KUNTHAVAI NAACCHIYAAR GOVERNMENT ARTS COLLEGE FOR WOMEN

An Autonomous College Affiliated to Bharathidasan University

Re-Accredited by NAAC with 'B' Grade

Thanjavur -613 007, Tamil Nadu, India.

Scheme of Instruction and Syllabus for

M.Sc., BOTANY

(I to IV Semester)

Effective from 2023 - 2024 onwards

PG & RESEARCH DEPARTMENT OF BOTANY

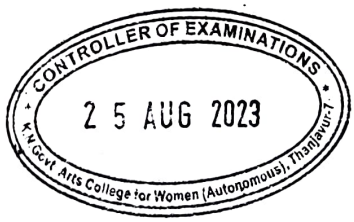
Introduction: PO & PSO

Programme Outcome, Programme Specific Outcome and Course Outcome

Students completing this programme will be able to present their core post-graduate discipline clearly and precisely, make abstract ideas precise by formulating them in the language of the specific discipline, describe related ideas from multiple perspectives and explain fundamental concepts. Completion of this programme will also enable the learners to join teaching profession, enhance their employability for government jobs, jobs in various other public and private enterprises.

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc. BOTANY**
Programme Code	
Duration	**PG - 2 years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavours and contribute significantly to society.

	PO 9 Multicultural competence Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviours, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.



Template for P.G., Programmes

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
1.1. Core-I	5	7	2.1. Core-IV	5	6	3.1. Core-VII	5	6	4.1. Core-XI	5	6
1.2 Core-II	5	7	2.2 Core-V	5	6	3.2 Core-VII	5	6	4.2 Core-XII	5	6
1.3 Core – III	4	6	2.3 Core – VI	4	6	3.3 Core – IX	5	6	4.3 Project with viva voce	7	10
1.4 Discipline Centric Elective -I	3	5	2.4 Discipline Centric Elective – III	3	4	3.4 Core – X	4	6	4.4Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
1.5 Generic Elective-II:	3	5	2.5 Generic Elective -IV:	3	4	3.5 Discipline Centric Elective - V	3	3	4.5 Skill Enhancement course / Professional Competency Skill	2	4
			2.6 I	2	4	3.6 II	2	3	4.6 Extension Activity	1	
			ECC 1	3		3.7 Internship/ Industrial Activity	2	-			
			ECC 2	4		ECC 3	3				
	20	**30**		**22**	**30**		**26**	**30**		**23**	**30**
Total Credit Points -91											

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System

for all Post – Graduate Courses including Lab Hours

First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
	Core – I	5	7
	Core – II	5	7
	Core – III	4	6
	Elective – I	3	5
	Elective – II	3	5
		20	**30**

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – IV	5	6
	Core – V	5	6
	Core – VI	4	6
	Elective – III	3	4
	Elective – IV	3	4
	Skill Enhancement Course [SEC] - I	2	4
	ECC 1	3	-
	ECC 2	4	-
		22	**30**

Second Year – Semester – III

Part	List of Courses	Credits	No. of Hours
	Core – VII	5	6
	Core – VIII	5	6
	Core – IX	5	6
	Core (Industry Module) – X	4	6
	Elective – V	3	3
	Skill Enhancement Course - II	2	3
	Internship / Industrial Activity [Credits]	2	-
		3	-
	ECC 3	**26**	**30**

Semester-IV

Part	List of Courses	Credits	No. of Hours
	Core – XI	5	6
	Core – XII	5	6
	Project with VIVA VOCE	7	10
	Elective – VI (Industry Entrepreneurship)	3	4
	Skill Enhancement Course – III / Professional Competency Skill	2	4
	Extension Activity	1	-
		23	**30**

Total 91 Credits for PG Courses

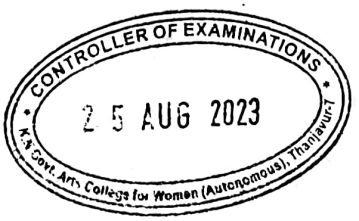
K. N. Govt. Arts College (W) Autonomous, Thanjavur-7.
M.Sc., Botany - Course Structure under CBCS
For the candidates admitted from the academic year 2023 – 2024 onwards)

Semester	Part	Course	Subject Code	Title of the Paper	Inst. Hrs.	Credit	Exam. Hrs	Marks		Total
								Int.	Ext.	
I	III	CC I	23KP1B01	Plant Diversity – I: Algae, Fungi, Lichen and Bryophytes	7	5	3	25	75	100
		CC II	23KP1B02	Plant Diversity – II: Pteridophytes, Gymnosperms and Paleobotany	7	5	3	25	75	100
		CC III (P)	23KP1B03P	Laboratory Course –I: Covering core papers- I and II	6	4	3	25	75	100
		EC I	23KP1BECB1:1	Mushroom Cultivation	5	3	3	25	75	100
			23KP1BECB1:2	Conservation of natural resources and policies						
		EC II	23KP1BECB2:1	Horticulture	5	3	3	25	75	100
			23KP1BECB2:2	Herbal Technology						
TOTAL					**30**	**20**		**140**	**360**	**500**
II	III	CC IV	23KP2B04	Plant Taxonomy of Angiosperms and Economic Botany	6	5	3	25	75	100
		CC V	23KP2B05	Plant Anatomy and Embryology of Angiosperms	6	5	3	25	75	100
		CC VI	23KP2B06P	Laboratory Course –II: Covering core papers- IV & V	6	4	3	25	75	100
		EC III	23KP2BECB3:1	Research Methodology & Computer Applications	4	3	4	25	75	100
			23KP2BECB3:2	Biopesiticide Technology						
		EC IV	23KP2BECB4:1	Applied Bioinformatics	4	3	3	25	75	100
			23KP2BECB4:2	Biostatistics						
	IV	SEC I	23KP2BSEC1	Agriculture and Food Microbiology	**4**	2	*3*	25	75	100
		ECC 1	23KP2BECC1:1	Green House Technology	-	3	*3*	-	100	100
			23KP2BECC1:1	MOOC		3				
		ECC 2	23KP2BECC2	Add on Course *	-	4	-	-	-	-
TOTAL					**30**	**22**		**165**	**435**	**600**

CONTROLLER OF EXAMINATIONS
25 AUG 2023
K.N. Govt. Arts College for Women (Autonomous), Thanjavur-7

III	III	CC VII	23KP3B07	Plant Physiology and Plant Metabolism	6	5	3	25	75	100
		CC VIII	23KP3B08	Genetics, Plant Breeding and Biostatistics	6	5	3	25	75	100
		CC IX	23KP3B09P	Laboratory course – III Covering Core Papers VII &VIII	6	5	3/4	25	75	100
		CC X	23KP3B10	Industrial Botany	6	4	3	25	75	100
		EC V	23KP3BECB5:1	Applied Plant Cell and Tissue Culture	3	3	3	25	75	100
			23KP3BECB5:2	Silviculture and commercial Landscaping						
	IV	SEC II	23KP3BSEC2	Entrepreneurial Opportunities in Botany	3	2	3	25	75	100
			23KP3I	Internship/ Industrial activity (carried out summer vacation at the end of I yr-30 hours)	-	2	-	-	-	-
		ECC 3	23KP3BECC3:1	Floriculture	-	3	3	-	100	100
			23KP3BECC3:2	MOOC		3				
	TOTAL				**30**	**26**		**165**	**435**	**600**
IV	III	CC XI	23KP4B11	Cell and Molecular Biology	6	5	3	25	75	100
		CC XII	23KP4B12	Biochemistry and Applied Biotechnology	6	5	3	25	75	100
		Project	23KP4BPW	Project with Viva – voce	10	7	-		100	100
		EC VI	23KP4BECB6:1	Gene Cloning and Gene therapy	4	3	3	25	75	100
			23KP4BECB6:2	Organic Farming						
	IV	SEC3	23KP4BSEC3	Botany for Advanced Research	4	2	3	25	75	100
	V		23KP4EA	Extension activities	-	1	-	-	-	-
	TOTAL				**30**	**23**	-	**140**	**360**	**500**
	GRAND TOTAL				**120**	**91**	-			**2200**

* Add on Course: Microbial Inoculant Technology



CORE COURSE I: PLANT DIVERSITY – I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM I	23KP1B01	5	2	_	7	5

Pre-requisite	Students should be familiar with the basics of algae, fungi, lichens and Bryophytes.
Learning Objectives	1. To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes. 2. To gain knowledge about the ecological and economic importance of algae, fungi, lichens and bryophytes. 3. To spark interest in the evolutionary roots of plant development. 4. To study the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms. 5. To expose the beneficial and harmful viewpoint.

UNIT	CONTENTS
I	**ALGAE:** General account of algology, Contributions of Indian Phycologist (T.V.Desikachary, V.Krishnamurthy and V.S. Sundaralingam), Classification of algae by F.E. Fritsch (1935-45) & Silva (1982). Salient features of major classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Charophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Range of thallus organization, algae of diverse habitats, reproduction (vegetative, asexual and sexual) and life cycles. Phylogeny and inter-relationships of algae, origin and evolution of sex in algae.Structure, reproduction and life histories of the following genera: *Oscillatoria, Scytonema, Ulva, Codium, Diatoms, Dictyota* and *Gelidium.*
II	**FUNGI:** General Characteristics, occurrence and distribution. Mode of nutrition in fungi. Contributions of Indian Mycologists (C.V.Subramanian), Classification of Fungi by Alexopoulos and Mims (1979) & Recent trends in the classification of fungi - Phylogeny and inter-relationships of major groups of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Heterothallism in fungi, sexuality in fungi, Para sexuality, sex hormones in fungi. Structure, reproduction and life histories of the following genera: *Plasmodiophora, Phytophthora, Rhizopus, Taphrina, Polyporus* and *Colletotrichum.*
III	**LICHENS:** Introduction and Classification (Hale, 1969). Occurrence and inter-relationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens.
IV	**BRYOPHYTES:** General characters and Classification of Bryophytes by Watson (1971). Distribution, Structural variations and evolution of gametophytes and sporophytes in Bryopsida, Anthoceropsida and Mosses. General characters of major groups - Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Reproduction - Vegetative and sexual, spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes. Structure, reproduction and life histories of the following genera: *Targionia, Lunularia, Porella* and *Polytrichum.*
V	**ECONOMIC IMPORTANCE:** Algae - Economic importance in Food and feed - Single cell protein, Industrial products (Agar-Agar, Carrageenan, Alginic acid, Iodine, biofertilizers, Vitamins and biofuel), Medicinal value and Diatomaceous earth. Fungi – Economic importance in food, industries and medicine. Culturing and cultivation of mushrooms *Pleurotus.* Lichen –Economic importance and as indicator pollution. Bryophytes – Ecological and Economic importance – industry, horticulture and medicine.

Course outcomes:	On completion of this course, the students will be able to:CO	Programme outcomes
CO1	Relate to the structural organizations of algae, fungi, lichens and Bryophytes.	K1
CO2	Demonstrate both the theoretical and practical knowledge in understanding the diversity of basic life forms and their importance.	K2
CO3	Explain life cycle patterns in algae, fungi, lichens and Bryophytes.	K3
CO4	Compare and contrast the mode of reproduction in diverse groups of basic plant forms.	K4
CO5	Discuss and develop skills for effective conservation and utilization of lower plant forms.	K5 &K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.

Recommended texts:

1. Barsanti, L. and Guadtieri, P. 2014. Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition.
2. Sharma, O.P. 2011. Fungi and Allied Microorganisms, Mc Graw Hill, ISBN:9780070700383,
3. Kevin K. 2018. Fungi biology and Application, 3rd Edition, Wiley Blackwell.
4. Pandey, P.B. 2014. College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant.
5. Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.
6. Sharma, O.P. 2014. Bryophyta, Mcgraw Hill, ISBN: 9781259062872, 1259062872

Reference Books:

1. Edwardlee,R. 2018. Phycology, 5thEd., Cambridge UniversityPress, London.
2.Johri, R.M., Lata, S. and Tyagi, K. 2012. A Textbook of Bryophyta. Dominant Publishers &Distributors Pvt., Ltd., New Delhi. ISBN: 9789384207335.
3.Alexopoulos, C.J. and Mims, M. 2007. Introductory Mycology. 4th Edition, Wiley Publishers, ISBN: 9780471522294

Web resources:

1. https://www.britannica.com/science/algae
2. https://en.wikipedia.org/wiki/Bryophyte
3. https://www.britannica.com/plant/bryophyte/Ecology-and-habits
4. https://www.livescience.com/53618-fungus.html.
5. https://www.youtube.com/watch?v=XQ_ZY57MY64
6. http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter22nf.pdf

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	3	2	3	2	1	2	2	2	2
CO 2	3	3	2	2	3	3	2	3	2	3
CO 3	2	2	3	3	1	2	1	3	1	3
CO 4	3	3	3	3	3	2	3	3	3	3
CO 5	3	3	2	3	2	3	3	3	3	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

CORE COURSE II: PLANT DIVERSITY – II (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM I	23KP1B02	5	2	_	7	5

Pre-requisite	Students should know about the fundaments of Pteridophytes, Gymnosperms and fossil records.
Learning Objectives	1. To investigate the classification, distinctive traits, distribution and reproduction and life history of the various classes and major types of Pteridophytes and Gymnosperms. 2. To identify and characterize diversity of lower vascular plants in order to comprehend the dynamics of diversity to realize the importance of diversity. 3. To research the classification, phylogeny and economic importance of Pteridophytes and Gymnosperms. 4. To study and understand the phylogeny and Paleontology of Pteridophytes and Gymnosperms. 5. To learn about the concept of fossils and process of fossilization; distinctive characteristics of fossil records of Pteridophytes and Gymnosperms.

UNIT	CONTENTS
I	**PTERIDOPHYTES:** General characteristics and classification (Reimer, 1954). Range of structure, reproduction and evolution of the gametophytes, Gametophyte types – sex organs. Apogamy and Apospory. Life cycles. Stellar evolution. Heterospory and seed habit, Telome theory, morphogenesis, Economic importance of Pteridophytes.
II	**PTERIDOPHYTES:** Structure, anatomy, reproduction and life histories of the following genera: *Isoetes, Equisetum Angiopteris, Osmunda, Pteris* and *Azolla.*
III	**GYMNOSPERMS:** General characters - A general account of distribution of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and classification (K.R.Sporne, 1965). Economic importance of Gymnosperms.
IV	**GYMNOSPERMS:** Structure (Exomorphic and endomorphic), anatomy, reproduction and life histories of the following genera: *Thuja, Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra*.
V	**PALEOBOTANY:** Geological Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleobotany. Gondwana flora of India. Study of fossils in understanding evolution. Fossilization and fossil types. Economic importance of fossils – fossil fuels and industrial raw materials and uses. Study of organ genera: *Rhynia, Lepidocarpon, Calamites, Cordaites* and *Lyginopteris.*

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Recall on classification, recent trends in phylogenetic relationship, general characters of Pteridophytes and Gymnosperms.	K1 & K3
CO2	Learn the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms.	K3 & K4
CO3	Comprehend the economic importance of Pteridophytes, Gymnosperms, and fossils.	K3 & K5
CO4	Understanding the evolutionary relationship of Pteridophytes and Gymnosperms.	K2
CO5	Awareness on fossil types, fossilization and fossil records of Pteridophytes and Gymnosperms.	K1 & K3

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Singh, V., Pande, P.C and Jain, D.K. 2021. A Text Book of Botany. Rastogi Publications, Meerut.
2. Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers,
3. Bengaluru.
4. Sharma, O.P. 2017. Pteridophyta, McGraw Hill Education, New York.
5. Vashishta. P.C., A.K. Sinha and Anil Kumar. 2018. Botany for Degree students - Gymnosperms. S.
6. Chand and Company Ltd., New Delhi.

Reference books:

1. Parihar, N.S. 2019. An Introduction to Embryophyta Pteridophytes. 5th Edition, Surjeet Publication, Delhi.
2. Pandey, S.N and Trivedi, P.S. 2015. A Text Book of Botany Vol. II- 12 th edition (Paper back), Vikas Publishing.
3. Sporne, K.R. 2017. The morphology of Pteridophytes (The structure of Ferns and Allied Plants) (Paper back), Andesite Press.

Web resources:

1. https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/
2. http://www.bsienvis.nic.in/Database/Pteridophytes-in-India_23432.aspx
3. https://books.google.co.in/books/about/Botany_for_Degree_Gymnosperm_Multicolor.html?id=HTdFYFNxnWQC&redir_esc=y
4. https://books.google.co.in/books/about/Gymnosperms.html?id=4dvyNckni8wC
5. https://books.google.co.in/books/about/Paleobotany.html?id=HzYUAQAAIAAJ
6. https://trove.nla.gov.au/work/11471742?q&versionId=46695996

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	2	3	3	3	3	1	3	3	3	3
CO 4	3	3	2	3	3	3	3	2	3	2
CO 5	3	2	2	2	2	2	2	1	2	1

S-Strong (3) **M-Medium (2)** **L-Low (1)**

CORE COURSE –III : LABORATORY COURSE-I COVERING CORE PAPERS I AND II

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM I	23KP1B03P	4	--	2	6	4

Pre-requisite	Students should be familiar with the fundamentals of algae, fungi, lichens, Bryophytes, Pteridophytes, Gymnospersms, Paleobotany and microbes in addition to essential laboratory techniques.
Learning Objectives	1. To learn how to employ the use of instruments, technologies and methodologies related to thallophytes and non-flowering plant groups.
	2. To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of algae, and fungi.
	3. To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.
	4. To develop the technical abilities in staining, sectioning, sterilizing, and characterizing. thallophytes, and other varieties of non-flowering plants.
	5. To compare the structural diversity of fossil and extant plant species.

