Wiley, J.M., Sherwood, L.M. and Woolverton C.J., Prescott. Microbiology. 2017. McGraw Hill International.
2. Brown A.E. and Smith H. Benson's Microbiological Applications: Laboratory Manual in General Microbiology.2016. McGraw-Hill Education. Madigan M.T., Martinko J.M., Bender K.S., Buckley D.H., Stahl D.A., Brock T. Brock Biology of Microorganisms (14th Edition). 2014. Pearson Publisher.
3. Frazier and Westhoff. Food Microbiology. Tata McGraw Hill.
4. Harvey R.A. and Cornelissen C.N. Lippincott Illustrated Reviews: Microbiology (Lippincott Illustrated Reviews Series) Third, North American Edition. 2012. LWW; Third, North American edition.
5. Pelczar, M.J. Microbiology. 2005.Tata McGraw-Hill Co, New Delhi

DETAILED SYLLABUS OF 6th SEMESTER

MAJOR SUBJECT: CELL & MOLECULAR BIOLOGY	
SUBJECT CODE: BOT142M601,	**COURSE LEVEL: 300**
CREDIT UNITS: 04,	**L-T-P-C=4-0-0-4,**
SCHEME OF EVALUATION: THEORY (T)	

Course objectives: Develop an understanding of the various physiological and biochemical processes operating in a plant system.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Understand** the fundamental concepts of cell and molecular biology.	**BT1**
CO2	**Describe** the components of cells and how cell organelles interact with each other to carry out the fundamental biological process	**BT2**
CO3	**Express** significance of cell division for multicellular organism and the key events that happen during cell cycle.	**BT2**
CO4	**Decipher** and understand the regulation of gene expression	**BT4**

Module	Topic and Course content	Lecture hours
I	**Cell:** Cell as a unit of structure and function; Origin of eukaryotic cell (Endosymbiotic theory); Structural organization of prokaryotic and eukaryotic cells. Cell organelles: Plasma membrane: structure and functions; Membrane transport: ion channels and pumps; Mitochondria: structure, and functions; Chloroplast: structure and organization of photosynthetic complexes; endoplasmic reticulum, rough and smooth; Nucleus structure	15
II	**Cell division**: Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle checkpoints. Eukaryotic Genome Organization: Eukaryotic chromatin and chromosome. Structure of nucleic acids: DNA and its A, B and Z conformations, RNA and its types: t-RNA, r-RNAs and mRNA	15
III	**DNA replication:** Machinery and mechanism in prokaryotes and eukaryotes. **Transcription**: Machinery and mechanism in prokaryotes and eukaryotes; RNA processing: concept of split gene, splicing. Genetic code and exceptions to its universality.	15
IV	**Translation:** Machinery and mechanism (tRNA charging, initiation in prokaryotes and eukaryotes, elongation and termination); Regulation of gene expression in prokaryotes and eukaryotes: lac and tryptophan operon; regulation at transcriptional and post-transcriptional level	15
TOTAL		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 • HOME ASSIGNMENTS • SEMINARS • VIVAVOCE • FIELD VISITS

Textbooks:

1. Cox, M., and Nelson, D. L. 2017. Principles of Biochemistry. Freeman and company, New York.

2. Dale, W.J. and Schontz, V.M. 2011. From Genes to Genomes. John wiley& sons ltd., England.
3. David. M. A., Freyer A.G., and Crotty, D. A. 2003. DNA Science A First Course, Cold Spring Harbor Laboratory Press, New York. Dey, P.M. and Harborne, J.B. (1997). Plant Biochemistry. Acad. Press.

Reference Books:

1. Buchanan, B.B., Gruissem, W. and Jones R.L. (2015). Biochemistry and Molecular Biology of Plants, Wiley Blackwell, Sussex, UK
2. Alberts, B., Bray, D. and Hopkin, K. 2018. Essential Cell Biology. Garland Science, U.S.A
3. Conn, E.E. and Stumpf, P.K. (1994). Outlines of Biochemistry. Wiley Eastern.
4. Dennis, D.T. (1998). Plant metabolism. Longman.
5. Heldt, H. (1997). Plant Biochemistry and Molecular Biology. Oxford Univ. Press.

MAJOR SUBJECT: PLANT ECOLOGY & ECOSYSTEM ANALYSIS
SUBJECT CODE: BOT142M602, COURSE LEVEL: 300
CREDIT UNITS: 04, L-T-P-C=4-0-0-4
SCHEME OF EVALUATION: THEORY (T)

Course Objectives: Develop an understanding to the basic concepts in plant ecology and Ecosystem.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Explain** key concepts in plant ecology, including population dynamics, community interactions, and ecological succession	BT1
CO2	**Apply** ecosystem analysis techniques to assess energy flow, nutrient cycling, and productivity in ecosystems	BT2
CO3	**Analyze** patterns of biodiversity and the impacts of human activities on ecosystems, using data from field and laboratory studies	BT3
CO4	**Evaluate** ecological models and conservation strategies in relation to ecosystem management and biodiversity conservation	BT4

