M.Sc. Botany
(Regular)
Programme

Syllabus and Regulations

Learning Outcome based Curriculum Framework
(LOCF) under Choice Based Credit System (CBCS)
(2022 - 2023 Batch onwards)

Approved in the SCAA held on 07.12.2022

DEPARTMENT OF BOTANY
SCHOOL OF LIFE SCIENCES
BHARATHIDASAN UNIVERSITY
TIRUCHIRAPPALLI 620024

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Dr. A. Muthusamy, Manipal University	Professor & Head, Alumni Member

For Eligibility, Course Fee etc., visit the University Website.

Program Outcome (P.O)

1. The M. Sc Botany Program provides the students to acquire the fundamental and applied knowledge in the field of Plant Science including knowledge on various kinds of life forms in plant kingdom, Anatomical, Embryological, Physiological, Cellular and Molecular approach of plants, Plant Tissue Culture, Genetic Engineering, Molecular Biology, and Conservation Biology.
2. The teaching learning pedagogies in the curriculum, mandatory seminar presentations and group discussion help the students to develop their communication skills. Students can communicate effectively with the Plant Science community and with society, write, and present the reports.
3. The program enables critical thinking, Problem solving and decision making skills. Students can demonstrate higher level of professional skills to tackle complex problems related to Botanical Science.
4. The curriculum is designed towards research oriented that advances the knowledge in their chosen field of study under the discipline. The program enables the students to identify, design, and execute innovative research projects which are the need of the hour, thus expanding their scientific knowledge and social responsibilities. They can pursue research/investigations in the field of biology.
5. The laboratory courses for the Core papers facilitate the team work among the students and enhance student's skills in basic techniques, critical analysis and problem solving approach.
6. The Program develops the students to sense the social responsibility and engage in continuous learning for professional growth and development to become an Entrepreneur.
7. The Program promotes the proficiency of learning through ICT based digital platforms and web based search of their domain. The Self-study Courses enable the student to work independently, identify the resources required for the course and aids in strengthening their carrier.
8. The Program enables the students with Leadership qualities, well-built character and competence to face the challenges both in local and global level.
9. The Program enhances the commitment of students towards ethics in their research understand the importance of Intellectual Property Rights, and develops students towards welfare of human life and environmental sustainability.

Program Specific Outcome (P.S.O)

1. Students can able to classify various life forms of plants, demonstrate the unique features for identification of plants, and differentiate the anatomical characters, genetics, and evolution.
2. The program enthuse the students to disseminate the concept of Biodiversity conservation and Sustainable utilization.
3. Students can able to understand the principle of Instruments used in biological sciences, their calibration.
4. Field/Industrial/Institutional visits help the students to interact among them and with Scientist, develop ideas, and identify the gaps in their domain and creative knowledge.
5. The program leads to consistent in learning by earning extra credits in the specialized courses offered through Swayam/MOOC to strengthen their carrier.
6. The Program leads to acquire advanced knowledge in the field of Plant Science to be placed in Government Sector/ Public Sector/ Biomedical Research Organizations/ or to become an Entrepreneur.
7. Students can able to have creative thinking, problem solving and decision making skills.
8. Students can develop skills to pursue research and solve problems
9. Students can develop skills in manuscript writing,

BHARATHIDASAN UNIVERSITY, Tiruchirappalli 620 024

M.Sc. BOTANY

COURSE STRUCTURE UNDER CHOICE BASED CREDIT SYSTEM – LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS – LOCF)

(For the candidates admitted from the year 2022 - 2023 onwards)

Sem	Course	Course Title	Ins. h/ Weeks	Credits	Exam hrs.	Marks		Total
						Int.	Ext.	
FIRST SEMESTER								
I SEMESTER	22PGBOTCC101	Plant Diversity – I: Algae, Fungi, Lichens & Bryophytes	5	5	3	25	75	100
	22PGBOTCC102#	Anatomy, Embryology and Morphogenesis	5	5	3	25	75	100
	22PGBOTCC103#	Developmental Botany						
	22PGBOTCC104	Cell Biology and Bioinstrumentation	5	5	3	25	75	100
	22PGBOTCC105	Genetics, Plant Breeding and Evolution	5	5	3	25	75	100
	22PGBOTCC106	Practical - I (22PGBOTCC101 & 22PGBOTCC102 / 03)	4	4	4	25	75	100
	22PGBOTCC107	Practical - II (22PGBOTCC104 & 22PGBOTCC105)	4	4	4	25	75	100
		Library/Student club	2	--	--	--	--	--
Total			**30**	**28**	**--**	**--**	**--**	**600**
SECOND SEMESTER								
II SEME	22PGBOTCC201	Plant Diversity – II: Pteridophytes, Gymnosperms and Paleobotany	5	5	3	25	75	100
	22PGBOTCC202#	Taxonomy of Angiosperms	5	5	3	25	75	100
	22PGBOTCC203#	Plant Systematics						