UNIT	EXPERIMENTS
I	**ALGAE** Study of algae in the field and laboratory of the genera included in theory. External morphology and internal anatomy of the vegetative and reproductive structures of the following living forms: *Oscillatoria, Scytonema, Ulva, Codium, Diatoms, Dictyota*and *Gelidium*(depending onavailability of the specimen).To record the local algal flora–Study of their morphology and structure.Identification of algae to species level (at least One).Preparation of culture media and culture of green algae and blue green algae in the laboratory (Demonstration).
II	**FUNGI** Study of morphological and reproductive structures of the following living forms: *Plasmodiophora, Phytophthora, Rhizopus, Taphrina, Polyporus* and *Colletotrichum* (depending on availability of the specimen). Isolation and identification of fungi from soil, air, and Baiting method. Preparation of culture media.Cultivation of mushroom in the laboratory (Demonstration). **LICHENS** Study of morphological and reproductive structures of the genera *Parmelia.*
III	**BRYOPHYTES** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Targionia, Lunularia, Porella* and *Polytrichum* (depending on availability of the specimen).
IV	**PTERIDOPHYTES** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Isoetes, Equisetum Angiopteris, Osmunda, Pteris* and *Azolla* (depending on availability of the specimen). *Fossil slides observation: Rhynia, Lepidocarpon, Calamites.*
V	**GYMNOSPERMS** External morphology and internal anatomy of the vegetative and reproductive organs of the following living forms: *Thuja, Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra* (depending on availability of the specimen). Fossil slides observation*: Cordaites* and *Lyginopteris.*

Course outcomes	On completion of this course the student will be able to	Programme outcomes
CO1	Recall and applying the basic keys to distinguish at species levelidentification of important algae and fungi through its structural organizations.	K1 & K4
CO2	Demonstrate practical skills in thallophytes, Pteridophytes and Gymnosperms.	K2
CO3	Describe the structure of algae, fungi, lichens, Bryophytes, Pteridophytes and Gymnosperms.	K3
CO4	Determine the importance of structural diversity in the evolution of plant forms.	K5
CO5	Formulate techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.Das, S and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers andDistributors (P) Ltd., New
2. Delhi, India. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd, New Delhi.
3. Sharma O.P and S, Dixit. 2002. Gymnosperms. Pragati Prakashan.
4. Johri, R.M, Lata, S, Tyagi, K. 2005. A text book of Gymnosperms, Dominate pub and Distributer, New Delhi.

Reference Books:

1. Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. AuthorHouse, Bloomington, USA.
2. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge UniversityPress, Cambridge.
3. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd, New Delhi.
4. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication.
5. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.

Web resources:

1. https://www.frontiersin.org/articles/10.3389/fmicb.2017.00923/full
2. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
3. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf
4. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4
5. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883
6. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gymnosperms&printsec=frontcover
7. https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	1	3	1	3
CO3	3	3	3	3	3	3	2	3	2	3
CO4	3	3	2	1	2	2	1	2	1	3
CO5	3	3	3	3	3	3	3	2	3	2

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE I: MUSHROOM CULTIVATION

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM I	23KP1BECB1:1	3	2	--	5	3

Pre-requisite	Basic knowledge on structure and function of various groups of mushrooms.
Learning Objectives	1. To teach the identification of mushrooms.
	2. To differentiate the edible mushrooms with toxic and hallucinating fungi.
	3.To study the cultivation technique of mushrooms
	4. To learn the economic importance of mushroom in various fields.
	5. To study how to establish mushroom cultivation as business enterprise.
	6.To teach the identification of mushrooms.

UNIT	CONTENTS
I	**INTRODUCTION:** Mushroom, Edible Mushroom, commercial production, medicinal value of mushrooms, nutraceuticals and dietary supplements
II	**MORPHOLOGICAL AND MICROSCOPICAL IDENTIFICATION OF EDIBLE AND POISONOUS MUSHROOMS**: Keys for identification of edible mushrooms: *Agaricus bisporus, Pleurotus sajorcaju, Volvariella volvcea* and *Calocybe indica*. Key for identifying hallucinogenic mushroom (*Psilocybe* sp.) Medicinal Mushroom – *Cordyceps, Ganoderma lucidum* and *Lentinus edodes.*
III	**CULTIVATION:** Substrate sterilization, bed preparation, cropping room and maintenance, raising of pure culture and spawn preparation, factors effecting button mushroom production (Temp, pH, air and water management, competitor moulds and other disease).
IV	**POST-HARVEST MANAGEMENT:** Harvest, storage - short term and Long term) quality assurance of mushrooms. Pest management- cultural control, physical control, chemical and mechanical control.
V	World production edible mushroom, Legal and regulatory issues of introducing the medicinal mushrooms in different countries. Developing small scale industry and Government schemes. Mushroom Research Centres – International and National levels.

Course Outcomes	On completion of this course the student will be able to	Programme outcomes
CO1	Knowledge on identification of edible and toxic mushrooms belonging toAscomycota and Basidiomycota.	K1, K3
CO2	Outline the nutraceutical properties of edible mushrooms.	K2, K4
CO3	Knowledge on cultivation techniques of edible and medicinal mushrooms.	K3, K6
CO4	Understand the harvest and post-harvest techniques of mushroom crops.	K4
CO5	Knowledge on the production and marketing strategies for mushrooms.	K5

Extended ProfessionalComponent (is a part of internal component only,Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Cheung, P. C.K. 2008. Mushrooms as functional food. A John Wiley & Sons, Inc., Publication.
2. Dijksterhuis, J. and Samson, R.A. 2007. Food Mycology: A multifaceted approach in fungi and food. CRC press, Newyork.
3. Hall., R.I., Stepheson, S.L., Buchanan, P.K., Yun, W. and Cole, A.L.J. 2003. Edible and poisonous mushrooms of the world. Timber Press, Portland, Cambridge.
4. Ting, S. and Miles, P.G. 2004. Mushrooms: Cultivation, nutritional value, medicinal effect and nutritional environmental impact. CRC press, Newyork.
5. Verma, 2013. Mushroom: edible and medicinal: cultivation conservation, strain improvement with their marketing. Daya Publishing House.

Reference books:

1.Tiwari., SC., Pandey K. 2018. Mushroom cultivation. Mittal publisher, New Delhi.
2.Philips, G., Miles, Chang, S-T. 2004. Mushrooms: Cultivation, nutritional value, medicinaleffect and environmental effect. 2nd ed. CRC Press.
3.Diego, C.Z., Pando-Gimenez, A. 2017. Edible and medicinal mushrooms: Technology and Application. Wiley-Blackwell publishers.
4.Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17.
5.Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.

Web resources:

1.https://www.amazon.in/Mushroom-Cultivation-India-B-C/dp/817035479X
2.http://nrcmushroom.org/book-cultivation-merged.pdf
3.http://agricoop.nic.in/sites/default/files/ICAR_8.pdf
4.http://www.agrimoon.com/mushroom-culture-horticulture-icar-pdf-book/
5.https://books.google.co.in/books/about/Mushroom_Cultivation_in_India.html?id=6AJx99OGTKEC&redir_esc=y

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	2	2
CO2	3	3	2	2	3	3	2	3	2	3
CO3	3	3	2	2	1	3	1	3	1	2
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	3	3

S-Strong (3) M-Medium (2) L-Low (1)

ELECTIVE COURSE-I CONSERVATION OF NATURAL RESOURCES AND POLICIES

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM I	23KP1BECB1:2	3	2	--	5	3

Pre-requisite	To create awareness of environmental problems and their consequences.
Learning Objectives	1.Explain the term natural resources.
	2.Describe the reasons for degradation of natural resources and suggest measures to prevent these.
	3.List the various endangered species of animals and plants.
	4.State the various environmental laws passed to conserve the natural resources.
	5.Explain sustainable development and justify its need; and describe the various conventional as well as non-conventional sources of energy.

UNIT	CONTENTS
I	**NATURAL RESOURCES:** Definition – Importance – Classification – Human physiological socio-economic and cultural development – Human Population Explosion – Natural Resource Degradation – Concept of conservation.
II	**FOREST RESOURCES:** Forest cover in India and the World – Importance – Desertification – Forest Wealth – Afforestation – Vanasamrakshna Samithi– Agroforestry – Social Forestry – Joint Forest Management Strategy for Forest Conservation – Sanctuaries and National Parks In India – Man and Bio sphere Programme.
III	**LAND AND SOIL RESOURCES:** Impacts of natural and man-made activities on land characteristics and land use planning– Soil Erosion – Loss of Soil Nutrients – Restoration of Soil Fertility – Soil Conservation Methods and Strategies in India. Wet Land Conservation and Management – Ecological Importance of wet lands in India – Conservation Strategy and ecological Importance. Water Resources: Rivers and Lakes In India – Water Conservation.
IV	**MINERAL RESOURCES:** Use and exploitation – Environmental effects of extracting and using mineral resources – Restoration of mining lands – Expansion of supplies by substitution and conservation. **Food Resources:** World Food Problems – Changes caused by agriculture – overgrazing effects of modern agriculture – Fertilizer-Pesticide problems – Water Logging – Salinity – Sustainable agriculture.
V	**ENVIRONMENTAL POLICY IN INDIA:** Need for policies- Public Policy – Economic policies – Relationship between economic development and environment – Implementing Environmental Public Policy Strategies in pollution control – Constitutional provisions in India regarding environment – Public Awareness and Participation in Environmental Management – National Land Use Policy 1988 – Industrial Policy 1991.

Course outcomes:	On completion of this course the student will be able to CO	Programme outcomes
CO1	Understand the concept of different natural resources and their utilization.	K1
CO2	Critically analyze the sustainable utilization land, water, forest and energy resources	K2 & K6
CO3	Evaluate the management strategies of different natural resources	K3
CO4	Reflect upon the different national and international efforts in resource management and their conservation.	K4
CO5	State the various environmental policy passed to conserve the natural resources.	K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional,Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Trivedi R.K.1994. Environment and Natural Resources Conservation.
2. Murthy J.V.S.1994. Watershed Management in India.
3. Raymond, F Dasmann. 1984. Environmental Conservation, John Wiley.
4. Nalini, K.S. 1993. Environmental Resources and Management, Anmol Publishers, New Delhi.
5. Shyam Divan and Armin Rosencranz. 2001. Environmental Law and Policy in India, Oxford Uni.Press.

Reference Books:

1. Haue, R and Freed V.H. 1975. Environmental Dynamics of Pesticides, Menum Press, London
2. Singh, B. 1992. Social Forestry for Rural Development, Anmol Publishers, New Delhi.
3. Shafi. R. 1992. Forest Ecosystem of the World.
4. Stacy Keach. 2016. Natural Resources Management. Syrawood Publishing House.
5. Rathor B.S. 2013. Management of Natural Resource for Sustainable Development. Daya Publishing House, New Delhi.

Web resources:

1.https://www.amazon.in/conservation-natural-resources-Gifford-Pinchot-ebook/dp/B07HX76TVN
2.https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&redir_esc=y
3.https://www.kobo.com/ww/en/ebook/natural-resources-conservation-law
4.https://www.scribd.com/book/552185119/Natural-Resources-Conservation-and-Advances-for-Sustainability
5.https://www.scribd.com/document/354699536/Conservation-of-Natural-Resources

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	M	S	M	S
CO2	S	S	S	S	M	M	L	S	L	S
CO3	S	S	S	M	M	M	L	S	L	S
CO4	S	S	S	M	M	M	L	S	L	S
CO5	S	S	S	M	M	M	L	S	L	S

S-Strong (3) M-Medium (2) L-Low(1)

ELECTIVE COURSE II: HORTICULTURE

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM I	23KP1BECB2:1	3	2	--	5	3

Pre-requisite	Students should know fundamental knowledge on horticulture applications.
Learning Objectives	1. Know about the brief history, divisions, classification and structure of horticultural plants.
	2. Acquire knowledge on plant growth processes and stages of plant growth.
	3. Understand the plant growth environment in relation to soil, nutrients, fertilizers, and bio inoculants.
	4. Study the sexual and vegetative propagation methods including propagation through specialized vegetative structures.
	5. Develop practical skills in micro propagation techniques and soil-less production of horticultural crops.

UNIT	CONTENTS
I	**INTRODUCTION TO HORTICULTURE** Definition; Brief History, Divisions of Horticulture, Classification of horticultural plants, Structure of Horticultural Plants –Cell and Tissue systems, Anatomy of stem root and leaf, Morphological structures, Plant growth processes-A brief account of Photosynthesis, Respiration, Transpiration and Translocation, Stages of plant growth.
II	**FACTORS AFFECTING PLANT GROWTH** Plant Growth Environment: Abiotic factors, Soil –Profile structure, Primary and Secondary nutrients and their functions, Organic matter, Fertilizers –organic, Inorganic and Potting Media, Bio inoculants, Methods of fertilizer application, Directing Plant growth-Training -Pruning and thinning.
III	**PLANT PROPAGATION** Plant propagation: Seeds –Advantages, Viability, Mechanism of Dormancy and Dormancy Breaking: Methods of Direct and Indirect Seedling Production in Nurseries and Transplantation; Propagation through specialized underground structures –Corm, Tuber, Sucker, Bulb, Bulbil, Rhizome; Vegetative Propagation –Cutting, Layering, Grafting and Budding.
IV	**MICROPROPAGATION TECHNIQUES** Stages, multiplication by shoot tip, Nodal culture and Callus culture-Application and Limitations, Somatic embryogenesis, Synthetic seeds –Preparation and Potential uses of artificial seeds, Embryo Rescue, Soil-less Production of Horticultural crops –Hydroponics, sand culture, gravel culture.
V	**AESTHETICS OF HORTICULTURE** Design: Elements and Principles of Design, Flower Arrangement, Terrarium Culture, Bonsai, Growing Plants Indoors, Turf Production, Landscaping-Principles, Types of Parks, Xeriscaping. Postharvest handling of Horticultural Products –Harvesting, Storage, Processing, Elements of Marketing. Robotics in Horticulture.

Course outcomes	On completion of this course, the students will be able to	Programme outcomes
CO1	Identify and categorize various horticultural plants and the conditions that affect their growth and productivity.	K1
CO2	Explain the various structures and growth processes of horticultural plants.	K2
CO3	Demonstrate the propagation, growth, and maintenance of plants in horticulture systems.	K3
CO4	Correlate the soil characteristics and fertility to good plant growth.	K4
CO5	Utilize the role plant tissue culture techniques in the production of quality planting stock in horticulture.	K5
CO6	Apply horticultural skills and knowledge to explore career opportunities in horticulture industry.	K6

Extended ProfessionalComponent (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

Acquaah, G. 2011.Horticulture: Principles and Practices. (4th ed), Pearson Education, London, UK.
Janik, J. 1972. Horticultural Science. W.H. Freeman & Company, San Francisco.
Kumar, N. 1994. Introduction to Horticulture, Rajalakshmi Publication, India.
Manibhushan Rao, K. 2005. Text Book of Horticulture. (2nd ed), Macmillan India Ltd., New Delhi.
Schilletter, J. C. and Richey, H. W. 2005. Text Book of general Horticulture. 2nd ed. Biotech Books, Delhi.
Sharma, R.R. 2016. Propagation of horticultural crops. Kalyani Publishers, New Delhi.
Subba Rao, N.S. 1997. Biofertilizers in Agriculture and Forestry. India Book House Limited, Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.

Reference Books:

Acquaah, G. 2002. Horticulture Principles and Practices. 2nd ed. Pearson Education (Singapore) Pvt. Ltd.
Ashman, M.A. and Puri, G. 2002. Essential soil science-A clear and concise introduction to soil science. Blackwell scientific publishers, London.
Denisen, E.L. 1979. Principles of Horticulture. MacMillan Publishing co, Inc. New York.
Dirr, M. and Heuser, C.W. 2009. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture. Timber Press, Oregon, USA.
Thomson, L.M. and Troen, F.R. 1975. Soils and soil fertility Tata, McGraw Hill Publication Co. Ltd. New Delhi.
Tolanus, S. 2006. Soil fertility, Fertilizer and Integrated Nutrient management. CBS Publication, Delhi, India.

Web resources:

https://www.kobo.com/in/en/ebooks/horticulture
https://www.gale.com/gardening-and-horticulture
https://www.iaritoppers.com/p/horticulture-icar-ecourse-pdf-books.html
https://www.amazon.in/Introduction-Horticulture-N-Kumar-ebook/dp/B08M4289M6
https://www.researchgate.net/publication/316438576_Polyembryony_in_Horticulture_and_ its_significance

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	2	1	3	3	3	3	3	3	3	2
CO3	3	1	3	3	3	3	3	2	3	3
CO4	3	3	3	1	1	2	2	3	1	3
CO5	3	3	3	3	3	3	2	3	3	2

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE-II HERBAL TECHNOLOGY

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM I	23KP1BECB2:2	3	2	--	5	3

Pre-requisite	To understand the importance of herbal technology.
Learning Objectives	1.To understand various plants based drugs used inayurvedha, unani, homeopathy, siddha etc.
	2.To apply the knowledge to cultivate medical plants.
	3.To know the pharmacological importance of medicinal plants.
	4.To enlist phytochemicals and secondary metabolites of market and commercial value.
	5.To design and develop their own business prepositions such as theo in the making of herbal insecticides.