Detailed Syllabus

Module	Course Content	Lecture hours
1	**Fundamentals of Plant Ecology** Definition, scope, and relevance of plant ecology. Population structure and dynamics. Life history strategies: r- and K-selection. Niche Concept: Fundamental and realized niche, niche differentiation, niche overlap, and competition.	**15**
2	**Energy Flow and Ecosystem Functioning** Ecosystem: structure and function. Types of ecosystems. Energy transfer: food chains and food webs. Trophic levels and ecological pyramids. Primary and secondary productivity.	**15**
3	**Biodiversity** Biodiversity Concept, levels of biodiversity. Factors affecting biodiversity patterns. Biodiversity hotspots. Biodiversity Indices and Measurement: species richness and diversity indices. Application of biodiversity indices in ecosystem analysis.	**15**
4	**Conservation Ecology** Causes of biodiversity loss: Habitat fragmentation, invasive species, pollution, and climate change. Impact of biodiversity loss on ecosystem functioning. In-situ and ex-situ conservation methods. Role of international and national bodies in conservation of biodiversity.	**15**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 DISCUSSIONS SEMINARS COLLABORATIVE PROJECTS FIELD WORK

Textbooks:

1. Odum, E.P. & Barrett, G.W. (2005). Fundamentals of Ecology. Brooks/Cole.
2. Begon, M., Townsend, C.R., & Harper, J.L. (2006). Ecology: From Individuals to Ecosystems. Wiley-Blackwell.
3. Groom, M.J., Meffe, G.K., & Carroll, C.R. (2006). Principles of Conservation Biology. Sinauer Associates.

Suggested Readings:

1. Molles, M.C. (2015). Ecology: Concepts and Applications. McGraw-Hill Education.
2. Krebs, C.J. (2008). The Ecological World View. University of California Press.
3. Primack, R.B. (2014). Essentials of Conservation Biology. Sinauer Associates.
4. Whittaker, R.J. & Fernández-Palacios, J.M. (2007). Island Biogeography: Ecology, Evolution, and Conservation. Oxford University Press.
5. Chapman, J.L. & Reiss, M.J. (1999). Ecology: Principles and Applications. Cambridge University Press.

MAJOR SUBJECT: FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE
SUBJECT CODE: BOT142M603, COURSE LEVEL: 300
L-T-P-C=, 4-0-0-4, CREDIT UNITS: 04
SCHEME OF EVALUATION: THEORY (T) ONLY

Course objective: This course explores the principles and practices of sustainable agriculture and various farming systems.

Learning Outcomes: After the successful completion of the course the students will be able to:

CO1	**Understand** and articulate the principles of sustainable agriculture	BT1
CO2	**Analyse** different farming systems and their environmental impacts	BT3
CO3	**Evaluate** soil health and fertility management practices	BT3
CO4	**Outline** sustainable farming solutions for local communities	BT4

Detailed Syllabus

Mod	Course content	hours
I	**Farming System-** Types, & Systems of farming. Factors affecting types of farming. Farming system components, and their maintenance.	**10**
II	**Cropping System:** Cropping systems & pattern, multiple cropping systems, efficient cropping system, and their evaluation. Tools for determining production & efficiencies in cropping and farming system. Importance of soil health on crop growth**.** Nutrient cycling in cropping systems.	**17**
III	**Soil fertility & nutrient management -** Soil fertility and productivity; availability of nutrients; relation between nutrient supply and crop growth; Organic farming - basic concepts and definitions. Recycling of organic wastes and residue management Integrated Nutrient management.	**17**
IV	**Sustainable agriculture-** Concept and importance of sustainable agriculture, indicators of sustainability, Sustainable agriculture in relation to SDGs, Conservation agriculture strategies in agriculture, Climate resilient agriculture.	**16**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 • HOME ASSIGNMENTS • SEMINARS • VIVAVOCE • FIELD VISITS

Textbook:

1. Cropping systems Theory and Practice -Chatterjee B.N. and Maiti S.

Reference Books:

2. Brady NC & Weil R.R 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.

3. Prasad R & Power JF. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press.
4. Cropping Systems in Tropics – Principles and practices. -Palanniappan S.P.
5. Organic Farming for Sustainable Agriculture by Dahama A. K. Agrobios Publication
6. Hand book of Agriculture, ICAR New Delhi

MAJOR SUBJECT: CELL, MOLECULAR BIOLOGY, ECOLOGY, AND AGRONOMY (PRACTICAL)
SUBJECT CODE: BOT142C612, COURSE LEVEL 300
L-T-P-C= 0-0-8-4, CREDIT UNITS: 04
SCHEME OF EVALUATION: PRACTICAL (P)

Course objective: To impart practical knowledge on various principles of ecology, agronomy and reproductive biology of angiosperms.

Learning Outcomes: At the end of the course the student will be able to:

CO 1	**Apply** key reproductive biology techniques, including floral dissection and pollen analysis.	**BT 3**
CO 2	**Analyse** ecological processes and biodiversity through quantitative ecological tools	**BT 4**
CO 3	**Apply** agronomic principles and techniques for crop management and soil fertility	**BT 3**

Detailed Syllabus

Module	Course content	Periods
I	1. Study of cell division-mitosis in available material. 2. Study of cell division-meiosis in available material. 3. Karyotyping analysis of available plant materials.	**15**
II	4. Extraction and purification of DNA from available plant samples and its agarose gel electrophoresis. 5. Spectrophotometric estimation of DNA.	**15**
III	6. Determination of soil physico-chemical properties 7. Interpretation of interaction effects and computation of economic and yield optima.	**15**
IV	8. Study the quality of compost and vermicompost used in agronomy. 9. Field Visit: Natural habitats and agricultural fields.	**15**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 FIELD VISITS SAMPLE COLLECTION LAB PERFORMANCE SUBMISSION

Textbooks:

1. Hand book of Agriculture, ICAR New Delhi.
2. Bendre and Kumar. Practical Botany Vol. 2. 2018. Rastogi Publications.
3. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
4. Pandey.B.P. Modern Practical Botany Vol. 1, 2, 3. 2011. S.Chand Publication.