S T E R	22PGBOTCC204	Plant Biotechnology	5	5	3	25	75	100
	22PGBOTCC205	Practical –III (22PGBOTCC201 22PGBOTCC202/03 & 04)	4	4	4	25	75	100
	22PGBOTEC201#	Basic Microbial and Immuno Technology	5	4	3	25	75	100
	22PGBOTEC202#	Phytochemistry						
		Extra Disciplinary Course I	3	2	3	25	75	100
		Summer Mini Project/Internship	-	2		25	75	100
		Library/Student Club	3	-	--	--	--	--
Total			**30**	**27**	**--**	**--**	**--**	**700**

THIRD SEMESTER								
III S E M E S T E R	22PGBOTCC301	Plant Physiology and Biochemistry	5	5	3	25	75	100
	22PGBOTCC302	Molecular Plant Pathology	5	5	3	25	75	100
	22PGBOTCC303	Ecology and Phytogeography	5	5	3	25	75	100
	22PGBOTCC304#	General Ecology						
	22PGBOTCC305	Practical IV (22PGBOTCC301, 302 & 22PGBOTCC303/304)	4	4	4	25	75	100
	22PGBOTEC301#	Economic Botany	5	4	3	25	75	100
	22PGBOTEC302#	Mushroom Technology						
		Extra Disciplinary Course II	3	2	3	25	75	100
		Library/Student Club	3	--	--	--	--	--
		Total	**30**	**25**	**--**	**--**	**--**	**600**
FOURTH SEMESTER								
	17PGBOTPW01	Project Work	30	10	--	25	75	**100**
		Total	--	**90**	--	--	--	**2000**

#Optional- any one per semester *** Viva-voce will be conducted in the first week of July**

Extra Disciplinary Courses offered in Department of Botany

Course	Course Title	h/ Weeks Ins.	Credits	Exam hrs.	Marks		Total
					Int.	Ext.	
SECOND SEMESTER							
22PGBOTED201	Biofertilizers	3	2	3	25	75	100
22PGBOTED202	Food Processing and Preservation	3	2	3	25	75	100
THIRD SEMESTER							
22PGBOTED301	Seaweed farming	3	2	3	25	75	100
22PGBOTED302	Herbal cosmetics	3	2	3	25	75	100

Other Courses offered in Department of Botany

Course	Course Title	h/ Ins. Weeks	Credits	Exam hrs.	Marks		Total
					Int.	Ext.	
FIRST SEMESTER							
22PGBOTVAC101	Algal Technology		2				
22PGBOTVAC102	Mushroom Cultivation		2				
22PGBOTSSC101	Economic Potential of Lower Plants		2				
SECOND SEMESTER							
22PGBOTVAC201	Organic farming		2				
22PGBOTVAC202	Nursery gardening		2				
22PGBOTSSC201	History of Science		2				
THIRD SEMESTER							
22PGBOTVAC301	Terrace gardening		2				
22PGBOTVAC302	Principles of Horticulture		2				
22PGBOTSSC301	Bio Resource Management		2				
FOURTH SEMESTER							
22PGBOTSSC401	IPR & Patenting		2				

VAC- Value Added Course; SSC- Self-Study Course

M. Sc Botany Program Structure

Two Year Program with Four Semesters

Semester	Course Work	Hours/Week*	Basic Credits	Extra Credit
I	6 Core courses (4T + 2P)	30	28	--
	1 VAC/MOOC	--	--	2
	1 SSC	--	--	2
II	4 Core Courses (3T+1P)	30	27	--
	1 Elective			
	1 ED			
	1 Mini Project/Internship	--		
	1 VAC	--	--	2
	1SSC	--	--	2
III	4 Core Courses (3T+1P)	30	25	--
	1 Elective			
	1 ED			
	1 VAC	--	--	2
	1SSC	--	--	2
IV	Project work	30	10	--
	1 SSC	--	--	2
		Total	90	14

* Includes Library/ Student Club activities

T – Theory, **P**- Practical, **VAC**- Value added course, **SSC**- Self study course, **ED**- Extra disciplinary, **MOOC** –Massive Open Online Courses

Distribution of Credits

Course	Semester				Total Credits
	I	II	III	IV	
Core	28	19	19	--	**66**
Elective	--	04	04	--	**08**
ED	--	02	02	--	**04**
Mini Project/Internship	--	02	--	--	**02**
End Semester Project	--	--	--	10	**10**
Total	**28**	**27**	**25**	**10**	**90**

SEMESTER - I

CORE THEORY I : PLANT DIVERSITY-I: ALGAE, FUNGI, LICHENS AND BRYOPHYTES

Code	22PGBOTCC101	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs.		-	5		
Pre-requisite	The students should have a prior knowledge of general characters, major classes and ecology of algae, fungi, lichens and bryophytes.								