UNIT	CONTENTS
I	**PHARMACOGNOSY** Pharmacognosy scope and importance - source - Crude Drugs – Scope and Importance, Classification (Taxonomical, Morphological); Cultivation, Collection and processing of crude drugs. Cultivation and utilization of medicinal and aromatic plants in India.
II	**PLANT TISSUE CULTURE AS SOURCE OF MEDICINES** Plant tissue culture as source of medicines, Role of plant tissue culture in enhancing secondary metabolite production (*Withania somnifera, Rauwolfia serpentina, Catheranthus roseus, Andrographis paniculata* and *Dioscorea sp*).
III	**PLANT PROPAGATION** **ANALYSIS OF PHYTOCHEMICALS** Methods of Drug evaluation (Morphological, microscopic, physical and chemical). Phytochemical investigations - Biological evaluation/assays, Microbiological methods - Chemical Methods of Analysis, Detection of Adulterants: Chemical estimations, Spectrophotometry and fluorescence analysis. Drug adulteration - Types of adulterants.
IV	**GENERAL METHODS OF PHYTOCHEMICAL AND BIOLOGICAL SCREENING** Carbohydrates and derived products: Glycosides - extraction methods (*Digitalis, Dioscorea*); Tannins (Hydrolysable and Condensed types); Volatile oils - extraction methods (Clove, Mentha). Study of some herbal formulation techniques as drug cosmetics.
V	**TYPES OF PHYTOCHEMICALS** Alkaloids - extraction methods (*Taxus, Cinchona*); Flavonoids- extraction methods, Resins-extraction method: Application of phytochemicals in phytopharmacueticals; Biocides, Biofungicides, Biopesticides. Women entrepreneurship development – marketing cultivated medicinal plants – National Medicinal Plants Board of India.

Course outcomes:	On completion of this course, the students will be able to:	Programme outcomes
CO1	Recollect the importance of herbal technology.	K1
CO2	Understand the classification of crude drugs from various botanical sources.	K2
CO3	Analyze on the application of secondary metabolites in modern medicine.	K3
CO4	Create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society.	K4
CO5	Comprehend the current trade status and role of medicinal plants in socio economic growth.	K5 & K6

Extended Professional Component (is a part of internal component only,Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved(To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional,Competency, Professional Communication and Transferrable Skill

Recommended Text:

1.Kokate, C.K., Purohit, A.P and S.B. Gokhale. 1996. Pharmacognosy. NiraliPrakashan, 4th Ed.
2.Roseline, A. 2011. Pharmacognosy. MJP publishers, Chennai.
3.Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.Natural Products in medicine: A Biosynthetic approach. 1997. Wiley.Hornok, L. (ed.).
4.Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons Treaseand Evans.
5.Mukherjee, P.K. 2008. Quality control of herbal drugs. 3rd edition. Business Horizons Pharmaceutical Publishers, New Delhi, India.
6.Kirthikar and Basu. 2012. Indian Medicinal Plants. University Bookstore, Delhi. India
7.Biswas, P.K. 2006. Encyclopedia of Medicinal plants (Vol. I-VII). Dominant Publishers, New Delhi.
8.Chaudhuri, A.B. 2007. Endangered Medicinal Plants. Daya Publishing House, New Delhi.
9.Tilgner, Sharol Marie. 2018. Herbal ABC's: The Foundation of Herbal Medicine.

Reference Books:

1.Wallis, T.E. 1999. Text book of Pharmacognosy. CBS Publishers and Distributors, New Delhi.
2.Kumaresan, V and Annie Regland. 2004. Taxonomy of Angiosperms systematic Botany, Economic Botany, Botany &Ethnobotany.
3.Anonymous, 2004. Cultivation of Selected Medicinal Plants. National MedicinalPlants Board, Govt. of India, New Delhi.
4.Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
5.Acharya Vipul Rao. 2000. Herbal cure for common diseases. Diamond books, Pvt. Ltd.
6.Dey, A.C. 1998. Indian medicinal plants used in Ayurvedic preparations, Bishen Singh Mahendra Pal Singh.
7.Sathya, S., Jaiganesh, K.P and Sudha, T. 2019. Current Trends in Herbal Drug Technology. Pharmacy Council of India New Delhi.
8.Lewis, W.H and M.P.F. Elwin Lewis. 1976. Medical Botany. Plants affecting Man's Health. A Wiley Inter Science Publication. John Wiley and Sons, New York.

Web resources:

https://www.kopykitab.com/Herbal-Science
https://kadampa.org/books/free-ebook-download-howtotyl?gclid=CjwKCAiA6vXwBRBKEiwAYE7iS5t8yenurClUCTdV9olKo9TbyAh4fsoFqPYWGs5qBTbytD22z7lo0BoCYnUQAvD_BwE
https://www.barnesandnoble.com/b/free-ebooks/nook-books/alternative-medicine-natural-healing/herbal-medicine/_/N-ry0Z8qaZ11iu
http://cms.herbalgram.org/heg/volume8/07July/HerbalEBooks.html?t=1310004932&ts=1579066352&signature=1dd0d5aef818b19bcdcd6c063a78e404
https://www.dattanibookagency.com/books-herbs-science.html
https://www.springer.com/gp/book/9783540791157

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	2	1	3
CO2	3	3	3	3	3	3	3	1	3	3
CO3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	1	3	3
CO5	3	3	3	3	3	3	3	1	2	3

S-Strong (3) **M-Medium (2)** **L-Low(1)**

CORE COURSE-IV: PLANT TAXONOMY OF ANGIOSPERMS AND ECONOMIC BOTANY

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2B04	4	2	--	6	5

Pre-requisite	Prior knowledge on morphological, anatomical characteristics and uses of plants.
Learning Objectives	1.To be familiar with the basic concepts and principles of plant systematics.
	2.To develop a suitable method for correct characterization and identification of plants.
	3.To understand the importance of taxonomic relationships in research of plant systematics.
	4.To provide information on various classification systems
	5.To know about the economic importance of plants.

UNIT	CONTENTS
I	**TAXONOMY AND SYSTEMATICS** Botanical exploration and contribution with special reference to India by William Roxburgh, J.D. Hooker, Robert Wright, Nathanial Wallich and Gamble, J.S. Principles of classification as proposed – Artificial – Linnaeus, Natural – Bentham and Hooker, Phylogenetic system - Hutchinson, Modern – Takhtajan. Botanical gardens and herbaria of world, preparation and maintenance of Herbarium, Botanical survey of India – its organization and role.
II	**MODERN TRENDS IN TAXONOMY** Modern trends in taxonomy, chemotaxonomy, numerical taxonomy, biosystemics. ICBN uninominal systems- genesis binomial nomenclature, importance and principle. Important articles, typification, principles of priority, effective and valid publication, author citation, recommendations and amendents of code. Glossories and dictionaries, Taxonomic literature (Index Kewensis)
III	**SYSTEMATIC ANALYSIS OF PLANTS-I** Polypetalae – Nympheaceae, Sterculiaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae.
IV	**SYSTEMATIC ANALYSIS OF PLANTS-II** Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae. Monochlamydeae – Nyctaginaceae, Aristolochiaceae, Casuarinaceae. Monocots – Orchidaceae, Amarylidaceae, Lilliaceae, Commelinaceae, Cyperaceae.
V	**ECONOMIC BOTANY** General account on utilization of selected crop plants: (i) Cereals (rice and wheat) – (ii) Pulses (red gram and black gram), (iii) Drug yielding plants (*Withaniasomnifera*and *Coleus aromaticus)* (iv) Oil yielding plants (Groundnut, sunflower).(v) Sugar yielding plants (sugarcane and sugar beet), (vi) Spices and condiments (cardamom, cinnamon). (vii) Commercial crops - fibre (jute), (viii) Timber (Teak andred sanders wood), (ix) Resins and gums (Asafoetida and gum arabic) – (x) Essential oils (lemon grass and menthol), (xi) Beverages (tea, coffee), (xii) Plants used as avenue trees for shade, pollution control and aesthetics (xiii) Energy plantation - uses of *Casuarina.*

Course outcomes	On completion of this course, the students will be able to:CO	Programme outcomes
CO1	Recollect the basic concepts of morphology of leaves, flowers. Identify the types of compound leaves , inflorescence and fruits Describe their characteristic features	K1, K2 K3
CO2	Explain the principles of taxonomy. Summarize the taxonomic hierarchy. Define Binomial nomenclature. Group Activity – Construct key preparation	K1, K2 K5, K6
CO3	Explain the various types of classification. Distinguish its advantages and disadvantage Construction of floral formula anf floral diagram.	K1, K2 K3, K4
CO4	Illustrate and explain the characteristic features and list out the economic importance of the families Field trip to local botanical garden and regional botanical garden.	K1, K2 K3, K4
CO5	Illustrate and explain the characteristic featuresand list out the economic importance of the families.	K1, K2 K3, K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved(To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1.Pandey, B.P. 2013. Taxonomy of Angiosperms, S. Chand Publishing, New Delhi.
2.Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies.
3.Singh, G. 2007. Plant systematics theory and practices. Oxford and IBH Publishing Co.
4.Jain, S.K and Rao R.R. 1993. A handbook of field and herbarium methods. Today and Tomorrow Publ.

Reference Books:

1. Vallabh. 2000. Practical Pharmacognosy, Kolkata. New Delhi.
2. Acharya Vipul Rao. 2000. Herbal cure for common diseases. Diamond books, Pvt. Ltd.
3. Dey, A.C. 1998. Indian medicinal plants used in Ayurvedic preparations, Bishen Singh Mahendra Pal Singh.

Web resources:

1.https://www.ipni.org/
2.http://www.theplantlist.org/
3.https://www.amazon.in/PLANT-TAXONOMY-Sharma/dp/0070141592
5.https://www.tropicos.org/home
6.http://apps.kew.org/herbcat/gotoHerbariumGrowthPage.do
7.https://www.absbooksindia.com/shop/science/botany/textbook-of-economic-botany

Mapping with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	2	1	2	2
CO3	3	3	2	3	1	3	2	3	3	1
CO4	3	2	3	3	2	3	3	1	3	3
CO5	3	3	2	2	1	2	1	3	2	1

S-Strong (3) M-Medium (2) L-Low (1)

CORE COURSE-V: PLANT ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2B05	4	2	--	6	5

Learning Objectives	1. Learn the importance of plant anatomy in plant production systems.
	2. Classify meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants.
	3. Understand the mechanism underling the shift from vegetative to reproductive phase.
	4. Trace the development of male and female gametophyte.
	5. Understand the recent advances in palynology.

UNIT	CONTENTS
I	**CELL WALL:** Morphological and physico-chemical changes; Plasmodesmata- types of pits – growth of cell wall – formation of intercellular spaces; Meristems: Classifications: Theories of shoot and root apices, Cytological zonation in shoot apex. Vascular Cambium: Composition and organization – multiplicative and additive divisions. Xylem: Primary and secondary xylem – tracheary elements and vessels – vesselless dicots – xylem rays and axial parenchyma of angiosperm wood; Dendrochronology – grain, texture and figure in wood; reaction wood; ring porous and diffuse porous wood. Phloem: Ultra structure and ontogeny of sieve tube elements and companion cell.
II	**PERIDERM:** Structure, organization and activity of phellogen. Polyderm and Rhytiderm – wound periderm. Normal secondary thickening in Dicots; Anomalous secondary growth in Dicots (Amaranthaceae, Aristolochiaceae, Bignoniaceae, Piperaceae, Nyctaginaceae) and arborescent Monocots. Primary thickening in palms; Ontogeny of leaf, Structure and types of Stomata; Leaf abscission; Major nodal types; Kranz anatomy and its significance. Microtechnique: Principle of killing and fixation, dehydration and rehydration of botanical specimens. Stains: Principle of double staining (fast-green and light green) of free hand sections; Protocol for serial sectioning of paraffin wax impregnated specimens; Mounting and mounting media.
III	**MICROSPORANGIUM AND MALE GAMETOPHYTE:** Structure and development of Anther; Ultrastructure and physiology of anther tapetum; Male gametophyte; Palynology: Morphology and ultrastructure of pollen wall, pollen kitt, pollen analysis, pollen storage, pollen sterility and pollen physiology.
IV	**MEGASPORANGIUM AND FEMALE GAMETOPHYTE:** Structure and development of Megasporangium; Types of ovules, Endothelium, obturator and nucellus. Megasporogenesis: Female gametophyte: Structure, types, haustorialbehavior and Nutrition of embryo sacs. Fertilization: Double fertilization and triple fusion; Endosperm: Development of endosperm, types, physiological efficiency of endosperm haustoria and functions; Ruminate endosperm. Embryogeny: Development of monocot (Grass) and dicot (Crucifer) embryos.
V	**POLYEMBRYONY:** Causes of Polyembryony, classification, induction and practical application. Apomixis and its significance. Seed and Fruit development and role of growth substances. Parthenocarpy and its importance.

Course outcomes	On completion of this course, the students will be able to:CO	Programme outcomes
CO1	Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.	K1& K2
CO2	Study the function and organization of woody stems derived from Secondary growth in dicot and monocot plants.	K1&K4
CO3	Apply their idea on sectioning and dissection of plants to demonstrate various stages of plant development.	K2& K6
CO4	Understand the various concepts of plant development and reproduction.	K3& K6
CO5	Profitably manipulate the process of reproduction in plants with a professional and entrepreneurial mindset.	K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.

Reference Books:

1. Krishnamurthy, K.V. 1988. Methods in Plant Histochemistry. S. Viswanathan & Co., Madras.
2. Swamy, B.G.L and Krishnamurthy. K.V 1990. From flower to fruits, Tata – McGraw Hill
3. publishing Co Ltd, New Delhi.
4. Pullaiah, T., Lakshiminarayana, K and Hanumantha Rao, B. 2006. Text book of Embryology
5. of Angiosperms. Regency Publications, New Delhi. Bierhorst, D.W. 1971. Morphology of Vascular Plants. Macmillan publishers, New York.

Web resources:

1. https://www.ipni.org/
2. http://www.theplantlist.org/
3. https://faculty.etsu.edu/liuc/plant_anatomy_sites.htm
4. http://aryacollegeludhiana.in/E_BOOK/Botany/plant_anatomy.pdf

Mapping with Programme Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	3	3	3	3	3	3	3	3	3
CO2	3	1	3	3	3	3	3	3	3	3
CO3	3	1	3	3	3	3	3	2	3	1
CO4	3	3	3	1	1	2	3	2	2	1
CO5	3	3	3	3	3	3	2	3	3	2

S-Strong (3) **M-Medium (2)** **L-Low (1)**

CORE COURSE VI: LABORATORY COURSE-II COVERING PAPERS, IV & V

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2B06P	4	2	--	6	4

Pre-requisite	Theoretical understanding of plant taxonomy, ecology and phytogeography, plant anatomy and embryology as well as basic laboratory skills for the relevant core course.
Learning Objectives	1. Understand and develop skill sets in plant morphological, floral characteristics and artificial key preparation.
	2. Expedite skilled workers to carry out research in frontier areas of plant science.
	3.Classify Meristems and identify their structures, functions and roles in monocot and dicot plants growth and secondary growth of woody plants
	4. Learn the importance of plant anatomy in plant production systems.
	5Know about different vegetation sampling methods.

UNIT	EXPERIMENTS
I	**TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS** Preparation of artificial keys. Description of a species, based on virtual herbarium and live specimens of the families mentioned in the theory. Polypetalae – Nympheaceae, Sterculiaceae, Portulaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae.
II	Gamopetalae – Sapotaceae, Oleaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Convolvulaceae, Acanthaceae, Verbenaceae. Monochlamydeae – Nyctaginaceae, Aristolochiaceae, Casuarinaceae. Monocots – Orchidaceae, Amarylidaceae, Lilliaceae, Commelinaceae, Cyperaceae.
III	Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family. Solving nomenclature problems. i) Cereals (rice and wheat) – (ii) Pulses (red gram and black gram), (iii) Drug yielding plants (*Withaniasomnifera*and *Coleus aromaticus)* (iv) Oil yielding plants (Groundnut, sunflower).(v) Sugar yielding plants (sugarcane and sugar beet), (vi) Spices and condiments (cardamom, cinnamon). (vii) Commercial crops - fibre (jute), (viii) Timber (Teak and red sanders wood), (ix) Resins and gums (Asafoetida and gum arabic) – (x) Essential oils (lemon grass and menthol), (xi) Beverages (tea, coffee), (xii) Plants used as avenue trees for shade, pollution control and aesthetics (xiii) Energy plantation - uses of *Casuarina.* **Field trip:** A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 20 herbarium sheets representing the families studied.
IV	**ANATOMY** 1. Study of shoot apex of *Hydrilla* 2. Observation of cambial types. 3. Sectioning and observation of nodal types. 4. Study of anomalous secondary growth of the following: STEM- *Nyctanthus, Bouerhhavia, Aristolochia, Bignonia, Piper* petal and *Mirabilis.* ROOT: *Acyranthus.* 5. Observation of stomatal types by epidermal peeling. 6. Maceration of wood and observation of the components of xylem. 7. Double staining technique to study the stem anomali.
V	**EMBRYOLOGY** 1. Observation of T.S. of anther. 2. Observation of ovule types. 3. Observation of mature embryo sacs. 4. Dissection and observation of embryos (globular and cordate embryos). 5. Study of pollen morphology 6. Study of in vitro pollen germination. 7. Observation of endosperm types.