MINOR SUBJECT: AGRONOMY & SUSTAINABLE DEVELOPMENT
COURSE LEVEL: 300, SUBJECT CODE: BOT142N641,
CREDIT UNITS: 4, L-T-P-C: 3-0-1-4
SCHEME OF EVALUATION: THEORY AND PRACTICAL

Course objective: First, to develop the theoretical and knowledge foundation on the concept of agronomy and

sustainable development and to gain an empirical understanding of the emerging global challenges for sustainable agricultural and environmental development.

Learning Outcomes: After the successful completion of the course the students will be able to**:**

CO1	Define the basic concepts of agronomy and classify crops based on agronomic and botanical criteria.	**BT 1**
CO2	Explain the principles of soil science and their relevance in soil productivity and fertility.	**BT 2**
CO3	Evaluate current agricultural practices considering sustainable development goals and challenges.	**BT4**

Module	**Topic and Course content**	**Lecture hours**
Theory		
I	**Introduction to Agronomy:** Agronomy and its scope, Agronomic classification of crops**. Major farming systems. Methods of sowing/planting.** Tillage and its types; Crop rotation: principles and its advantages.	**12**
II	**Principles of Soil Science:** Nature and origin of soils; soil forming processes, classifications of soils. Soil physico-chemical properties and their importance.	**12**
III	**Soil productivity and fertility** - Crop nutrition; Nutrient sources; Nutrient cycling in agro-ecosystems; Fertilizers and biofertilizers; Green manure crops and cover crops	**12**
IV	**Introduction to Sustainable Development:** Its importance and impact; History and Current practices; Sustainable Development Goals (SDGs), Significance and Challenges of Sustainable Development; Dimensions to Sustainable development.	**12**
TOTAL		**48**
	PRACTICAL	
1	Identification of crops and seeds	**2**
2	Identification of fertilizers and pesticides	**2**
3	Effect of sowing depth on germination	**4**
4	Seed germination and viability test	**4**
5	Determination of soil temperature, pH and moisture content	**4**
6	Determination of water holding capacity of soil	**3**
7	Identification of rocks and minerals	**3**
TOTAL		**22**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
48	22	20 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Text Books:

1. A Textbook of Agronomy" by C. S. Tomar
2. Soil Science and Agronomy" by D.K. Das

Reference Books:

1. A Handbook of Agriculture" by ICAR
2. Agricultural Practices in India" by A. S. Jadeja and P. M. Thaker

DETAILED SYLLABUS OF 7TH SEMESTER (Draft)

MAJOR SUBJECT: BIOSTATISTICS & BIOINFORMATICS	
SUBJECT CODE: BOT142M701,	**COURSE LEVEL: 400**
L-T-P-C: 4-0-0-4,	**CREDIT UNITS: 04**
SCHEME OF EVALUATION: THEORY ONLY (T)	

Course Objectives: To equip students with foundational knowledge and practical understanding of bioinformatics tools and biostatistical methods for analyzing biological data, understanding molecular evolution, and supporting drug discovery and structural biology research.

Learning Outcomes: By the end of the course the students shall be able to:

CO1	Retrieve and interpret biological sequence and structural data from primary and secondary databases.	BT2
CO2	Perform sequence alignment and construct phylogenetic trees using standard bioinformatics tools.	BT3
CO3	Explain protein structure hierarchy and demonstrate the use of visualization tools for molecular modeling.	BT2
CO4	Apply statistical methods and hypothesis testing (parametric and non-parametric) to analyze biological data.	BT3 BT4

Module	Topics / Course content	Lecture hours
I	**Overview of Bioinformatics:** Definition and Scope**,** Historical Development, Importance in Modern Biology and Medicine **Biological Databases:** Types of Databases (Primary, Secondary, Composite), Nucleic Acid Databases (GenBank, EMBL), Protein Databases (UniProt, PDB), Specialized Databases (OMIM, Pfam). **Sequence Alignment:** Pairwise Sequence Alignment, Multiple Sequence Alignment, Tools and Algorithms (BLAST, ClustalW). **Molecular Evolution and Phylogenetics:** Basic Concepts of Molecular Evolution, Phylogenetic Tree Construction, Software and Tools (MEGA, PhyML).	15
II	**Structural Bioinformatics:** Protein Structure Basics (Primary, Secondary, Tertiary), Introduction to PDB and Visualization Tools (RasMol, PyMOL), Protein Structure Prediction, Molecular Modeling and Simulation. **Drug Discovery and Design:** Role of bioinformatics in identifying drug targets, Molecular docking and virtual screening.	15
III	**Introduction**: Statistics, Biostatistics, Frequency distribution Measures of central tendency: Mean, Median, Mode Measures of dispersion: Dispersion, Range, mean deviation, standard deviation, co-efficient of variance Correlation: Definition, Karl Pearson's coefficient of correlation, Multiple correlation	15

IV	**Satistical Analysis:** Regression: Curve fitting by the method of least squares, fitting the lines y = a + bx and x = a + by, Multiple regression, standard error of regression Probability: Definition of probability, Binomial distribution, Normal distribution, Poisson's distribution, properties - problems Sample, Population, large sample, small sample, Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, Error-I type, Error-II type, Standard error of mean (SEM) Parametric test: t-test (Sample, Pooled or Unpaired and Paired), ANOVA, (One way and Two way), Least Significance difference Non-Parametric tests: Wilcoxon Rank Sum Test, Mann-Whitney U test, Kruskal-Wallis test, Friedman Test	15
Total Hours		60

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Textbooks:

1. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount
2. "Introduction to Bioinformatics" by Arthur M. Lesk
3. "Bioinformatics and Functional Genomics" by Jonathan Pevsner
4. "Developing Bioinformatics Computer Skills" by Cynthia Gibas and Per Jambeck
5. "Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner

Reference Books:

1. "Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids" by Richard Durbin, Sean R. Eddy, Anders Krogh, and Graeme Mitchison
2. "Structural Bioinformatics" by Jenny Gu and Philip E. Bourne
3. "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases, and Analytical Tools" by Supratim Choudhuri
4. "Systems Biology: A Textbook" by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, and Axel Kowald"Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools" by Vince Buffalo.

PAPER I: APPLIED MICROBIOLOGY
SUBJECT CODE: BOT142M702 **COURSE LEVEL: 400**
CREDIT: 04, **L-T-P-C 4-0-0**
SCHEME OF EVALUATION: THEORY (T)

Course Objective: This course aims to explore microbial growth and regulatory mechanisms, and applications of microbes in modern science and technology

Course outcomes:

By the end of the course the students will be able to:

CO1	Understand bacterial growth, control methods and various regulatory processes in microbes	**BT2 + BT3**
CO2	Understand the application of virology in modern technology	**BT3 + BT4**
CO3	Analyse the role of microbes in industry and environment.	**BT4**

Module	**Topic and Course content**	**Lecture hours**
I	**Microbial Growth and regulation:** Bacterial growth kinetics; Mathematical expression, Measurement and control of microorganisms; regulation system in bacteria; chemotaxis, Quorum sensing and nitrogen assimilation, overview	15

	of genetic and metabolic manipulation in bacteria.	
II	**Virology**: Next Generation Sequencing Technology in discovery of viruses, oncogenic viruses; antiviral compounds and their mode of action. Use of viral vectors in cloning and expression, overview on viral vaccine, bacteriophage therapy as an alternative to antibiotics, attenuated plant viruses in crop protection.	15
III	**Microbial biotechnology**: Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains. Fermentation technology, types of bioreactors; Laboratory, pilot-scale and production fermenters. Production of microbial products and their industrial importance.	15
IV	**Microbes for Biofuel and Environment:** Different generations of biofuel, Bio-ethanol and bio-diesel production:, commercial production from lignocellulosic waste and algal biomass, methane and hydrogen production using microbes. Microbes in biodegradation of hydrocarbons, toxic chemicals and agricultural residues, Microbial production of bio-pesticides, bioplastics Microbial biosensors.	15
Total		60

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Suggested readings:

Textbooks

1. Pelczar, M.J. 2005. Microbiology. Tata McGraw-Hill Co, New Delhi
2. Stainer, Roger Y, Ingrahan JL, Wheelis ML, Painter PR. Microbial World 5th edition. Prentice-Hall India, Pvt. Ltd. New Delhi (1990).
3. Dubey RC, Maheshwari D K. A Text book of Microbiology, S.C.Chand and Company, Ltd. Ramnagar, New Delhi (2002).
4. Biotechnology- Expanding Horizons, BD Singh.

Reference Books

1. Madigan M.T., Martinko J.M., Bender K.S., Buckley D.H., Stahl D.A., Brock T. Brock. 2014. Biology of Microorganisms (14th Edition). Pearson Publisher.
2. Prescott H, Klein S. Microbiology., 12th Edition McGraw-Hill International Edition, 2022
3. Tortora G.J., Funke B.R., Case C.L., Weber D and Bair W. 2018. Microbiology: An Introduction. Pearson Publisher
4. Prescott and Dunns Industrial Microbiology 4th edition (Pb 2004). CBS Publisher.
5. LEJR Casida. Industrial Microbiology Paperback 2nd edition (2019) New Age International Publisher
6. JC Bertrard, P Caumette, P Lebaron, Environmental Microbiology: Fundamentals and Applications 2015. Springer

MAJOR SUBJECT: PLANT BIOTECHNOLOGY
SUBJECT CODE: BOT142M703, COURSE LEVEL: 400
L-T-P-C: 4-0-0-4, CREDIT UNITS: 04
SCHEME OF EVALUATION: THEORY ONLY (T)

Course Objectives: The course is designed to impart theoretical knowledge on various tissue culture media and sterilization techniques that are pre-requisite to plant tissue culture and application of plant biotechnology

Learning Outcomes: By the end of the course the students shall be able to:

CO1	**Classify** different types of media and growth hormones hormones required for different tissue culture technique.	**BT2 BT3**
CO2	**Outline** different tissue culture techniques and their application.	**BT3**
CO3	**Evaluate** strategies to develop Agrobacterium mediated plant transformation	**BT4**

Modules	**Topics / Course content**	**Periods**
I	Concept of Totipotency and organogenesis. In vitro culture techniques: Sterilization methods, Culture media – composition, types of medium and role of hormones in in-vitro culture. Callus, single cell and suspension culture and its significance.	**12**
II	Organ culture: Anther, Embryo & Meristem culture. Organogenesis, somatic embryogenesis. Somoclonal Variation and its significance. Somatic hybridization – methods and applications and protoplast culture, Micropropagation, Cryopreservation methods and applications.	**12**
III	Organization and function of Plant nuclear genome (*Arabidopsis thaliana*), Genetic transformation of plants by Agrobacterium: Genetic organization of Ti plasmids Functions encoded by integrated T- DNA. Molecular mechanism involved in transformation of plants by Agrobacterium tumefaciens. Agrobacterium mediated gene transfer.	**12**
IV	Applications of plant biotechnology in crop improvement, transgenic crops (Bt cotton, Golden rice), production of secondary metabolites and plant-based biopharmaceuticals, intellectual property rights, regulatory frameworks, biosafety guidelines, ethical and social issues in plant biotechnology.	**12**
TOTAL		**48**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Textbooks:

1. Bhojwani, S.S. and Razdan, M.K., 2004. Plant tissue culture: theory and practice, Revised Edition - (Studies in Plant Science), Elsevier Publications, Netherlands.
2. Chawla, H.S.,2009. Introduction to plant biotechnology, Oxford & IBH Publishing Co.
3. Taylor, M. (2003). Plant Biotechnology and Transgenic Plants,. 2002. Edited by K-M. Oksman-Caldently and W. H. Barz. New York: Marcel Dekker Inc. Experimental Agriculture.
4. Slater, A. Scott, N. and Fowler, M.R., 2008. Plant biotechnology, Oxford University Press.
5. Loyola- Vargas. Walker J.M. and Rapley, R., 2002. Methods in plant molecular biology. A laboratory course manual plant cell culture protocols.

References :

1. Grierson, D and Convey, S.N., 1988 . Plant Molecular Biology Published in the USA by Chapman and Hall, New York.
2. Ignacimuthu, S., 1997. Plant Biotechnology . Oxford Publishing Co. Pvt. Ltd., New
3. Delhi.

MAJOR SUBJECT: BIOSTATISTICS, BIOINFORMATICS, PLANT BIOTECHNOLOGY, APPILED MICROBIOLOGY PRACTICAL
SUBJECT CODE: BOT142M714, COURSE LEVEL: 400

L-T-P-C: 4-0-0-4, CREDIT UNITS: 04
SCHEME OF EVALUATION: PRACTICAL ONLY (P)

Course Objectives: The course is designed to impart practical knowledge and hands on learning statistical and bioinformatics approaches in analyzing biological data. The course will help the students to master microbiological techniques. Learn various tissue culture media and sterilization techniques.

Course Outcomes:

By the end of the course the students shall be able to:

CO1	Understand and interpret biological system through statistical and bioinformatics approahes	**BT2&BT3**
CO2	Master the technique of bacterial isolation and control methods.	**BT3**
CO3	Outline different tissue culture techniques and their application	**BT4**

Modules	Topics / Course content	Periods
I	. Introduction to NCBI, GenBank, EMBL, and UniProt databases . Pairwise and multiple sequence alignment using BLAST, ClustalW, MEGA software – tree construction . Introduction to structure visualization: PyMOL / RasMol . Calculation of measures of central tendency: Mean, Median, Mode . Measures of dispersion: Standard deviation, Range, Coefficient of variation, Correlation (Karl Pearson) and Regression analysis . Hypothesis testing using t-test (independent and paired), ANOVA (One-way)	**15**
II	. Isolation of bacteria by soil serial dilution technique. . Determination of bacterial growth by turbidity measurement. . Study the effect of membrane filtration in control of microbial growth. 0. Determination of quality of milk sample by methylene blue reduction test. 1. Role of yeast in bread making.	**15**
III	2. Lab safety and sterilization techniques in plant tissue culture. 3. Preparation of MS medium and its components (stock solutions, hormones) 4. Surface sterilization and inoculation of explants 5. Callus induction from seed, leaf or stem explants. 6. Micropropagation: Nodal and shoot tip culture	**15**
IV	7. Anther and embryo culture demonstration (if facilities permit). 8. Observation of somatic embryogenesis stages. 9. Artificial seed preparation (encapsulation of somatic embryos or shoot tips)	**15**
TOTAL		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
00	60	30 SAMPLE COLLECTION INDUSTRIAL VISITS FIELD VISITS

Textbooks

1. **Baxevanis, A.D., & Ouellette, B.F.F.** (2004) – *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (3rd Ed.). Wiley.
2. **Daniel, W.W., & Cross, C.L.** (2018) – *Biostatistics: A Foundation for Analysis in the Health Sciences* (11th Ed.). Wiley.
3. **Bhojwani, S.S., & Razdan, M.K.** (1996) – *Plant Tissue Culture: Theory and Practice – A Revised Edition*. Elsevier.
4. KR Aneja. Experiments in Microbiology, Plant Pathology and Biotechnology, 2007. New Age International.

5. ***Online Tools & Software Resources*:**
   - NCBI BLAST: https://blast.ncbi.nlm.nih.gov
   - MEGA X Phylogenetic Software: https://www.megasoftware.net
   - Clustal Omega: https://www.ebi.ac.uk/Tools/msa/clustalo/
   - PyMOL: https://pymol.org/2/

Reference Books:

1. James G. Cappuccino. Microbiology- A Laboratory Manual, 2014. Pearson.
2. **Dodds, J.H., & Roberts, L.W.** (1995) – *Experiments in Plant Tissue Culture* (3rd Ed.). Cambridge University Press.
3. **Rosner, B.** (2015) – *Fundamentals of Biostatistics* (8th Ed.). Cengage Learning.
4. **Xiong, J.** (2006) – *Essential Bioinformatics*. Cambridge University Press.
5. **Bailey, N.T.J.** (1995) – *Statistical Methods in Biology* (3rd Ed.). Cambridge University Press.
6. **Daniel, W.W., & Cross, C.L.** (2013) – *Biostatistics: Basic Concepts and Methodology for the Health Sciences* (10th Ed.). Wiley.
7. **Slater, A., Scott, N.W., & Fowler, M.R.** (2008) – *Plant Biotechnology: The Genetic Manipulation of Plants* (2nd Ed.). Oxford University Press.
8. **Lindsey, K.** (Ed.) (1992) – *Plant Tissue Culture Manual*. Springer.