Course Outcomes	On completion of this course the student will be able to	Programmes Outcomes:
CO1	To gain recent advances in plant morphological and floral Characteristics.	K1
CO2	Understand about different floral characteristics and artificial key Preparation which employed for plant identification and conservation.	K2
CO3	Recall or remember the information including basic and advanced in Relation with plant anatomy and embryology.	K4 &K5
CO4	Apply their idea on sectioning and dissection of plants to demonstrate Various stages of plant development.	K3
CO5	Know about different vegetation sampling methods.	K3

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi.
2. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. NiraliPrakashan, 1st Edition. ISBN: 9351642062.
3. Joshi, S.G. 2018. Medicinal Plants. Oxford & IBH Publishing C., Pvt., Ltd., New Delhi. ISBN:

Reference books:

1. Aler Gingauz. 2001. Medicinal Chemistry. Oxford University Press & WileyPublications.
2. Mann J. Davidson, R.S and J.B. Hobbs, D.V. Banthorpe, J.B. Harborne. 1994. *Natural Products*. Longman Scientific and Technical Essex.
   Gopalan, C., B.V. Ramasastri and S.C. Balasubramanian. 1985. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad.

Web resources:

1. https://www.kobo.com/gr/en/ebook/phytochemistry-2
2. https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	S	3	3
CO2	3	3	2	3	3	2	1	2	3	2
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	1	2	3
CO5	3	2	2	3	3	3	3	2	3	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE III: RESEARCH METHODOLOGY& COMPUTER APPLICATIONS

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2BECB3:1	2	2	--	4	3

Pre-requisite	To impart expertise about analysis and research.
Learning Objectives	1. To equip students to collect, analyze and evaluate data generated by their own inquiries in a scientific manner.
	2. To provide an overview on modern equipments that they would help students gain confidence to instantly commence research careers and/or starts entrepreneurial ventures.
	3.To develop interdisciplinary skills in using computers in botany to learn about the biological database.
	4. Students aware with the most recent technologies for sequencing and bioinformatics analysis and is able to apply them to the structural and functional genomics of plants.
	5. Operate various software resources with advanced functions and its open office substitutes.

UNIT	CONTENTS
I	Literature collection and citation: bibliography —bibliometrics (scientometrics): definition-laws — citations and bibliography - *biblioscape— plagiarism— project proposal writing — dissertation writing – paper presentation (oral/poster) - E-learning tools- monograph — introduction and writing-Standard operating procedure (SOP) – introduction and preparation — Research Institutions - National and International.
II	Basic principles and applications of pH meter, UV-visible spectrophotometer, centrifuge, lyophilizer, chromatography- TLC, Gas chromatography with mass spectrum (GC/MS), and HPLC-Scanning electron microscopy-Agarose gel Electrophoresis — Polyacrylamide Gel Electrophoresis –Polymerase chain reaction
III	Introduction to computers and Bioinformatics. Types of hardware and software operating systems. Fundamentals of networking, operation of networks, telnet, ftp, www, Internet. Biological Research on the web: Using search engines, finding scientific articles.
IV	Public biological databases, searching biological databases. Use of nucleic acid and protein data banks.
V	NCBI, EMBL, DDBJ, SWISSPORT, Protein prediction and Gene finding tools. Techniques in Bioinformatics- BLAST, FASTA, Multiple Sequence Analysis **.**

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Realize the need of centrifuges and chromatography and their uses in Research	K1 &K2
CO2	Learn the principles and applications of electrophoresis.	K2 &K3
CO3	Construct the phylogenetic trees for similar characteristic feature of plant genomes and study *de novo* drug design through synthetic biology.	K5 &K6
CO4	Understand the concept of pairwise alignment of DNA sequences using algorithms.	K3 &K4
CO5	Interpret the features of local and multiple alignments.	K4 &K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Veerakumari, L. 2017. Bioinstrumentation. MJP Publisher, India. p578.
2. SreeRamulu, V.S.1988. Thesis Writing, Oxford& IBH Pub. New Delhi.
3. Kothekar, V and T.Nandi. 2009. An introduction to Bioinformatics. Panima publishing crop, New
4. Mani, K and N. Vijayaraj. 2004. Bioinformatics – A Practical Approach.1st Edn. Aparna publication, Coimbatore.

Reference Books:

1. Jayaraman, J. 2000. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002.
2. Pevsner, J.2015.Bioinformatics and functionalgenomics.Hoboken,NJ:Wiley-Blackwell.
3. Arthur Conklin W.M and Greg White, 2016. Principles of computer security. TMH. McGraw-Hill Education; edition.
4. Irfan Ali Khan and Attiya Khanum (eds.). 2004. Introductory Bioinformatics. Ukaaz Publications, Hyderabad.

Web resources:

1. https://www.kobo.com/in/en/ebook/bioinstrumentation-1
2. https://www.worldcat.org/title/bioinstrumentation/oclc/74848857
3. https://www.amazon.in/Bioinstrumentation-M-H-Fulekar-Bhawana-Pandey-ebook/dp/B01JP3M9TW
4. https://en.wikipdia.org/wiki/bioinstrumentation

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	3	3	3	1	3	3
CO2	3	2	2	3	3	3	3	2	3	3
CO3	3	1	2	3	3	3	3	1	3	3
CO4	3	2	1	3	3	3	2	1	3	2
CO5	3	1	2	2	3	3	3	2	3	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE III: BIOPESTICIDE TECHNOLOGY

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2BECB3:2	2	2	--	4	3

Pre-requisite	Prior knowledge on impact of chemical pesticides on environment andbiopesticides.
Learning Objectives	1.To understand the value and applications of biopesticides.
	2.To comprehend the various issues related to the use of chemical pesticides in horticulture, forestry, and agriculture.
	3.To gain knowledge about several biopesticides (bio-insecticides, bio-fungicides, bio-bactericides, bio-nematicides and bio-herbicides).
	4.To gain knowledge of the techniques for mass production of selected biopesticides.
	5.To be aware of the application strategies and weeds, nematodes, and disease targets.

UNIT	CONTENTS
I	**INTRODUCTION** Introduction of biopesticides. Biological control, History and concept of biopesticides. Importance, scope and potential of biopesticide. Advantages for the use of biopesticides.
II	**TYPES OF BIOPESTICIDES** Classification of biopesticides, botanical pesticides and biorationales. Mass production technology of bio-pesticides. Major classes-Properties and uses of Bioinsecticides and biofungicides. Importance of neem in organic agriculture.
III	**IMPORTANT BIOINSECTICIDES** *Bacillus thuringiensis*, NPV, entomopathogenic fungi (*Metarhizium, Verticillium*). Biofungicides: *Trichoderma, Gliocladium,* non-pathogenic *Fusarium, Pseudomonas* spp., *Bacillus* spp. Biobactericides: *Agro bacterium radiobacter*. Bionematicides: *Paecilomyces*, *Trichoderma*, Bioherbicides: *Phytophthora, Colletotrichum*.
IV	**STANDARDIZATION OF BIOPESTICIDES** Target pests and crops of important biopesticides and their mechanisms of action. Testing of quality parameters and standardization of biopesticides.
V	**FORMULATION** Mass multiplication and formulation technology of biopesticides. Prospects and problems in commercialization and efficacy of biopesticides. Commercial products of biopesticides.

Course outcomes:	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	Understand the issues in use of chemical pesticides and their harmful effects on life.	K1 & K2
CO2	Aware the significance of biopesticides and their beneficial role in controlling insect pests, diseases, nematodes and weeds.	K1 & K4
CO3	Knowledge on identification of promising biopesticides and their mechanisms of action against insect pests, diseases, nematodes and weeds.	K2 & K6
CO4	Learn the mass production and formulation technology of selected biopesticides.	K3 & K6
CO5	Knowledge on product development for commercialization of biopesticides.	K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional,Competency, Professional Communication and Transferrable Skill

Recommended Text:

Johri, J. 2020. Recent Advances in Biopesticides: Biotechnological Applications. New India Publishing Agency (NIPA), New Delhi.

Kaushik, N. 2004. Biopesticides for sustainable agriculture: prospects and constraints. TERI Press, New Delhi.

Sahayaraj, K. 2014. Basic and Applied Aspects of Biopesticides. Springer India, New Delhi.

Joshi, S.R. 2020. Biopesticides: A Biotechnological Approach. New Age International (P) ltd. New Delhi.

Reference Books:

Carlile, M.J., Watkinson, S.C and Gooday, G.W. 2001. The Fungi. 2nd Edition. Academic Press, San Diego

Manoj Parihar, Anand Kumar. 2021. Biopesticides. Volume 2: Advances in Bio- inoculants. Elsevier.

Manoharachary, C., Singh, H.B., Varma, A. 2020. Trichoderma: Agricultural Applications and Beyond. Springer International Publishing, New York, USA.

Anwer, M.A. 2021. Biopesticides and Bioagents: Novel Tools for Pest Management. Apple Academic Press, Florida, USA.

Awasthi, L.P. 2021. Biopesticides in Organic Farming: Recent Advances. CRC Press, Florida, USA.

Bailey, A., Chandler, D., Grant, W., Greaves, J., Prince, G., Tatchell, M., 2012. Biopesticides: Pest Management and Regulation. CABI, Surrey, UK.

Glare, T.R and Moran-Diez, M.E. 2016. Microbial-Based Biopesticides: Methods and Protocols. Humana Press, New Jersey, USA.

Web resources:

https://www.kobo.com/gr/en/ebook/phytochemistry-2
https://www.amazon.in/Textbook-Pharmacognosy-Phytochemistry-Kumar-Jayaveera-ebook/dp/B06XKSY76H
https://www.amazon.in/Computational-Phytochemistry-Satyajit-Dey-Sarker-ebook/dp/B07CV96NZJ
https://studyfrnd.com/pharmacognosy-and-phytochemistry-book/
https://www.worldcat.org/title/textbook-of-pharmacognosy-and-phytochemistry/oclc/802053616
https://www.worldcat.org/title/phytochemistry/oclc/621430002

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	2	2	2	3	2	3	1	3	3
CO3	3	3	3	3	1	2	S	2	3	2
CO4	3	2	2	2	3	3	2	1	2	1
CO5	3	3	3	3	2	2	2	3	2	3

S-Strong (3) M-Medium (2) L-Low(1)

ELECTIVE COURSE IV: APPLIED BIOINFORMATICS

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2BECB4:1	2	2	--	4	3

Pre-requisite	Basic knowledge in molecular biology. Familiarity with operations of computersand MS office tools.
Learning Objectives	1. To learn about the bioinformatics databases, databanks, data format and data retrieval from theonline sources.
	2. To explain the essential features of the interdisciplinary field of science for better understandingbiological data.
	3. To outline the types of biological databases.
	4. To demonstrate different online bioinformatics tools.
	5. To summarize the strong foundation for performing further research in bioinformatics.

UNIT	CONTENTS
I	**BIOINFORMATICS AND INTERNET:** Internet Basics - File Transfer Protocol - The World Wide Web - Internet Resources – databases – types- Applications - NCBI Data Model - SEQ-Ids – Biosequences- Biosequence sets – Sequence annotation – Sequence description.
II	**GENBANK SEQUENCE DATABASE:** **Introduction**- Primary And Secondary Databases - Format Vs. Content - Genbank Flatfile- Submitting DNA Sequences to the Databases - DNA/RNA - Population, Phylogenetic, and Mutation Studies - Protein-Only Submissions. Genome Centers - Contact points for submission of sequence data to DBJ/EMBL/Genbank.
III	**STRUCTURE DATABASES:** Introduction to Structures - Protein Data Bank (PDB) - Molecular Modeling Database at NCBI Structure File Formats - Visualizing Structural Information - Database Structure Viewers - Advanced Structure Modeling - Structure Similarity Searching.
IV	**SEQUENCE ALIGNMENT AND DATABASE SEARCHING:** Introduction - Evolutionary Basis of Sequence Alignment - Modular Nature of Proteins - Optimal Alignment Methods - Substitution Scores and Gap Penalties- Database Similarity Searching - FASTA – BLAST (BlastP, BlastN, etc.,) - Position Specific Scoring Matrices, Spliced Alignments.
V	**PREDICTIVE METHODS:** Using Protein Sequences Protein Identity Based on Composition - Physical Properties Based on Sequence - Motifs and Patterns - Secondary Structure and Folding Classes - Specialized Structures or Features - Tertiary Structure.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Familiarize with the tools of DNA sequence analysis.	K1 & K2
CO2	Use and explain the application of bioinformatics.	K2 & K3
CO3	C Master the aspects of protein-protein interaction, BLAST and PSI-BLAST.	K3 & K4
CO4	Describe the features of local and multiple alignments.	K3 & K4
CO5	Interpret the characteristics of phylogenetic methods and bioinformatics applications.	K4 & K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Baxevanis, A. D. & Ouellette, B. F. 2001. Bioinformatics: A practical guide to the analysis ofgenes and proteins. New York: Wiley-Interscience.
2. Bourne, P. E., & Gu, J. 2009. Structural bioinformatics. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. 2002. Introduction to bioinformatics. Oxford: Oxford University Press.
4. Mount, D. W. 2001. Bioinformatics: Sequence and genome analysis. Cold Spring Harbor, NY:Cold Spring Harbor Laboratory Press.

Reference Books:

1. Campbell, A.M and Heyer, L.J. 2003. Discovering genomics, proteomics, and bioinformatics.San Francisco: Benjamin Cummings.
2. Green, M.R and Sambrook, J. 2012. Molecular cloning: A laboratory manual. Cold SpringHarbor, NY: Cold Spring Harbor Laboratory Press.
3. Liebler, D.C. 2002. Introduction to proteomics: Tools for the new biology. Totowa, NJ: HumanaPress.

Web resources:

1. https://link.springer.com/book/10.1007/978-3-540-72800-9.
2. https://www.amazon.in/Applied-Bioinformatics-Paul-Maria-Selzer-ebook/dp/B001AUOYY2.
3. https://books.google.co.in/books/about/Applied_Bioinformatics.html?id=PXZZDwAAQBAJ&redir_esc=

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	2	3	3	3	3	2	2	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	1	3	3
CO5	3	2	2	2	3	3	3	3	3	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE IV: BIOSTATISTICS

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2BECB4:2	2	2	--	4	3

Pre-requisite	Fundamental knowledge on using in statistical tools and apply the tools to interpret the results.
Learning Objectives	1.To provide the student with a conceptual overview of statistical methods.
	2.To emphasis on usefulness of commonly used statistical software for analysis, research, and experimentation.
	3.To understand and evaluate critically the acquisition of data and its representation.
	4.To gain the knowledge about the probability and statistical inference are all topics that will be taught in order to obtain knowledge about the graphical representation of data.
	5.To learn more about how to organize, create, and carry out the distribution of scientific knowledge.

UNIT	CONTENTS
I	**INTRODUCTION TO STATISTICS** Introduction to biostatistics, basic principles, variables - Collection of data, sample collection and representation of Data - Primary and Secondary - Classification and tabulation of Data – Diagrams, graphs and presentation.
II	**DESCRIPTIVE STATISTICS** Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range of variation, standard deviation and standard error and coefficient variation.
III	**PROBABILITY** Basic principles - types - Rules of probability - addition and multiplication rules. **PROBABILITY DISTRIBUTION** Patterns of probability distribution; binomial - Poisson and normal.
IV	**HYPOTHESIS TESTING** Chi-square test for goodness of fit; Null hypothesis, level of Significance - Degrees of Freedom. Student 't' test – paired sample and mean differences 't' tests. ANOVA. Basic introduction to Multivariate Analysis of Variance (MANOVA).
V	**CORRELATION AND REGRESSION** Correlation - types of correlation - methods of study of correlation - testing the significance of the coefficients of correlation. Regression and types. Sampling and experimental designs of research-Randomized block design and split plot design.

Course outcomes:	On completion of this course, the students will be able to:	Programme outcomes
CO1	Create and interpret visual representations of quantitative information, such as graphs or charts.	K5 & K6
CO2	Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods	K3 & K5
CO3	Know the latest version using in statistical tools and apply the tools to interpret the results	K2
CO4	To develop their competence in hypothesis testing and interpretation.	K4
CO5	Understand why biologists need a background in statistics.	K1

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved(To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional, Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Gurumani, N. 2005. Biostatistics, 2nd edn. MJP publications, India.
2. Datta, A.K. 2006. Basic Biostatistics and Its Applications. New Central Book Agency. ISBN 8173815038.
3. Pillai, R.S.N and Bagavathi, V.S. 2010. Statistics theory and practice. Chand & Co. Ltd, New Delhi.
4. Mahajan, B.K. 1984. Methods in Biostatistics for Medical students and Research works. Smt. Indu Mahajan, New Delhi.
5. Pillai, R.S.N and Bagavathi, V.S. 2010. Statistics theory and practice. Chand & Co. Ltd, New Delhi.
6. Khan, I.D and Khanum, A. 2004. Fundamentals of Biostatistics, Ukazsz Publications, Hyderabad, India.
7. Gupta, S.C. 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.
8. Kothari, C.R and Garg, G. 2014. Research methodology –Method and techniques. New Age International (P) Ltd. New Delhi.

Reference books:

1. Milton, J.S. 1992. Statistical method in Biological and Health Sciences. McGraw Hill Inc., New York.
2. Schefler, W.C. 1968. Statistics for biological sciences, Addision- Wesely Publication Co., London.
3. Spiegel, M.R. 1981. Theory and Problems of statistics, Schaum's Outline series McGraw-Hill International Book Co., Singapore.
4. Pillai, R.S.N and Bagawathi, V. 1987. Practical Statistics (For B.Com. and B.A., Students) S.Chand & Co. (Pvt.) Ltd., New York.
5. Sobl. R.R and Rohif, F.J. 1969. Biometry. The principles and Practice and Statistics in Biological Research. W.H. Freman and Co., San Francisco.
6. Zar, J.K. 2011. Biostatistical Analysis, Fourth Edition, Prantice-Hall International, New Jersey, USA.

Web resources:

1. nu.libguides.com/biostatistics
2. https://newonline courses.sciences.psu.edu/
3. https://bookauthority.org/books/beginner-biostatistics-ebooks
4. https://www.amazon.com/dp/1478638184?tag=uuid10-20
5. https://hastie.su.domains/ElemStatLearn/

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1	3	3	3	3	1	3	1
CO 2	3	2	2	3	3	3	2	1	2	1
CO 3	3	1	2	3	3	3	3	2	2	2
CO 4	3	2	1	3	2	2	3	3	3	3
CO 5	3	2	3	3	3	3	3	1	3	1

S-Strong (3) **M-Medium (2)** **L-Low(1)**

SKILL ENHANCEMENT COURSE I: AGRICULTURE AND FOOD MICROBIOLOGY

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2BSEC1	2	2	--	4	2

Pre-requisite	To understand the benefits of microbes in agriculture and food industry.
Learning Objectives	1. To provide comprehensive knowledge about plant – microbe interactions.
	2.To provide basic understanding about factors affecting growth of microbes
	3. To appreciate the role of microbes in food preservation.
	4. To understand about the benefits of microbes in agriculture and food industry.
	5. To gain knowledge about practices involved in food industry.

UNIT	CONTENTS
I	**ROLE OF MICROORGANISMS IN AGRICULTURE** Role of symbiotic and free-living bacteria and cyanobacteria in agriculture., Mycorrhiza, Plant Growth Promoting Microorganims (PGPM) and Phosphate Solubilizing Microorganims (PSM).
II	**BIOCONTROL AND BIOFERTILIZATION** Biocontrol of plant pathogens, pests and weeds. Biofertilizers: Types, technology for their production and application, vermi-compost.
III	**FOOD MICROBIOLOGY** Intrinsic and extrinsic factors influencing growth of microorganisms in food, Microbes as source of food: Mushrooms, single cell protein.
IV	**FOOD MICROBIOLOGY** Microbial spoilage of food and food products: Cereals, vegetables, prickles, fish and dairy products. Food poisoning and food intoxication. Food adulteration- common adulterants and their ill-effects, Simple physical and chemical tests for detection of food adulterants.
V	Food preservation – Perishable, Semi perishable and non perishable foods. Methods of preservation- Temporary preservation- Asepsis, Low temperature, pasteurization and exclusion of air. Premantant preservation – Sterilization or processor by heat.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Recognize the general characteristics of microbes and factors affecting its growth	K1
CO2	Explain the significance of microbes in increasing soil fertility	K2
CO3	Elucidate concepts of microbial interactions with plant and food.	K3
CO4	Analyze the impact of harmful microbes in agriculture and food Industry.	K4
CO5	Determine and appreciate the role of microbes in food preservation and as biocontrol.	K5 &K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Pelczar M.J., Chan E.C.S. and Krieg N.R. 2003. Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Subba Rao, N. S. 2000. Soil microbiology. 4th Edition, Oxford and IBH publishing Co. Pvt. Ltd., Calcutta, New Delhi, India.
3. Rangaswami, G. and Bagyaraj, D.J. 2006. Agricultural Microbiology. 2nd Unit 2nd Edition, PHI Learning, New Delhi, India.
4. Prescott, L.M., Harley J.P., Klein D. A. 2005. Microbiology, McGraw Hill, India. 6thedition.
5. Goldman, E. and Green, L.H. 2015. Practical Handbook of Microbiology (3rd Ed.). CRCPress.

Reference Books:

1. Adams, M.R. and Moss M. O. 2008. Food Microbiology, 3rd Edition, Royal Society of Chemistry, Cambridge, U.K.
2. Sylvia D.M. 2004. Principles and Applications of Soil Microbiology, 2nd Edition, Prentice Hall, USA.
3. Frazier, W.C. 1995. Food Microbiology, 4th Edition, Tata McGraw Hill Education, Noida, India.
4. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. 2001. Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
5. Das, S. and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers and Distributors (P) Ltd., New Delhi, India.

Web resources:

1. https://www.kopykitab.com/Agriculture-And-Food-Microbiology-In-Hindi-by-Dr-Q-J-Shammi
2. https://agrimoon.com/agricultural-microbiology-icar-ecourse-pdf-book/
3. https://www.scientificpubonline.com/websitebooks/ebooks/agriculture/microbiology
4. https://www.amazon.in/Food-Microbiology-Martin-R-Adams-ebook/dp/B01D6B7V6A

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	2	1
CO2	3	3	2	2	3	3	2	3	3	3
CO3	2	2	3	3	1	2	1	3	1	2
CO4	3	3	3	3	3	2	3	3	3	2
CO5	3	3	2	3	2	3	3	3	2	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ECC 1: GREEN HOUSE TECHNOLOGY

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM II	23KP2BECC1:1	-	-	--	-	3

Pre-requisite	To understand the benefits of green house technology
Learning Objectives	1. Acquire knowledge on construction, design and maintenance of a greenhouse.
	2. Appreciate the nature of soil required, methods of irrigation and plant propagation.
	3. To evaluate plant nutritional requirement and irrigation methods.
	4. Learn the techniques pest and disease management.
	5. To collect knowledge on greenhouse maintenance and safety practices.

UNIT	CONTENTS
I	**FUNDAMENTALS OF GREENHOUSE TECHNOLOGY:** Importance, scope and status of greenhouse. Structure and construction of Greenhouse - location, frame work for various types of green house, covering material, construction of typical glasshouse/poly house/ net house, Construction of floors and layout, Design and development of low cost greenhouse structures. Automated greenhouses, microcontrollers, waste water recycling. Heating: Sources of heat, Cooling: Types of cooling, Environmental control: air temperature, sunlight, carbon dioxide, relative humidity.
II	**GREENHOUSE ROOT MEDIUM:** Properties of root medium for greenhouse and media handling. Media components – peat, bark, sawdust, coir, crop by product, composted garbage, perlite, vermiculite, sand, rock wool and polystyrene foam. Water quality and sanitation – Advanced protected agricultural systems and plastic mulches. Properties of root medium for greenhouse, Media handling, FYM, concentrated organic manures, macro and micronutrient availability.
III	**PLANT NUTRITION FOR GREEN HOUSES:** Plant nutrition: Fertilizers – chemical and organic; Choice of nitrogen fertilizers and time of application; Water quality and sanitation, Methods of irrigation - drip irrigation, micro irrigation; Fertigation, Advanced protected agricultural systems - plastic mulches.
IV	**PEST AND DISEASE MANAGEMENTS:** Identification and control measures of Bacterial, fungal, nematodes and viral diseases in greenhouse plants. Management of pest and diseases – physical, chemical, biological, Integrated Pest Management (IPM).
V	**HEALTH AND SAFETY:** Maintenance of erected structure, operational elements of green house for periodic checking, tightening, greasing. Understanding basic safety checks. Operation of all vehicles and hazards, renders appropriate emergency procedures. Environmental control: air temperature, sunlight, carbon dioxide, relative humidity.

REFERENCES:

1. Prasad S, Kumar U. Green House Management for Horticultural Crops. Agrobios India, 2012.
2. Pant V, Nelson. Green House Operation and Management. Bali Publication
3. Gupta P K Manures and soil fertilizers.
4. George Acquaah. Horticulture, Principles and Practices. Eastern Economy Edition.
5. Alex Lauric and Victor h Ries. Floriculture, Fundamentals and Practices. Agrobios, India.
6. http://www.agrimoon.com/wpcontent/uploads/Introduction-tosoil-science.pdf
7. http://scialert.net/fulltext/?doi= ijar.2006.364.372&org=10
8.http://www.lindegas.com/en/products_and_supply/fumigants/carbon_dioxide_in_agriculture/greenhouse_applications/index.html

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II YEAR - SEMESTER III

CORE COURSE VII: PLANT PHYSIOLOGY AND PLANT METABOLISM

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3B07	4	2	-	6	5

Pre-requisite	Basic knowledge on physiological processes in plants.
Learning Objectives	1. To acquire knowledge on the functional aspects of plants.
	2. To understand the biophysical and biochemical processes of plants.
	3. To study the metabolism of plants.
	4. To learn the plant growth regulations.
	5. To know the adaptive mechanisms of plants in adverse environmental conditions.

UNIT	CONTENTS
I	Water Relations: Physical and chemical properties of water –Components of water potential - Plasmolysis - water absorption by roots – Apoplast and Symplast concept - water transport through the xylem — Transpiration and evapotranspiration- stomatal structure and function – mechanism of stomatal opening and closing – mineral nutrition – essential nutrients – macro and micro nutrients – deficiencies and plant disorders – absorption of solutes – translocation of solutes – pathways and mechanisms. phloem loading and unloading - translocation of photosynthates – source- sink relationship – partitioning of assimilates and harvest index
II	Photosynthesis: The physical nature of light – the absorption and fate of light energy – absorption and action spectra- photoreceptors- Ultrastructure and biochemical compartmentation of Chloroplast; Photosynthetic Electron Transport and Photo phosphorylation (cyclic and noncyclic): Photosystems and reaction centres - Light Harvesting complexes - Photosystem I & II and Oxidation of Water; Carbon metabolism: C3, C4 and CAM pathways and their distinguishing features - photorespiration and its significance. Biochemistry and Molecular Biology of RUBISCO.
III	An overview of plant respiration – Glycolysis – TCA cycle– Electron Transport – oxidative phosphorylation and ATP synthesis – Chemiosmotic Theory - Pentose Phosphate Pathway– Respiration and its significance in crop improvement. Cyanide resistant respiration; Nitrogen fixation (Biological - symbiotic and non-symbiotic), Physiology and Biochemistry of nitrogen fixation.
IV	Growth and development – Phases of plant growth – growth types- Growth substances - Auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassino steroids - physiological effect and mechanism of action in agricultural and horticultural crops –Photoperiodism – Classification of plants and mechanism of flowering – Phytochrome and their action on flowering – Vernalization- Mechanism and its practical application, biological rhythms and movements. Seed dormancy and causes and Seed germination and their biochemical changes.
V	Plant senescence –Types and Mechanism of senescence- Abscission: Morphological and biochemical changes – Significance. Fruit ripening- Biochemical, Physiological changes and control of fruit ripening. Plant response to environmental stress: Biotic and Abiotic stress – Water, temperature, light and salinity- Adaptive mechanism to various stresses (avoidance, escape, tolerance)–stress responsive proteins – anti-oxidative mechanism.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Relate understand properties and importance of water in biological system, nutrients and its translocation.	K1
CO2	Demonstrate the importance of light in plant growth and the harves of energy.	K2
CO3	Explain the energy requirement and nitrogen metabolism.	K3
CO4	Compare the various growth regulators that influence plant growth.	K4
CO5	Discuss the senescence and plant response to environmental stress.	K5 &K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Gauch, H.G.1972. Inorganic Plant Nutrition. Hutchinson & Dowd. New York.
2. Govindji. 1982. Photosynthesis. AP. New York.
3. Jacob, W.P. 1979. Plant Hormones and Plant Development. Cambridge University Press.
4. Cambrigde
5. Khan, A.A. 1982. The Physiology and Biochemistry of Seed development, Dormancy and
6. Germination. Elesiver. Amsterdam.
7. Salisbury, F. B.C.W. Ross.1991. Plant Physiology. Wassworth Pub. Co. Belmont.

Reference Books:

1. Bidwell, R.G.S. 1974. Plant Physiology, Macmillan Publisher, Boston.
2. Devlin, R.M. 1996. Plant Physiology, PWS publisher, Boston.
3. Jain, V.K. 2017. Fundamentals of Plant Physiology. Chand & Company Ltd., New Delhi.
4. Gontia. 2016. A textbook of Plant Physiology. Satish Serial publishing House, New Delhi.
5. Leopold, A.C, 1994. Plant Growth and Development, McGraw Hill, New York.

Web resources:

1. https://www.sciencedirect.com/topics/agriculture-and0biological-sciences/plant-physiology.
2. https://learn.careers360.com/biology/plant-physiology-chapter/
3. https://apan.net/meetings/apan45/files/17/17-01-01-01.pdf

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	3	2
CO2	3	3	2	2	3	3	2	3	2	3
CO3	2	2	3	3	1	2	1	3	3	1
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	3	2

S-Strong (3) M-Medium (2) L-Low (1)

CORE COURSE VIII- GENETICS, PLANT BREEDING & BIOSTATISTICS

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3B08	4	2	-	6	5

Pre-requisite	To acquire knowledge on genetic traits and plant breeding techniques for crop improvement.
Learning Objectives	1. The students will be able to have conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
	2. Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
	3. Familiarize with genetic basis of heterosis.
	4. Reflect upon the role of various non-conventional methods used in crop improvement.
	5.Solve problems quantitatively using appropriate arithmetical, algebraic, or statistical methods

UNIT	CONTENTS
I	Mendal's Law of inheritance. Gene interactions and modified dihybrid ratios. Quantitative inheritance. Sex determination in plants and theories of sex determination. Sex linked characters. Structure of Gene, Operon , inducible operon, Operator site, Promoter, Polycistronic m RNA, Regulator, repressor, super repressor, inducer. Gene function and regulation in prokaryotes with reference to Lac operon and trp operon.
II	Recombination: Homologous and non-homologous recombination, site-specific recombination. Holiday model of recombination. Transposable genetic elements: Ac element, transposase, transposon, simple transposon, composite transposon, Is element. Transposons in *Zea mays*. Transposable elements in prokaryotes. UV induced mutation and its repair mechanism. Mismatch DNA repair mechanism. Mutation types- frame shift mutation, addition, deletion, substitution, transition and transversion.
III	Gene mapping methods**:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. Extra chromosomal inheritance, maternal inheritance. Organelle genomes: Organization and functions of chloroplast and mitochondrial DNA.
IV	**PLANT BREEDING:** Objectives of plant breeding, characteristics improved by plant breeding, Genetic basis of breeding self and cross – pollinated crops. Pure line theory, pure line selection and mass selection, clonal selection methods. Hybridization, Genetics and physiological basis of heterosis.
V	**BIOSTATISTICS:** Measures of central tendency (Mean , Median , Mode) and dispersal (Mean deviation , standard deviation) , standard errors ANOVA (One way).probability distributions (Binomial, Poisson andnormal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance; X2 test.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Understand the Mendal's Law of inheritance and gene interactions.	K1
CO2	Analyze the various factors determining the heredity from one Generation to another.	K2
CO3	Explain Gene mapping methods**:** Linkage maps.	K3
CO4	Compare and contrast the genetic basis of breeding self and cross Pollinated crops.	K4
CO5	CO5 Discuss and develop skills for statistical analysis of biological problems.	K5 & K6

Extended ProfessionalComponent (is a part of internal component only, Not to be included in the External Examinationquestion paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Benjamin, A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England.
2. Sinnott, E.W.Dunn, L.E and Dobzhansky, T. 1973. Principles of Genetics. McGraw-Hill.New York.
3. Chaudhari, H.K.1984. Elementary Principles of Plant Breeding. Oxford & IBH Publishing Company.

Reference Books:

1. Lewin, B. 2003. Genes VIII. Oxford University Press.
2. Friefelder,D. 2005. Molecular Biology. Second Edition. NarosaPub.House.
3. Sobtir.C. and Gobe. 1991. Eukaryotic chromosomes. Narosa Publishinghouse.

Smith-Keary, P. 1991. Molecular Genetics. Macmillan Pub. Co. Ltd. London.

Web Resourses

1. https://www.cdc.gov/genomics/about/basics.htm
2. https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/
3. https://www.britannica.com/science/evolution-scientific-theory
4. https://www.britannica.com/science/cell-biology
5. https://medlineplus.gov/genetocs/understanding/basics/cell/

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	3	2	1	2	2	2	1
CO2	3	3	2	2	3	3	2	3	3	3
CO3	2	2	3	3	1	3	1	3	1	2
CO4	3	3	3	3	3	2	3	3	3	2
CO5	3	3	2	3	2	3	3	3	2	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

CORE COURSE IX: LABORATORY COURSE-III -COVERING CORE PAPERS VII & VIII

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3B09P	4	2	-	6	5

Pre-requisite	Practicals pertaining to above subjects is important to get knowledge on overall cell structure, cellular organelles and staining procedures and fundamental principles of genetics and plant breeding.
Learning Objectives	1. Observe the different stages of mitosis and chromosome behaviour and organization during various stages and to learn staining techniques of various plant tissues.
	2. Explain the principles of linkage, crossing over and the hereditary mechanisms.
	3. Expose the students to gain recent advances in molecular biology.
	4.Understand the principles of plant breeding to apply crop improvement programmes
	5. Understand the principles of rDNA techniques.