MINOR SUBJECT: PLANT BIOTECHNOLOGY
SUBJECT CODE: BOT42N701, COURSE LEVEL: 400
L-T-P-C: 4-0-0-4, CREDIT UNITS: 04
SCHEME OF EVALUATION: THEORY ONLY (T)

Course Objectives: This course aims to introduce the basic principles and techniques of plant biotechnologY. It provides a foundation for understanding the potential of biotechnological interventions in sustainable agriculture, conservation, and plant-based industries.

Course Outcomes:

By the end of the course the students shall be able to:

CO1	**Classify** different types of media and growth hormones hormones required for different tissue culture technique.	**BT2&BT3**
CO2	**Outline** different tissue culture techniques and their application.	**BT3**
CO3	**Evaluate** strategies to develop Agrobacterium mediated plant transformation	**BT4**

Detailed Syllabus

Modules	Topics / Course content	Periods
I	**Introduction to Plant Tissue Culture:** Concept of totipotency, basic requirements for tissue culture, preparation and composition of culture media, sterilization methods, introduction to callus and organ culture	**15**
II	**Plant Regeneration Techniques:** Callus culture, shoot and root formation, micropropagation, somatic embryogenesis, artificial seeds, cryopreservation and germplasm conservation, uses of plant hormones in culture.	**15**
III	**Cell Culture and Metabolite Production** Single-cell and suspension cultures, growth measurement, use of cultures to produce plant-based compounds (e.g., flavours, colours, medicines), use of hairy root cultures.	**15**
IV	**Applications of Cell and Tissue culture:** Artificial seeds, production of secondary metabolites. Crop improvement in terms of yield and quality. Biosafety and bioethics. Biosafety concerns.	**15**
TOTAL		**60**

Textbooks:

1. Bhojwani, S.S. and Razdan, M.K., 2004. Plant tissue culture: theory and practice, Revised Edition - (Studies in Plant Science), Elsevier Publications, Netherlands.
2. Chawla, H.S.,2009. Introduction to plant biotechnology, Oxford & IBH Publishing Co.

3. Taylor, M. (2003). Plant Biotechnology and Transgenic Plants,. 2002. Edited by K-M. Oksman-Caldently and W. H. Barz. New York: Marcel Dekker Inc. Experimental Agriculture.

References :

1. Grierson, D and Convey, S.N., 1988 . Plant Molecular Biology Published in the USA by Chapman and Hall, New York.

PAPER I: GENETIC ENGINEERING IN PLANTS
SUBJECT CODE: BOT142C801, COURSE LEVEL: 400
L-T-P-C: 4-0-0-4, CREDIT UNITS: 04
STUDENTS SCHEME OF EVALUATION: THEORY ONLY (T)

Course Objectives: The course will impart basic knowledge about different molecular techniques used in genetic engineering and their application.

Course Outcomes: By the end of the course the students shall be able to:

CO1	**Describe and explain** various molecular tools required for gene cloning	**BT1 & BT2**
CO2	**Relate and breakdown** different cloning strategies that would be undertaken according to the experiment required.	**BT3 & BT4**
CO3	**Outline** and **devise** genetic engineering experiments	**BT4**

Module	Topics / Course content	Periods
I	General introduction and concept: DNA modifying enzymes: restriction enzymes, ligases, nucleases, end-modifying enzymes, linkers and adaptors. Cloning Vectors: Vectors for *E. coli,* vectors for yeast *S. cerevisiae,* vectors for plants: Plasmid vectors, Bacteriophage - Lambda and M13 vectors, Cosmids, Phagemids. Artificial chromosomes (YACs, PACs, BACs).	**15**
II	Gene transfer protocols: Transformation, particle gun bombardment, microinjection, electroporation. Cloning strategies: single gene cloning, genomic libraries, cDNA libraries.	**15**
III	Methods of screening of recombinants: Selectable and screenable markers, Hybridizations- Colony, Southern, northern, western. Expression vector system and reporter gene assay	**15**
IV	Development of genetically modified (GM) crops for biotic and stress resistance. Case studies for nutritional enhancement in plants using genetic engineering (Golden rice, iron-rich crops, omega-3 fatty acids crops, protein enhancement). Biosafety guidelines.	**15**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Textbooks:

1. Brown, T.A., 2020. Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
2. Primrose S.B. and Twyman RM., 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing, Oxford, U.K.

Reference books:

1. Glick, B.R., Pasternak, J.J., 2003. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. Clark DP and Pazdernik NJ., 2009. Biotechnology-Applying the Genetic Revolution. Elsevier Academic

Press, USA. Walker J.M. and Rapley, R. (2002). Molecular biology and biotechnology. Panima.
3. Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2014). Molecular biology of the gene. 7th Ed. Pearson.
4. Watson, J.D., Gilman, M., Witowski, J. and Zoller, M.,1992. Recombinant DNA. Scientific American Books.

PAPER II: RESEARCH METHODOLOGY
SUBJECT CODE: BOT142N801, COURSE LEVEL 400
L-T-P-C: 4-0-0-4, CREDIT UNITS: 04
STUDENTS SCHEME OF EVALUATION: THEORY ONLY (T)

Pre-requisite: Basic knowledge of biology and chemistry up to class 12

Course Objectives: To make students understand the overall process of designing a research study from its inception to its report and to make them understand the way of writing various research article, papers and proposals.

Course Outcomes: By the end of the course the students shall be able to:

CO1	**Identify** and **interpret** a research problem	**BT1 & BT2**
CO2	**Analyse** the importance of educational research	**BT3 & BT4**
CO3	**Outline** and **devise** the basics of research design	**[BT4**

Modules	Topics / Course content	Periods
I	Research fundamentals and terminology: Foundations of Research: Meaning, Objectives, Motivation, Utility and Understanding the language of research concept. Concept of hypothesis, theory and scientific law. Difference between hypothesis, theory and scientific law. Formulation of hypothesis.	**15**
II	Data collection: Understand concepts of quantitative and qualitative data collection. Types of data and methods and techniques of data collection. Methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study). Methods of secondary data collection (internal/ external, schedule method). Use of computers in data collection: Literature survey using web, handling search engines.	**15**
III	Data analysis: Methods to analyse data and elements of analysis in data processing. The different conventions for scholarly/ report writing. Experimental data collection and data processing, Processing operations, problems in processing. Software for data processing.	**15**
IV	Report writing and presentation: poster and oral presentations. Types of research reports, guidelines for writing a report, report format, appendices, project proposals. Miscellaneous information. Writing of review of literature.	**15**
Total		**60**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Suggested readings:

Textbooks:

1. C.R. Kothari. Research Methodology: Methods And Techniques. 2019. New Age Publ. Wiley Eastern.
2. P.S.G. Kumar (2004). Research methods and statistical techniques. B.R. publishing Academy, Udaypur.
3. Ranjit kumar. Research methodology: a step-by-step guide for beginners. 2019. Sage Publication.

Reference books:

1. Select references from the Internet.
2. Wayne C. Booth et al. The craft of research. 2016. University of Chicago Press.

IN LIEU OF DISSERTATION

PAPER III: ADVANCED PLANT SYSTEMATICS
SUBJECT CODE: BOT142M802,
L-T-P-C: 4-0-0-4, CREDIT UNITS: 04
STUDENTS SCHEME OF EVALUATION: THEORY ONLY (T)

Course Objectives: This course aims to apply the fundamental principles of plant systematics, including species concepts, classification systems, and botanical nomenclature in conservation and research.

Course Outcomes: By the end of the course the students shall be able to:

CO1	**Apply** the key concepts of plant systematics, including species, genera, and families.	BT3
CO2	**Differentiate** between taxon based on various classification systems	BT4
CO3	**Design** various conservation measures for extinct and important plant groups.	BT5

Module	Topics / Course content	Periods
I	Introduction to Plant Systematics: Fundamentals of Plant Systematics; Phylogenetics and Evolutionary Relationships; Monophyly, Paraphyly, and Polyphyly; Cladistics, Phenetics, and Evolutionary Systematics.	**12**
II	Botanical Nomenclature and Principles of Classification: International Code of Botanical Nomenclature (ICN); Principles and ranks of taxa; Rules of priority and limitations; Effective and valid publications. Nomenclature and Typification: Definitions: Synonym, Basionym, Tautonym, Superfluous name, Nomen nudum, homonym; Legitimate and illegitimate names; Type method and typification concepts.	**12**
III	Angiosperm Phylogeny and Classification: APG (Angiosperm Phylogeny Group) system of classification; Cladistic relationships among major families. Concept of PhyloCode. Molecular Systematics: DNA based markers, RAPD, AFLP, RFLP, SNP in molecular systematics. Construction of Dendrograms and cladogram	**12**
IV	Biogeography and Speciation in Plants: Typological, Biological, Evolutionary, and Phylogenetic species concepts.; Vicariance vs. Dispersal, Endemism, Adaptive Radiation.; Evolutionary Trends in Plant Diversity: Coevolution with Pollinators, Seed Dispersers; Genome Duplication and Hybridization.; Floristics and plant identification: Use of keys, floras, and monographs.	**12**

Total	**48**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Suggested readings:

Textbooks:

1. Singh G. Plant Systematics (Theory & Practice). 4th edition, CBS publishing, 2022.
2. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). *Plant Systematics: A Phylogenetic Approach.* Sinauer Associates.
3. Singh OP. Plant Taxonomy 2nd Edition, McGraw Hill Education 2017.

Reference Books:

1. Radford, A. E. (1986). *Fundamentals of Plant Systematics.* Harper & Row, New York.
2. Gifford, E. M., & Foster, A. S. (1989). *Morphology and Evolution of Vascular Plants.* W. H. Freeman.
3. Govaerts, R., Nic Lughadha, E., Black, N., Turner, R., & Paton, A. (2021). *The World Checklist of Vascular Plants: A New Research Infrastructure for Taxonomy.* Plants, People, Planet, 3(3), 229-240.
4. Turland, N. J., et al. (2018). *International Code of Nomenclature for Algae, Fungi, and Plants (ICN) – Shenzhen Code.* IAPT (International Association for Plant Taxonomy).
5. Heywood, V. H. (1993). *Flowering Plants of the World.* Oxford University Press.