UNIT	EXPERIMENTS
I	**PLANT PHYSIOLOGY** 1. Determination of osmotic potential by plasmolytic method. 2. Determination of water potential using gravimetric method. 3. Determination of water potential using dye method (Chardakov's method). 4. Effect of Monochromatic light on apparent photosynthesis. 5. Effect of CO_2 concentration on apparent photosynthesis.
II	**PLANT PHYSIOLOGY** 1. Effect of temperature on protoplasmic membrane. 2. Separation of chloroplast pigments using paper chromatographic technique. 3. Estimation of chlorophyll content using Arnon's method. 4. Determination of rate of photosynthesis using O_2 electrode. 5. Experiment to study the rate of Hill activity of isolated chloroplast by dye-reduction
III	**GENETICS** 1. Problem solving on dihybrid phenotypic, genotypic and test cross ratios. 2. Incomplete dominance in plants. 3. Interactions of factors and modified dihybrid ratios. 4. Multiple alleles in plants, blood group inheritance in human. 5. Sex linked inheritance in Drosophila and plants. 6. Quantitative inheritance in plants. 7. Tetrad analysis in Neurospora. 8. Complementation analysis to find out complementation groups in viruses. 9. Chromosome mapping from three point test cross data. Calculation of chiasmatic interference. 10. Calculate gene and genotypic frequency by Hardy- Weinberg equation.
IV	**PLANT BREEDING** 1. Selection –Pure Selection, Mass Selection and Clonal Selection 2. Techniques in plant hybridization 3. Heterosis
V	**BIOSTATISTICS** 1. Find out the mean from the given samples. 2. Find out the median from the given samples. 3. Find out the mode from the given samples. 4. Find out the deviation from the given data. 5. Find the ANOVA form the given table.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Recall or remember the various aspects of cell biology, genetics, Molecular biology, plant breeding and tissue culture.	K1
CO2	Understand various concepts of cell biology, genetics, plant breeding and tissue culture.	K2
CO3	Apply the theory knowledge gained into practical mode in order to acquire applied knowledge by day-to-day hands-on experiences.	K3
CO4	Analyze or interpret the results achieved in practical session in the context of existing theory and knowledge.	K4
CO5	Evaluate the theory and practical skills gained during the course.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from thiscourse	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. George M Malacinski. 2015. Freifelders Essentials of Molecular Biology (4th ed.). Jones &
2. Bartlett.
3. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut.
4. Gupta, P.K. 2018. Cytogenetics, Rastogi Publications, Meerut.
5. Kumar, H.D. 2007. Molecular Biology and Biotechnology, Vikas Publishing House, New
6. Delhi.

Reference Books:

1. Harris, N and K.J. Oparka. 1994. Plant cell Biology: A Practical Approach. IRL Press, At Oxford University Press, Oxford, UK.
2. Gelvin, S.B., Schilperoort, R.A. (Eds.). 2000. Plant Molecualr Biology Manual.
3. Henry, RJ. 1997. Practical applications of plant molecular biology, Chapman & Hall, London.
4. Krebs, J.E., Goldstein E.S. and Kilpatrick S.T. 2017. Lewin's GENES XII (12thed.). Jones & Bartlett Learning.

Web sources:

1. https://www.kopykitab.com/Practical-Plant-Breeding-by-Gupta-S-k
2. https://www.kopykitab.com/Cell-And-Molecular-Biology-A-Lab-Manual-by-K-V-Chaitanya
3. https://www.amazon.in/Plant-Tissue-Culture-Theory-Practicals/dp/9386347350

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	2	1
CO2	3	3	2	2	3	3	2	3	3	3
CO3	2	2	3	3	1	2	1	3	1	2
CO4	3	3	3	3	3	2	3	3	3	2
CO5	3	3	2	3	2	3	3	3	2	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

CORE COURSE X- INDUSTRY MODULE - INDUSTRIAL BOTANY

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3B10	6	-	-	6	4

Pre-requisite	The course will equip students to either obtain employment in the field or start their own business there, depending on the needs of the industry.
Learning Objectives	1. To learn the applied aspects of industrial application of algae, fungi, bacteria, plants, molecular biology and recombination technology.
	2. The student would be competent to work in industries.
	3. To educate people about the widespread commercial uses of fungi.
	4. To know about the economic importance of plants.
	5. To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.

UNIT	CONTENTS
I	**ALGAE IN INDUSTRIES:** Fertilizer industry-Seaweeds, pharmaceutical industry – antibiotics, agar, carageenin, alginin, diatomate earth, mineral industry, fodder industry
II	**FUNGI IN INDUSTRIES:** Beneficial use of yeast, Fermentation of alcohol, preparations of enzyme, organic acid preparation, cheese production, protein manufacture, vitamins, fats.
III	**PLANT PRODUCTS:** Fibres and Fibre-Yielding Plants, wood and cork, tannins and dyes, rubber, fatty oils and Vegetable fats, sugars and starches, pulp and paper, gums and resins.
IV	**BACTERIA IN INDUSTRY:** Food industry, dairy products, bioleaching, biogas production**,** bioremediation
V	**RECOMBINANT PLANTS:** Tissue culture: Micropropagation, somatic seeds, cell culture.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Understand the basics of algae in industrial applications.	K1
CO2	Demonstrate and to recollect the uses in fungi in industries.	K2
CO3	Explain bacterial role in industries.	K3
CO4	Compare and contrast the use of plants in industries.	K4
CO5	Discuss and develop skills for working in industries specializing in biomolecules.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from thiscourse	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
2. Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
3. Poonam Singh and Ashok Pandey. 2009. Biotechnology for agro-Industrial residues utilization. Springer.
4. Dilip K. Arora. 2003. Handbook of Fungal Biotechnology. CRC Press book.
5. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
6. Dubey R.C. 2004. A text book of Biotechnology aspects of microbiology, British Sun Publication.
7. Narayanaswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi

Reference books:

1. Alexander N. Glazer and Hiroshi Nikaido. 1994. Microbial Biotechnology.
2. Pandey, B.P. 2005. College Botany I: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S Chand & Company.
3. Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons
4. William Charles Evans.1989. Pharmacognosy, 14th ed. Harcourt Brace & Company.
5. Kumar, H.D.1999. Introductory Phycology.Affiliated East-West Press, Delhi.

Web resources:

1. https://www.elsevier.com/books/algal-biotechnology/ahmad/978-0-323-90476-6
2. https://www.amazon.in/Fungi-Biotechnology-Prakash-ebook/dp/B07PBF2R3D
3. https://link.springer.com/book/10.1007/978-981-16-5214-1
4. https://link.springer.com/book/10.1385/0896031616

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	1	2	2
CO2	3	3	2	2	3	3	2	3	2	3
CO3	2	2	3	3	1	2	1	2	1	3
CO4	3	3	3	3	3	2	3	2	3	3
CO5	3	3	2	3	2	3	3	3	3	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE V - APPLIED PLANT CELL & TISSUE CULTURE

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3BECB5:1	3		--	3	3

Pre-requisite	The course will equip students to either obtain employment in the field or start their own business there, depending on the needs of the industry.
Learning Objectives	1.To comprehend the basic principles and methodologies of plant tissue culture.
	2.To acquire knowledge on *in vitro* cultivation techniques to develop protocols targeted towards commercialization.
	3.To gain understanding of the various techniques of tissue culture for secondary metabolites production. .
	4.To recognize the worth of traditional germ plasm and receive training in preserving and enhancing crop varieties to meet consumer demand and global legal policies.
	5.To impart practical information on plant tissue culture in order to produce labour suitable for the demands of the industry and research facilities

UNIT	CONTENTS
I	**BASIC PLANT TISSUE CULTURE:** Concepts of plant tissue culture – Laboratory organization –Aseptic techniques - Plant culture media – Inorganic nutrients – Macronutrients – Micronutrients - Carbon and energy sources – Organic supplements – Growth regulators – Solidifying agent – MS medium and B5 medium – Explant preparation - Methods of sterilization – Transfer and incubation of culture – Transplantation area.
II	**MICROPROPAGATION:** Micropropagation – Stages of micropropagation - Multiplication by axillary and apical shoots – Multiplication by adventitious shoots – Multiplication through callus culture – Organogenesis and somatic embryogenesis – Multiplication and Rooting - Hardening - Factors effecting micropropagation.
III	**CELL AND PROTOPLAST CULTURES AND HAPLOID PRODUCTION:** Single cell and cell suspension culture – Applications - Production of haploids - Anther culture and pollen culture. Protoplast culture: Protoplast isolation, purification – regeneration – culturing. Protoplast fusion techniques – somatic hybridization and cybridization - Applications of protoplast culture and hybridization.
IV	**METABOLIC ENGINEERING:** Application of cell culture systems in metabolic engineering - advantages of cell, tissue and organ culture as a source of secondary metabolites - Hairy root culture - Screening of high yielding cell lines - Procedures for extraction of high value industrial products – Alkaloids, food additives and insecticides in *in vitro* system.
V	**CRYOPRESERVATION AND BIOREACTORS:** Germplasm storage and conservation – Methods of in vitro conservation – Cryopreservation and steps involved in cryopreservation of plant materials - Types of bioreactors (Stirred tank and airlift) and their uses - Industrial scaling – Upstream and downstream processing. Applications of tissue culture in agriculture, Horticulture and forestry.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Recall the principles and culture techniques of cells, callus, organs, pollen, anthers, embryos and protoplasts.	K1
CO2	Understand the techniques used in plant growth and regeneration under *in vitro* conditions.	K2
CO3	Apply the role plant tissue culture techniques in the production some secondary metabolites and planting stock in horticulture.	K3
CO4	Analyze the conditions that are suitable for direct and indirect plant regeneration.	K4
CO5	Evaluate the self-skills obtained during the course thorough internal and external assessment systems.	K5
CO6	Create idea to seek for suitable job in relevant industries/research centers or to become a potential entrepreneur based on knowledge achieved during the course.	K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examinationquestion paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Narayanaswamy, S. 1999. Plant cell and tissue culture. 8th edn. Tata McGraw Hill Publ. ISBN 0074602772.
2. Bhojwani, S.S and Razdan, M.K. 2004. Plant Tissue Culture, Read Elsevier India Pvt. Ltd. ISBN 818147 3256.
3. Gupta, S.D and Ibaraki, Y. 2006. Plant tissue culture engineering (Vol. 6). Springer Science & Business Media, Germany.

Reference Books

1. Bhojwani, S. S and Dantu, P.K. 2013. Plant tissue culture: an introductory text (Vol. 318). New Delhi, India: Springer.
2. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands..
3. Hall, R.D. (Ed.). 1999. Plant Tissue Culture: Techniques and Experiments, Academic
4. Press, New York.

Web resources:

1. https://nptel.ac.in/courses/102/103/102103016/
2. http://ugcmoocs.inflibnet.ac.in/ugcmoocs/spoc.php?coordinator=574
3. https://www.youtube.com/watch?v=bi755vQVNx8

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	1	3
CO2	3	3	2	2	3	3	2	3	2	2
CO3	2	2	3	3	1	2	1	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	2	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE V - SILVICULTURE AND COMMERCIAL LANDSCAPING

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3BECB5:2	3		--	3	3

Pre-requisite	Students should know about the fundamental concepts of gardening and landscaping.
Learning Objectives	1.To understand the basic concepts of horticulture.
	2.To learn the various methods of plant propagation.
	3.To know the art of fruit crop and vegetable crop cultivation.
	4.To know about the fundamental concepts of gardening and landscaping.
	5. To provide an overview of various gardening styles and its scope in recreation and bio-aesthetic planning.

UNIT	CONTENTS
I	Basics of Horticulture: Importance and scope of Horticulture - Divisions of Horticulture – Climate, soil and nutritional needs – Manures and fertilizers – Organic manures – Inorganic fertilizers.
II	Plant propagation: Natural method: Propagation through seeds and specialized vegetative structures - Artificial methods: Cutting: types (root, stem, leaf cuttings), advantages and disadvantages - Layering: types (simple, compound, tip, trench, mound, air-layering) advantages and disadvantages - Grafting: types (inarching, side, splice, whip/tongue) advantages and disadvantages.
III	Fruit crops: Training and pruning methods for fruit plants – Induction of flowering, flower thinning - fruit setting and fruit development – Seedlessness in horticultural fruits – Importance of plant growth regulators in fruit crops – Cultivation and harvesting methods of important fruit crops; Mango, Sapota.
IV	Flower and vegetable crops: Floriculture – Cultivation of commercial flower crops – Rose, Jasmine and Chrysanthemum– Cut flowers - Flower decoration – Dry and wet decoration - Classification of vegetables – Cultivation of important vegetables – Tomato and Potato.
V	Landscape designing: Principles and methods of landscape designing – Types of garden – Garden components – Shrubs and shrubberies, ornamental hedges, edges, flower beds, borders and carpet beds – Climbers and creepers – Foliage plants - Succulents and cacti – Ornamental palms – Orchids - Topiary and trophy - Rockeries and arches – Lawn making and maintenance.

Course outcomes:	**On completion of this course, the students will be able to:**	**Programme outcomes**
CO1	To understand the importance and divisions of horticulture.	K1
CO2	Demonstrate the art of floriculture and landscape gardening.	K2
CO3	Explain plant propagation and fruit crop cultivation.	K3
CO4	Compare and contrast the vegetable cultivation and kitchen gardening.	K4
CO5	Discuss and develop skills for effective understanding on landscaping and components of gardens.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Edmond, J.B. 1977. Fundamentals of Horticulture. Tata McGraw Hill Publishers Co. Ltd., New Delhi.
2. Kumar, N. 2017. Introduction to Horticulture, Midtech Publisher.
3. Manibushan Rao, K. 1991. Textbook of Horticulture. Macmillan Publishing Co., New York.
4. Rao, K.M. 2000. Text book of Horticulture. Macmillan India Ltd, New Delhi.
5. George, A. 2002. Horticulture Principles and Practices. 2nd Edition. Pearson Education, Delhi.
6. Bohra, M.P.S. and Arora, 2017. Introduction to Horticulture, 2 nd Edition.
7. Singh, J. 2018. Fundamentals of Horticulture. Kalyani Publishers.
8. Acquaah, J. 2009. Horticulture – principles and practices, 4th edition, PHI learning Pvt. Ltd.
9. Rao Manibhushan K. 1991. Textbook of horticulture. MaC Millan India Ltd.
10. Gangulee H. C. and Kar A. K. 2004. College Botany Vol II, New Central Book Agency
11. Sharma V. K. 1999. Encyclopaedia of Practical Horticulture, Vol I –IV, Deep And Deep Publ. Pvt. Ltd.

Reference books:

1. Edment Senn Andrews. 1994. Fundamentals of Horticulture.Tata. McGraw Hill Publishing Co., Ltd., Delhi.
2. Adams, 2005. Principles of Horticulture. IVth Ed. Elsevier India Pv. Ltd
3. Antje Rugullis. 2008. 1001 Garden Plants and Flowers. Parragon Publishers.
4. Berry, F. and Kress, J. 1991. Heliconia: An Identification Guide . Smithsonian Books.
5. Butts, E. and Stensson, K. 2012.Sheridan Nurseries: One hundred years of People,Plans, and Plants. Dundurn Group Ltd.
6. Russell, T. 2012. Nature Guide: Trees: The world in your hands(Nature Guides).

Web Resources:

1. https://courses.opened.uoguelph.ca/contentManagement.do?method=load&code=CM000019
2. www.teachervision.com/gardening
3. https://pace.oregonstate.edu/catalog/master-gardener-series-oregon-master-gardener-program
4. https://www.amazon.in/Gardening-Landscape-Design-and-Botanical-Garden/s?rh=n%3A1318122031%2Cp_27%3Aand+Botanical+Garden
5. https://www.overdrive.com/subjects/gardening
6. https://www.scribd.com/book/530538456/Opportunities-in-Landscape-Architecture-Botanical-Gardens-and-Arboreta-Careers

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	2	1	2	2	3	1
CO2	3	3	2	2	3	3	2	3	3	2
CO3	2	2	3	3	1	2	1	3	2	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	3	2

S-Strong (3) **M-Medium (2)** **L-Low(1)**

SKILL ENHANCEMENT COURSE :II- ENTREPRENEURIAL OPPORTUNITIES IN BOTANY

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3BSEC2	3	-	--	3	2

Pre-requisite	To understand the importance of floriculture and nursery management.
Learning Objectives	1.Understand the different classifications of horticultural crops, nursery management, and use of technology in horticulture.
	2.Develop their competency on pre and post-harvest technology in horticultural crops.
	3.Analyze the different methods of weed control and harvest treatments of horticultural crops.
	4.Examine the economic implications of cultivation of tropical and sub-tropical vegetable crops.
	5.Evaluate the importance of floriculture and contribution spices and condiments on economy.