PAPER IV: ADVANCED PLANT PHYSIOLOGY & BIOCHEMISTRY
SUBJECT CODE: BOT142M803, COURSE LEVEL 400
L-T-P-C: 4-0-0-4, CREDIT UNITS: 04
STUDENTS SCHEME OF EVALUATION: THEORY ONLY (T)

Course Objectives: The course is devised to help students understand the concept of molecular biology: understanding the process of replication, transcription and translation and learning how these are regulated

Course Outcomes: On completion of the course the student will be able to:

CO1	**Reproduce and explain** the study of chemical processes within and relating to living organisms	**BT1 & BT2**
CO2	**Summarize** the Central Dogma of life and understand its regulatory aspect	**BT2**
CO3	**Predict and identify** the key regulators that is involved in controlling information flow through biochemical processes and signalling that give rise to the complexity of life.	**BT3 & BT4**

Detailed Syllabus:

Module	Topics / Course content	Periods
I	Hormonal regulation of Plant Growth and Development: Definition and classification of plant growth regulators, Sites of synthesis and mechanism of action of plant growth hormones, Importance of mutants and transgenic plants in understanding role of hormones.	**12**
II	Biotic and abiotic stresses: Response of plants to abiotic stress: Basic principles of crop improvement programme under stress, High temperature stress tolerance mechanism. Chilling stress: Effect on physiological processes. Salinity: Salt tolerance mechanism.	**12**

	Signal transduction: primary and secondary signalling molecules, two component signalling, Histidine kinases, phospholipids signalling, Cyclic nucleotides, role of cyclic nucleotides as second messengers, Ca-Calmodulin cascade, specific signalling mechanisms	
III	**Senescence and ageing:** Senescence and ageing, senescence associated genes. Role of ethylene in senescence and ripening. Biotechnological approaches to manipulate ethylene biosynthesis and action. Respiration in seeds, mitochondrial activity, seed ageing, mobilization of stored reserves, Seed viability, seed vigour, seed dormancy, types and regulation. Means to overcome seed dormancy.	**12**
IV	**Secondary metabolites**: Shikimate Pathway as the precursor to secondary metabolite biosynthesis in plants. Regulatory controls in flavonoid, flavonol and anthocyanin biosynthesis.	**12**
Total		**48**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Suggested readings:

Textbooks:

1. Dennis D. T., Turpin, D. H. Lefebvre D. D. and Layzell D. B.(eds) (1997). Plant Metabolism (Second Edition) Longman, Essex, England.
2. Willium G Hopkins, Norman P Hunar (2009) Introduction To Plant Physiology, Wiley.
3. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

Reference Books:

1. Buchanan B.B, Gruissem W. and Jones R. L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

PAPER V: ENVIRONMENTAL POLLUTION AND CONSERVATION
SUBJECT CODE: BOT142M804, COURSE LEVEL 400
L-T-P-C: 4-0-0-4, CREDIT UNITS: 04
STUDENTS SCHEME OF EVALUATION: THEORY ONLY (T)

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of the sources, types, and impacts of environmental pollution on ecosystems and human health, effective environmental conservation and sustainable resource management.

Course Outcomes: On completion of the course the student will be able to:

CO1	**Understand** the Concepts of Pollution and their sources, causes, and impacts on ecosystems and human health	**BT2**
CO2	**Analyse** Environmental Impacts and Critically evaluate the short-term and long-term consequences of pollutants on biodiversity, climate, public health, and socio-economic development.	**BT2**

CO3	**Interpret** major environmental laws, policies, and international agreements related to pollution control and conservation, including the role of regulatory agencies	**BT3 & BT4**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Environmental Pollution:** Types, causes, effects and control; Air pollution: Natural and anthropogenic sources and types of air pollutants. Air quality standards, vehicular pollution; Water pollution: Sources and types of water pollutants, Effect of water pollutants on living organisms, water pollution linked human diseases, ground water pollution, heavy metals and their effects on biota, thermal pollution, characteristics of industrial effluents.; Nuclear Hazards and human health risks; Solid waste management: management of urban, biomedical and industrial wastes. Case studies on pollution and nuclear hazards.	**12**
II	**Environmental Policies and Practices:** Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, and case studies on human wildlife conflicts.	**12**
III	**Natural Resource Management:** Concept and significance; types of natural resources; renewable and non-renewable resources; resource degradation; resource conservation. Water resources management: Concept, world water balance; fresh water and marine water resources; conservation of water resources; integrated water resource management; rainwater harvesting; watershed management, wetland conservation and management. Soil and land resources management: Concept, soil types, soil degradation and soil erosion; integrated strategies for soil conservation and regeneration; land resources: land use pattern and planning. Mineral resources: Concept and types; Bioresource Management: Concept and categories; Forest resources: Concept and types; Energy resources: Concept and types.	**12**
IV	**Biodiversity and Conservation:** Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and informational value.	**12**
Total		**48**

CREDIT DISTRIBUTION		
LECTURE/TUTORIAL	**PRACTICALS**	**EXPERIENTIAL LEARNING**
60	00	30 HOME ASSIGNMENTS SEMINARS VIVAVOCE FIELD VISITS

Suggested readings:

Textbooks:

1. Hill, M.K. 2010 Understanding Environmental Pollution, Cambridge University Press, UK.
2. Rieuwerts, J, 2015, The Elements of Environmental Pollution, Routledge Taylor & Francis Group, UK
3. Ginley, D. S. & Cahen, D. 2011. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press.

4. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.

Reference Books:

1. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.Environment. 8th edition. John Wiley & Sons.
2. Warren, C. E. 1971. Biology and Water Pollution Control. WB Saunders.
3. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
4. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.