UNIT	CONTENTS
I	Organic manures and fertilizers. Composition of fertilizer, NPK content of various fertilizers. Common organic manures bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost, aerobic and anaerobic – advantages. Vermicompost preparation, vermiwash. Panchakaviyam.
II	Common garden tools. Methods of plant propagation by seeds. Vegetative propagation, cutting, grafting, budding and layering. Use of growth regulators for rooting.
III	Gardening – types of garden, ornamental, indoor garden, kitchen garden, terrace garden, vegetable garden for marketing. Rockery and artificial ponds. Ornamental garden designing, garden components flower beds, borders, hedges, edges, drives, paths, garden adornments.
IV	Packaging of fruits, vegetables. Preservation techniques drying, heat treatment, low temperature storage and by chemicals. Preparation of wine, vinegar and dairy products.
V	Significance of mushrooms. Types of mushrooms (button mushroom, oyster mushroom). Spawn isolation and preparation. Cultivation. Value added products from mushroom – pickles, candies and dried mushrooms.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Students can acquire knowledge about organic farming and their Advantages	K1
CO2	Analyze both the theoretical and practical knowledge in understanding various horticultural techniques.	K2
CO3	To develop kitchen garden or terrace garden in their living area.	K3
CO4	Evaluate the horticultural techniques to students can develop self employment and economical improvement.	K4
CO5	Create and develop skills for mushroom cultivation.	K5 & K6

Extended ProfessionalComponent (is a part of internal component only,Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from thiscourse	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. AuthorHouse,
2. Bloomington, USA.
3. Russell, T. 2012. Nature Guide: Trees: The world in your hands(Nature Guides). Mukherjee D. Gardening in India, Oxford IBH publishing co, New Delhi.
4. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
5. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge UniversityPress,
6. Cambridge.
7. Bendre, M. Ashok and Ashok Kumar, A. 2020. Text Book of Practical Botany 1 (10th ed).Rastogi Publications, Meerut.
8. Singh, R and U.C. Singh 2020. Modern mushroom cultivation, 3d Edition Agrobios (India), Jodhpur.

Reference Books:

1. Adams, C.R. Banford, K.M. and Early, M.P. 1993. Principles of Horticulture.
2. Sathe,T.V. 2004. Vermiculture and Organic farming, Daya Publishers.
3. Peter, K.V. 2017. Basic Horticulture.

Web resources:

1. https://books.google.co.in/books/about/Plant_Propagation.html?id=K-gQh6OI7GcC&redir_esc=y
2. https://www.ebooks.com/en-us/subjects/gardening/
3. https://www.elsevier.com/books/food-preservation-techniques/zeuthen/978-1-85573-530-9

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	3	2
CO2	3	3	2	2	3	3	2	3	2	3
CO3	2	2	3	3	1	2	1	3	3	1
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	3	3	2

S-Strong (3) **M-Medium (2)** **L-Low (1)**

INTERNSHIP/INDUSTRIAL ACTIVITY

YEAR I	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3I	-	-	--	-	2

Pre-requisite	The summer internship programme will give students the chance to experience real-world organisational situations, learn about processes and rules, and grasp the operations of the industry.
Learning Objectives	The main goal of the internship programme is to give students exposure to industry and help them comprehend current management techniques by having them work for at least fifteen days in an industry/institution over the summer..
	To comprehend how theoretical ideas are applied in many sectors and industries.
	To create a foundation for industry-integrated education, as well as to give students better practical knowledge and hands-on experience, improve their leadership qualities, and sharpen their problem-solving and management skills.
	The internship must focus on practice. The college will require the students to visit the offices of the research lab/industry/institution it has a memorandum of understanding (MOU) with in order to receive on-the-job training in the many different areas of those businesses' operations.
	Internships provide students with practical experience in a variety of fields, including manufacturing, productivity, development, and quality analysis. These experiences prepare students for competitive hiring processes in reputable MNC industries.

UNIT	CONTENTS	No. of Hours
I	**Guidelines for Internship Programme:** To give students the opportunity to spend at least fifteen days on their own during the II Semester vocation in order to acquire exposure to research labs, industry, and respected institutions and comprehend contemporary research procedures. Individual instruction is provided for the internship. The internship programme must be completed in order to receive a credential. Students are required to indentify a research labs/industry/recognized institution for their Internship Programme Coordinator in consultation with and approval of their faculty guide. The choice of the research labs/industry/recognized institution should be intimated to the Internship coordinator before commencement of the Internship. Simultaneously, students should also have identified a guide within the research labs/industry/recognized institution (industry guide) under whose supervision and guidance they would carry out their Internship Program. Students are expected to learn about the history of the research labs, industry, and recognized institution during their time. They must also learn about its founders or shareholders, the nature of business, organizational structure, reporting relationships, and how the various management functions (such as finance, HR, marketing, sales, and operations) operate. This list is merely illustrative and not comprehensive. Students should collect and gather as much as possible of written materials, published data, and related matter. 1. Before leaving the research labs/industry/recognized institution, obtain the Internship Programme completion certificate on the letterhead of a research lab/industry/, or an accredited institution. 2. Maintain Internship Programme record with details on activities and personal learning during their project period. 3. The department head and the coordinator of the internship programme form a committee to ensure that the internship is followed.	

	4. At least two copies of the report must be prepared by the intern at the conclusion of the internship program—one for submission to the college and one copy for the student. If the organization, the guide, or both request additional copies, more copies may be made. The sources from which the information was gathered should be made crystal apparent in the report. Every page needs to have a number, which should be centred at the bottom of the page. All tables, figures, and appendices must be appropriately labeled and consecutively numbered or lettered. The report must be printed, bound (ideally with soft binding), and contain at least 25 pages. 5. The internship training report should be submitted to the department within a month from the date of commencement of third semester. 6. However, such submission shall not be accepted after the end of third semester Examinations.	
II	**Evaluation of the Internship:** i. The internship program will be assessed by the assigned Internship Programme Coordinator from the host institute. ii. Evaluation will be done by the Internship Programme Coordinator of the host institute and through seminar presentation/viva-voce. iii. The presentation should be specific, clear and well analyzed, and indicate the specific sources of information. iv. According to the statement of the draft the evaluation of the interns will be done as per the sincerity and research output of the students. In addition the evaluation will also be assessed according to the activity of the log book, format of presentation, quality of the report made by the interns, uniqueness, skill sets and evaluation report of the internship coordinator.	
III	**College Guide Manual – Summer Internship Program** 1. The Internship Programme Coordinator should give proper procedures to the intern before and after the Internship. 2. The Internship Programme Coordinator should interact with the research labs/industry/recognized institution at least once before completion of the internship. 3. The weekly report submitted by the student should be reviewed and reported to the Internship Programme coordinator.	
IV	**Internal:** 100 marks Internship Programme Completion certificate - 30 marks Internship report - 30 marks Presentation - 20 marks Viva-voce - 20 marks	
V	**CONTENTS OF THE REPORT** Title page Page for supervisory committee Table of Acknowledgement Internship Certificate **Executive Summary** Introduction of the Report Overview of the Organization What I have Learned Analyses Summary Recommendations and Conclusion References Appendices	

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	For students in those pertinent core areas, the internship is preparing them to become professionals after graduation.	K1
CO2	Compile data and familiarize yourself with techniques for planning and carrying out tests.	K2
CO3	Collect data and educate yourself on how to e the analy results of your scientific studies.	K3 & K5
CO4	This in-the-moment industrial exposure helps them become more knowledgeble and skilled in the latest technology.	K4
CO5	CO5 Improving communication skills and coming up with creative ideas are crucial components of training that help someone become an entrepreneur.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:
1.Dawson, C. 2002. Practical research methods. UBS Publishers, New Delhi. 2.Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. 1995. Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	1	3	3	3	3	3	2
CO 2	3	3	3	3	3	3	2	1	3	3
CO 3	3	3	3	3	3	3	2	1	3	3
CO 4	3	2	3	3	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	3	2	3

S-Strong (3) **M-Medium (2)** **L-Low(1)**

ECC III -FLORICULTURE

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM III	23KP3BECC3:1	-	-	--	--	3

Pre-requisite	To acquire knowledge On Floriculture
Learning Objectives	To state fundamentals and potentials of floriculture.
	To study the sexual and vegetative propagation methods for commercial flowering plants
	To describe propagation and cultivation of commercial flowering plants.
	To illustrate basic concepts of preservation of cut flowers and floral decorations.
	To understand the entrepreneurship in floriculture.

UNIT	CONTENTS
I	**FUNDAMENTALS OF FLORICULTURE:** Scope, importance and division of floriculture in India. Present status, Future prospects and strategies needed for improvement. Area, production and exports. Soil and climate limiting factors. Irrigation types – surface, sub and special irrigation – Manures, fertilizers and herbicides..
II	**CULTIVATION METHODS:** Sexual and vegetative propagation methods for commercial flowering plants. Cultivation of flowers – rose, marigold, chrysanthemum, jasmine, dahlia, orchid and crossandra. Training and pruning of flowering plants. Ornamental bulbous plants – Cacti, succulents, palms, cycads, ferns and *Selaginella*. Bonsai – Importance and methods of making bonsai.
III	**CUT FLOWER TECHNOLOGY:** Cut flowers – Production, packaging, drying and preservation - Cut flower production techniques for domestic and export market with special reference to rose, marigold, chrysanthemum, anthurium, gladiolus, jasmine, dahlia, tuberose, gerbera, orchid and crossandra
IV	**FLORAL DECORATIONS:** Flower arrangements - Practices and preparation of floral bouquets. Dry decorations – preservation of plant materials for dry decorations, design for dried arrangements – Preparation of floral rangoli and ikebana. Flower arrangements for horticulture shows.
V	**ENTREPRENEURSHIP IN FLORICULTURE:** Marketing of floriculture products – methods, publicity and marketing. Schemes and supporting agencies for entrepreneurship of floriculture. Investment procurement – project formation, feasibility, legal formalities, shop act, estimation and costing, investment procedure, loan procurement, banking processes and export strategies.

REFERENCES:

1. Randhawa, G. S and Mukhopadhyaya, A. 2004. Floriculture in India. Allied Publishers
2. Pvt. Ltd., New Delhi.
3. Brain M, Flowering Bulbs for the Garden (The Royal Botanical Gardens, KEW in association with COLLINGRIDE),8th Edition, The Himalayan Publishing Group Pvt Ltd, Kew, London, 2013.
4. Chadha KL and Choudhury B, Ornamental Horticulture in India, 6th Edition, ICAR, New Delhi, India, 2014.
5. Lauria A & Ries VH. 2001. Floriculture – Fundamentals and Practices. Agrobios.
6. Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios.
7. Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
8. http://www.apeda.gov.in/apedawebsite/SubHead_Products/Floriculture.htm
9. https://agriexchange.apeda.gov.in/indexp/Product_description_32head.aspx?gcode=0101
10. https://agriexchange.apeda.gov.in/FTP/ftp2015-20E.
11. www.Anilrana13014.webbly.com.
12. https://www.zauba.com/export-INDIAN+FRESH+FLOWERS-hs-code.html.

CORE COURSE XI-CELL AND MOLECULAR BIOLOGY

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM IV	23KP4B11	4	2	-	6	5

Pre-requisite	To acquire knowledge on cell and expose the students a fundamental of the various techniques used in molecular studies.
Learning Objectives	1. Enable to learn various cell structures and functions of prokaryotes and eukaryotes and understand the salient features and functions of cellular organelles.
	2. To understand the cell division and it molecular mechanism so as to appreciate and manipulate normal and abnormal cell and tissue growth.
	3. To enlighten people of past molecular biology developments.
	4. To comprehend the molecular processes.
	5. A thorough examination of DNA structure, replication process, transcription process and translation processes.

UNIT	CONTENTS
I	The dynamic cells, Concept of prokaryote and Eukaryote. Structural organization of plant cell, specialized plant cell types chemical foundation. Cell wall- Structure and functions, Plasma membrane; structure, models and functions, site for ATPase, ion carriers' channels and pumps, receptors. Plasmodesmata and its role in movement of molecule.
II	Chloroplast-structure and function, genome organization, gene expression, RNA editing, Mitochondria; structure, genome organization, biogenesis. Plant Vacuole - Tonoplast membrane, ATPases transporters as a storage organelle. Structure and function of other cell organelles- Golgi apparatus, lysosomes, endoplasmic reticulum and microbodies.
III	Nucleus: Structure and function, nuclear pore, Nucleosome organization, euchromatin and heterochromatin. Ribosome- Structure and functional significance. RNA and DNA Structure. A, B and Z Forms. Replication, transcription, translation in prokaryotes and eukaryotes. DNA damage and repair (Thymine dimer, photoreactivation, excision repair).
IV	DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair. DNA sequencing. Transcription, enzymes involved in transcription, post transcription changes, reverse transcription, Translation. Overlapping genes.
V	DNA/gene manipulating enzymes: endonuclease, ligase, polymerase, phosphatase, transcriptase, transferase, topoisomerase. Gene cloning: cloning vectors, molecular cloning and DNA libraries. Molecular genetics elements, insertion elements, transposons. Recombinant DNA. Direct and indirect gene transfer. Detection of recombinant molecule, production of gene products from cloned genes. Genome library, cDNA library.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Recall a plant cell structure and explain its function.	K1
CO2	Illustrate and explain the structure of various cell organelles.	K2
CO3	Explain the structure and functional significance of nucleic acid.	K3
CO4	Compare and contrast the DNA replication (prokaryotes and eukaryotes), enzymes involved in replication, DNA repair	K4
CO5	Discuss and develop skills for DNA/gene manipulating and the Enzymes involved.	K5 &K6

Extended ProfessionalComponent (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Roy, S.C and Kumar, K.D.C. 1977. Cell Biology, New Central Book Agency, Calcutta.
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments.6th edition. John Wiley & Sons.
3. Aminul, I. 2011. Text Book of Cell Biology. Books and Allied (P) Ltd, Kolkata, India.
4. Geoffrey M. Cooper. 2019. The Cell: A Molecular Approach, Oxford University Press.
5. Turner, P.C., Mclenann, A.G., Bates, A.D. and White, M.R.H. 2001. Instant notes on molecular biology.

Reference Books:

1. Alberts B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989. Molecular biology of the Cell (2nd edition). Garland Pub. Inc., New York.
2. Karp, G. 1999. Cells and Molecular Biology: Concepts & Experiments. John Wiley and Sons, Inc., USA.
3. Lodish S, Baltimore B , Berk, C and Lawrence K, 1995 , Molecular Cell Biology , 3rd edn, Scientific American Books, N.Y
4. De Robertis and De Robertis, 1988, Cell and Molecular Biology, 8th edn, Info-Med, Hongkong.

Web resources:

1. https://www.pdfdrive.com/cell-biology-books.html
2. http://www.bio-nica.info/Biblioteca/Bolsover2004CellBiology.pdf
3. https://www.e-booksdirectory.com/listing.php?category=549
4. https://www.elsevier.com/books/molecular-biology/clark/978-0-12-813288-3
5. https://www.kobo.com/in/en/ebooks/molecular-biology

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	2	1
CO2	3	3	2	2	3	3	2	3	3	3
CO3	2	2	3	3	1	3	2	3	1	2
CO4	3	3	3	3	3	2	3	3	3	2
CO5	3	3	2	3	2	3	3	3	2	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

CORE COURSE XII - BIOCHEMISTRY & APPLIED BIOTECHNOLOGY

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM IV	23KP4B12	4	2	-	6	5

Pre-requisite	Basic knowledge on primary and secondary plant metabolites and enzymes. To empower students recognize and appreciate the basic principles that sustain biotechnology as an interdisciplinary domain of learning and research.
Learning Objectives	1. To study the fundamentals and significance of Plant Biochemistry.
	2. To know the structure and properties of plant biomolecules.
	3. To learn the fundamental and applications of Plant Biotechnology.
	4. To study the mechanism of enzyme action and inhibition.
	5. To expose the students on the fundaments of genetic transformation.

UNIT	CONTENTS
I	Atomic structure: chemical bonds - ionic bond, covalent bond, coordinate covalent bond, hydrogen bond, hydrogen ion concentration (pH), buffers. Thermodynamics principle, First Law of Thermodynamics a) energy (b) Enthalpy (ii) second law of thermodynamics (a) Spontaneity and disorder (b) entropy (c) free energy, redox potential, dissociation and association constant, activation energy, binding energy.
II	Classification of carbohydrates; Structure and properties of monosaccharides, Oligosaccharides, Polysaccharides – Glycoproteins. Protein and Amino acids: Structure, Classification and properties; Peptides - Structure: Primary, secondary, Ramachandran plot, tertiary and quaternary structures. Classification of Lipids: Structure and properties of fatty acids, phospholipids, glycolipids, lipoproteins, cholesterol - structure and functions.
III	Enzymes- Classification and nomenclature chemical nature of enzymes – factors affecting enzyme action – Michaelis – Menton constant, MM equation, Lineweaver Burk plot, Enzyme inhibition, co enzymes- mechanism of enzyme action, isoenzymes. Properties and role of Secondary Metabolites- alkaloids, steroids, terpenoids, Flavonoids.
IV	Transgenic plants - pest resistance, herbicidal resistance, Disease resistant, abiotic and biotic stress tolerant, in improving crop yield, food quality- Golden rice, Edible vaccines, Virus and Bacteria based transient gene expression systems. Virus induced gene complementation. Seed technology, antisense technology for Delayed fruit ripening, Plants as factories for useful products and pharmaceuticals.
V	Screening of Biotransformants - Fermentation techniques- Types. Industrial Production of enzymes-amylase, protease & lipase and their applications. Immobilization for enzymes production. Antibiotic Penicillin production. Amino acid - Glutamic acid production. Production of Alcohol. Super bug and its role in biodegradation. Bioremediation - *In situ* and *Ex situ*.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Knowledge on the fundamentals and significance of Plant Biochemistry	K1
CO2	Understanding on the structure and properties of plant biomolecules.	K2
CO3	Explain the role of enzymes in plants.	K3
CO4	CO4 Compare and contrast the methods of transgenic plants production and natural plants.	K4
CO5	CO5 Discuss and develop skills for effective utilization of microbial/plan enzymes and their role in biological cells.	K5 &

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill

Recommended Text:

1. Satyanarayana, U and chakrapani, U. 2005. Biochemistry, Books and Allied (P) Ltd. Calcutta.
2. Stryer, L. 1994. Biochemistry. Freeman & Co, New York.
3. Zubay, G. 1988. Biochemistry. 1988 Macmillan Publishing Co, New York.
4. Harold, F.M. 1986. The vital force: A study of Bioenergetics. Freeman & Co, New York.

Reference Books

1. Bonner, J. and Warner, W.H. 1961. Plant Biochemistry. Academic Press. Inv. New York.
2. Gupta, S.N. 2016. Biochemistry Rastogi Publications, Meerut.
3. Nelson, D.L. and Cox, M.M. 2017. Lehninger's Principles of Biochemistry, Prentice Hall, International N.J, 7th Edition.
4. Heldt, H-W. 2005. Plant Biochemistry, 3rd Edition. Elsevier Academic Press.

Web sources:

1. http://priede.bf.lu.lv/grozs/AuguFiziologijas/Augu_biokimija/Plant%20Biochemistry 204.pdf
2. http://www.brainkart.com/subject/Plant-Biochemistry_257/
3. https://swayam.gov.in/nd2_cec20_bt12/preview
4. https://www.biorxiv.org/content/10.1101/660639v2
5. https://www.scribd.com/document/378882955/

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	3	1
CO2	3	3	2	2	3	3	2	3	2	3
CO3	3	2	3	3	1	2	1	3	3	1
CO4	3	3	3	3	3	2	3	1	3	3
CO5	3	3	2	3	2	3	3	1	3	2

S-Strong (3) M-Medium (2) L -Low (1)

PROJECT

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM IV	23KP4BPW	5	-	5	10	7

Pre-requisite	To allow students to demonstrate the personal abilities and skills required to produce and present an extended piece of work and as well as to practice writing thesis.
Learning Objectives	1. To recognize the concept of research and its various forms in the context of botany.
	2. To improve abilities relating to scientific experiments.
	3. To become proficient in data collection and the documentation of scientific findings.
	4. To prepare students for entry-level positions or professional training programmes in any field of Botany.
	5. Compare the various reporting and writing styles used in science.

UNIT	CONTENTS
I	1. Each student will be allotted a Project Guide from the faculty of the department concerned by lot method. 2. The topic of the dissertation shall be assigned to the candidate before the beginning of third semester. 3. After the completion of the project work, the student has to submit four copies of dissertation with report carrying his/her project report for evaluation by examiners. After evaluation, one copy is to be retained in the College Library. 1. Project work will be evaluated by both the external and the internal (Project Guide) examiners for the maximum of 100 marks in total on the scale of the maximum of 50 marks for the internal and the external each. Viva-voce will be conducted by the panel comprising, External examiner and Internal Examiner for the maximum of 100 marks in total on the scale of the maximum of 50 marks for the internal and the external each.
II	All the candidates of M.Sc (Botany) are required to undergo a major project and submit the following: 1. Dissertation/Thesis based on the work done by the student. 2. Soft copy of the project on CD/DVD. **PROJECT EVALUATION GUIDELINES:** **The project is evaluated on the basis of following heads:** For Viva-Voce maximum is 60 marks which will be conducted by both the internal and external examiners during end semester university practical examinations. **Internal:** 40 marks I Review – Selection of the field of study, topic and literature collection - 15 marks II Review – Research design and data collection - 10 marks III Review – Analysis and conclusion, preparation of rough draft - 15 marks **External:** 60 marks Thesis/ Dissertation - 30 marks Presentation - 15 marks Viva-voce - 15 marks
III	**Suggested areas of work:** Algae, fungi, microbiology, biocontrol agents, plant tissue culture, plant physiology, phytochemistry, biochemistry, anatomy, plant taxonomy, Ethnobotany, ecology, sustainable agriculture, herbal formulations, cytogenetics, molecular biology, biotechnology, bioinformatics, nanotechnology and applied botany.

IV	**Methodology:** **Each project should contain the following details:** 1. Brief introduction on the topic 2. Review of Literature 3. Materials and Methods 4. Results and Discussion – evidences in the form of figures, tables and photographs. 5. Summary 6. Bibliography

Course Outcomes	**On completion of this course the student will be able to**	**Programme Outcomes:**
CO1	For students in those pertinent core areas, the project is preparing them to become professionals after graduation.	K1
CO2	Compile data and familiarize yourself with techniques for planning and carrying out tests.	K2
CO3	Collect data and educate yourself on how to evaluate the analyzed results of your scientific studies.	K3 & K5
CO4	In-the-moment industrial exposure helps them become more knowledgeble and skilled in the latest technology	. K4
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill	

Recommended Texts:

1. Wilson, K and J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry (4th Edition) Cambridge University Press, Cambridge.
2. Bendre, A.M and Ashok Kumar. 2009. A text book of practical Botany. Vol. I & II. Rastogi Publication. Meerut. 9th Edition.
3. Manju Bala, Sunita Gupta, Gupta, N.K. 2012. Practicals in Plant Physiology and Biochemistry. Scientific Publisher.

Reference Books:

1. Dawson, C. 2002. Practical research methods. UBS Publishers, New Delhi.
2. Ruzin, S.E. 1999. Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
3. Wilson and Goulding. 1987. Principles of biochemical techniques, Oxford University Press.
4. Taiz, L and Zeiger, E. 2010. Plant Physiology. 5th Edition. Sinauer Associates, USA.

Web resources:

1. https://handbook.monash.edu › units › BIO3011
2. https://www.amazon.in/Practical-Manual-on-Plant-Biochemistry/dp/6200539790
3. https://kau.in/document/laboratory-manual-biochemistry

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	1	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	2	1	3	2
CO 3	3	3	3	3	3	3	2	1	3	2
CO 4	3	2	3	3	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	3	3	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE VI- GENE CLONING AND GENE THERAPY

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM IV	23KP4BECB6:1	2	2	-	4	3

Pre-requisite	To know about the gene cloning and gene therapy.
Learning Objectives	1. To give a clear knowledge of genetic engineering, cloning vectors, enzymes involved in cloning.
	2. To understand the procedure involved in recombinant DNA technology and restriction mapping.
	3. To focus on the application of gene cloning in plants and animals.
	4. To enable the students to information on Gene Therapy.
	5. To raise student to create transgenic plants for hybrid seed production and molecular farming.

UNIT	CONTENTS
I	Definition of genetic engineering, gene cloning and recombinant DNA cloning vectors: plasmids, bacteriophages, plant and animal vectors.
II	Gene cloning in prokaryotes and eukaryotes, Isolation of DNA to be cloned, insertion of DNA fragment into vector. Use of Restriction Linkers: use of Homopolyer tails, Transfer of recombinant DNA into Bacteria cell. Selection of clones.
III	Gene Therapy: Definition, Germ cell and Somatic cell. Amniocentesis in human; patient therapy, embryo therapy.
IV	Restriction mapping –. Random amplified polymorphic DNA using PCR. DNA finger printing; Gene Tagging. Physical methods of gene delivery. Gene transfer techniques.. Genetic counselling – Eugenics, Euthenics.
V	Transgenic plants with herbicide resistance, insect resistance, virus resistance andresistance against bacterial and fungal pathogens. Transgenic plants for hybrid seed producion and molecular farming.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Recollect the basic concepts of gene cloning.	K1
CO2	Demonstrate and to identify the selection of clones.	K2
CO3	Acquire knowledge on the gene therapy.	K3
CO4	Compare and understand the concept of gene therapy.	K4
CO5	Discuss and develop skills for hybrid seed production and molecular farming.	K5 & K6

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:
1. Das, H.K. 2010. Textbook of Biotechnology (4th edition). Wiley India Pvt. Ltd. New Delhi 2. Verma, P.S and Agarwal V.K. 2009. Genetic Engineering. S.Chand & Co. Ltd. New Delhi 3. Ramavat, K.G. 2006. Plant Biotechnology. S. Chand and Co. Ltd., New Delhi. 4. Chawla, H.S. 2009. Introduction to Biotechnology. 2nd edn. Oxford IBH, ISBN: 978-81-204- 1732-8. 5. Thieman. 2014. Introduction to Biotechnology 3rd Edition. Pearson Education India..
Reference books:
1. Smith. J.K. 1996. Biotechnology – 3rd Ed. Cambridge Univ. Press, Cambridge. 2. Reynolds, P.H.S. 1999. Inducible Gene Expression in Plants. CABI Publishing, U.K. 3. Chawla, H.S. 2009. Introduction to Biotechnology, 2nd edn. Oxford IBH, ISBN:978-81-204-1732-8. 4. Glick B.R and J. J. Pasternak. 2009. Molecular Biotechnology, Panima Publication Co. 5. Ignacimuthu, S.1998. Applied Plant Biotechnology. Tata Mc Graw Hill, publishing company Ltd., New Delhi.
Web resources:
1. https://www.amazon.in/Gene-Cloning-Manipulation-Christopher-Howe-ebook/dp/B000SK4YLI 2. https://www.amazon.in/Gene-Cloning-Steve-Minchin-ebook/dp/B000SHTUT2 3. https://www.futuremedicine.com/doi/book/10.2217/9781780842134 4. https://link.springer.com/book/10.1007/978-88-470-1643-9

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	1	2
CO2	3	3	2	2	3	3	2	3	3	2
CO3	3	2	3	3	1	2	1	3	2	1
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	2	3	2	3	3	3	3	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

ELECTIVE COURSE VI-ORGANIC FARMING

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM IV	23KP4BECB6:2	2	2	-	4	3

Pre-requisite	To understand the students about the organic farming.
Learning Objectives	1To study various aspects of organic farming.
	2.To understand the relevance of organic farming, its advantages and short comings against conventional high input agriculture.
	3.To know the importance of organic farming in the present scenario and its impact on environment and soil health.
	4.Awareness on the importance of organic farming in the present scenario and its impact on environment and soil health.
	5.Expose the students to about quality aspect and grading.

UNIT	CONTENTS
I	**AGRONOMY:** Organic farming- concept, characteristics, significance, organic ecosystem, scope of organic farming in India - Principles and types of organic farming. Choice of crops & varieties in organic farming - Initiative by Govt/NGOs/Other organizations for promotion of organic farming.
II	**SOIL SCIENCE:** Organic farming for sustainable agriculture; Manures- compost, methods of composting - Green manuring, vermicompost and biofertilizer Harmful effect of non-judicious chemical fertilization - Organic farming practices for improving soil health
III	**FUNDAMENTAL OF ORGANIC FARM MANAGEMENT:** Land management in organic farming - Water management in organic farming. Organic insect disease management - Organic pest disease management. Preventive and cultural methods for insects and pest control - Identification of different fungal and bacterial biocontrol agents.
IV	**POST HARVEST MANAGEMENT:** Processing, labeling of organic produce - Storage and transport of organic produce.
V	**ORGANIC QUALITY CONTROL STANDARDS:** Certification- types, process & procedure and agencies. Quality aspect and grading - Packaging and handling. Economic considerations and viability of organic products - Export of organic product and marketing

Course outcomes: CO	On completion of this course, the students will be able to:	Programme outcomes
CO1	Knowledge on various aspects of organic farming.	K1
CO2	Understand the relevance of organic farming, its advantages.	K2
CO3	Explain the short comings against conventional high input agriculture.	K3
CO4	Compare the packaging methods of harvest.	K4
CO5	Discuss and develop skills for post harvest management.	K5 & K6
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	

Recommended Text:

NIIR Board. 2012. The complete Technology Book on Biofertilizer and organic farming. 2nd Edition. NIIR Project Consultancy Services.

Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya publishers.

Subba Rao N.S. 2017. Biofertilizers in Agriculture and Forestry. Fourth Edition. Medtech.

Vayas,S.C, Vayas, S. and Modi, H.A. 1998. Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.

Singh, S M. 2018. Organic Manure: Sources Preparation and Usage in Farming Lands,Siya Publishing House

Reference books:

Reddy, S.R. 2019. Fundamentals of Agronomy Kalyani Publications, Uttar Pradesh

Tolanur, S. 2018. Fundamentals of Soil Science IIndEdition , CBS Publishers , New Delhi

Reddy, S.R. 2017. Principles of Organic Farming Kalyani Publishers , New Delhi

Dongarjal, R.P and Zade, S.B. 2019. Insect Ecology and Integrated Pest Management Akinik Publications, New Delhi.

Ahmad Mehraban. 2013. The Basis of Organic Fertilizers, LAP LAMBERT Academic Publishing.

Web resources:

https://www.amazon.in/Healthy-earth-organic-Hari-prasad-ebook/dp/B08L5KFKDV
https://www.kobo.com/in/en/ebook/organic-farming-for-sustainable-agriculture
https://www.elsevier.com/books/organic-farming/chandran/978-0-12-813272-2
https://link.springer.com/book/10.1007/978-3-030-04657-6
https://www.afrimash.com/product-category/livestock-section/book/organic-farming-ebooks/

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	1	2
CO2	3	3	2	2	3	3	2	3	3	2
CO3	2	2	3	1	1	2	1	3	2	1
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	2	3	2	3	3	2	3	1

S-Strong (3) M-Medium (2) L-Low(1)

SKILL ENHANCEMENT COURSE III - BOTANY FOR ADVANCED RESEARCH

YEAR II	Course Code	Instructional Hours per week				Credit
		Lecture	Tutorial	Lab practice	Total	
SEM IV	23KP4BSEC3	2	2	-	4	2

Pre-requisite	Students should to improve their career prospects, or pursuing a passion.
Learning Objectives	1. To be familiar with the basic concepts and principles of plant systematics.
	2. Learn the importance of plant anatomy in plant production systems.
	3. To expose the students a fundamental of the various techniques used in molecular studies.
	4. To learn about the physiological processes that underlie plant metabolism.
	5. To know the energy production and its utilization in plants.

UNIT	CONTENTS
I	**MOLECULAR GENETICS** Molecular Biology of gene expression: Brief overview of the Central Dogma and Teminism. Transcription in prokaryotes and eukaryotes. Types and structure of RNA polymerase, Different types of RNA, Regulatory sequences and transcription factors involved. Mechanism: Initiation, elongation and termination. Split genes and RNA splicing in eukaryotes. Translation in prokaryotes and eukaryotes. Salient features, exceptions, tRNA-suppressor mutations. Mechanism of translation: Chain initiation, elongation and termination, proteins involved, factors affecting translation accuracy.
II	**ADVANCED TRENDS IN SYSTEMATICS** **Basic concepts of:** a. Morphology - History, general morphology, types of data, methods of gathering data, b. Anatomy - History, general anatomy, types of data, methods of gathering data, c. Embryology – History, types of data, methods of gathering data; d. Palynology: History, general palynological characters, types of data, methods of gathering data; e. Cytology and Cytogenetics: History, general cytological and cytogenetic characters, types of data, methods of gathering data;
III	f. Ecology, History, general ecology, types of data, methods of gathering data g. Chemotaxonomy: a. History, general chemical and chemotaxonomic characters, types of data, methods of gathering data. h. Numerical taxonomy i. Molecular taxonomy
IV	**PLANT PHYSIOLOGY** (i) Photomorphogenesis Phytochrome genes and their expression, control of photo-morphogenic responses. Dose-response relations in Photomorphogenesis, light induced chloroplast differentiation, effect of photoreceptors. (ii)Biological clock: Circadian rhythms, rhythm responses to environment, clock mechanism (iii) Photoperiodism General principles (iv) Vernalization General principles (vi) Seed dormancy (vii) Stress physiology
V	**ECONOMC BOTANY** Economic importance of Cereals, Tuber Crops, Fibre yielding plants, Plantation Crops, Sugar yielding plants, Narcotics, Vegetables, Oil yielding plants, Pulses and Beverages.

Course Outcomes	On completion of this course the student will be able to	Programme Outcomes:
CO1	Understand of the basic principles of systematics, including identification, nomenclature, classification, and the inference of evolutionary patterns from data	K1, K2 & K5
CO2	Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and dicot plant growth.	K1,K3 & K5
CO3	Understand the organization of nuclear genome	K3 & K5
CO4	Understand the various steps involved in the basic functioning plant growth and the nutritive value of food.	K2, K3 & K5
CO5	Gain awareness about the various process involved in the energy production in plants and metabolic pathways.	K1, K5

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text:

1. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies.
2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi.
3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.
4. Jain, V.K. 2017. Plant Physiology, S.Chand & Company Ltd. New Delhi.

Reference books:

1. Pandey.B.P. 1999. Economic Botany. S. Chand Limited, New Delhi.
2. Steward, F.C. 2012. Plant Physiology Academic Press, US.
3. Lodish Harvey. 1999. Molecular Cell Biology. W.H. Freeman &Co. New York.
4. Snustad, D. P. & Simmons M.J. 2003.Principles of Genetics. John Hailey & Sons Inc.U.S.A.

Web resources:

1. http:// www.ornl.gov.
2. http:// ash. gene. ncl. ac .nk..
3. http://tor. cshl. org. http:www. gdb. org.
4. http: //www. neg r. org.

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	2	2
CO 2	3	3	2	2	3	3	2	3	2	3
CO 3	2	2	3	3	1	2	1	3	1	3
CO 4	3	3	3	3	2	2	3	2	3	1
CO 5	3	3	2	3	2	1	3	3	2	3

S-Strong (3) M-Medium (2) L-Low (1)