Course Objectives:

•	To know about the ultrastructure of Prokaryotic and Eukaryotic cell.
•	To learn the general characters, major classes and ecology of algae.
•	To elucidate the salient features and major classes of fungi.
•	To explain about the Lichens general features and classification.
•	To study the bryophytes classification and Comparative study of gametophytes and sporophytes.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Understand the details of soil, marine, and symbiotic algae.	**K1 & K2**
CO2	Recognize the general characteristics, distribution, and mode of fungal nutrition.	**K2 & K4**
CO3	The students will be able to comprehend the significance of lichens as pollution indicators.	**K3 & K6**
CO4	Learn about the general characteristics and classification of bryophytes.	**K4 & K5**
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **PHYCOLOGY** **Lectures**	Introduction and brief history. Ultrastructure of Prokaryotic and Eukaryotic cell and their difference. *Algal classification (Smith, 1955). General characteristics, thallus organization, occurrence, reproduction and economic importance of algae. Alternation of generations and lifecycle patterns in algae. 9 HRS

Unit II **GENERAL CHARACTERS OF MAJOR CLASSES** **Lectures**	Cyanophycophyta – Chlorophycophyta – Charophyta – Bacillariophycophyta – Xanthophycophyta – Phaeophycophyta and Rhodophycophyta. Prochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Phaeophyta and Rhodophyta #Ecology of Algae: Fresh water algae, marine algae, soil algae, symbiotic algae and parasitic algae. Algae as pollution indicators, algal blooms and algicides. 8 hrs.
Unit III **MYCOLOGY** **Lectures**	*General features, occurrence and distribution, Mode of nutrition and reproduction in fungi (vegetative, asexual and sexual). Classification of fungi (Alexopoulos and Mims, 1979) General characters of *major divisions -Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina. Ecology of fungi-spore dispersal mechanism. 9 hrs.
Unit IV **FUNGI AND LICHEN** **Lectures**	Phylogeny and interrelationship of major classes of fungi. Homothallism and Heterothallism Sex hormones in fungi. Fossil Fungi. Role of fungi in agriculture: Micro-remediation, Nutrient cycling, Bio-control and Biodegradation. Role of Fungi in Food Industries. Lichens - *General features, classification (Miller, 1984). Association of phycobionts and mycobionts. Structure and reproduction in Usnea. Lichens as indicators of pollution. Economic importance of lichens. Identification of lichens: Basics of MATLAB software, and Image processing techniques. 7 hrs.
Unit V **BRYOPHYTES** **Lectures**	*Classification (Retailer, 1951), general and reproductive characters of major classes. #Comparative study of gametophytes and sporophytes of major classes: Hepaticopsida: Marchantia, Porella, Anthocerotopsida: Anthoceros, Notothyllus, Bryopsida: Sphagnum, Polytrichum. Reproduction - Vegetative and sexual, spore dispersal and germination patterns in bryophytes. Ecological and economic importance of bryophytes. *Fossil bryophytes. 7 hrs.
Current Contour	Current developments related to the plant diversity-I: algae, fungi, lichens and bryophytes during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, social media, Webinars and so on.
Total Lectures –	40 hrs.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	1	2	1	2	3
CO2	3	2	2	2	1	3	2	3	3
CO3	3	1	3	3	2	3	2	3	2
CO4	3	3	1	3	3	3	3	2	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9
CO1	3	3	2	3	2	2	3	2	3
CO2	2	3	2	3	2	2	3	2	3
CO3	3	2	3	3	3	2	3	3	3
CO4	2	2	3	3	3	2	3	3	3
	1 – Basic level, 2 – Intermediate level; 3 - Advance level								

Recommended References:

1. Arun K. Zingare. (2019). The Biology of Algae and Fungi. Satyam Publishers and Distributors, Jaipur, India
2. Alexopoulos, C. J. and Mims, C. W. (1979). Introductory Mycology. Wiley Eastern Ltd., New York.
3. Hale, M. E. Jr. (1983). Biology of Lichens. Edward Arnold, Maryland.
4. Cavers, F. (1911). The Inter relationship of Bryophytes. Cambridge University Press, London.

Related Online Contents:

1. https://www.schandpublishing.com/books/higher-education/commerce-management/public finance/9789352710805/#.Wwz_pUiFPIU.
2. https://www.abebooks.com/book-search/title/introduction-to-the-algae-structure-and reproduction/

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SEMESTER - I

CORE THEORY II : ANATOMY, EMBRYOLOGY AND MORPHOGENESIS

Course Code	22PGBOTCC102	CourseType	Core	L	T	P	C	Syllabus version	2022-2023
				3	3	-	5		
Pre-requisite	To acquire knowledge on the anatomical structure and reproductive phase of angiosperms.								

Course Objectives:

- To classify various tissue such as meristems and cambium and study about various epidermal structure
- To understand various mechanical tissues and illustrate anatomical dissection of various plant parts
- To study the reproductive organs in plant and its development
- Study the post fertilization changes in plant reproduction
- To learn about molecular basis morphogenesis

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Learn about various tissues, meristem, cambium, and epidermal structure with suitable examples.	**K2 & K1**
CO2	Know about Anatomical characteristics of plant organs with both reference to monocotyledonous Dicotyledonous	**K3 & K2**
CO3	Differentiate the structural and developmental changes in male and female reproductive organs in plants.	**K2 &K5**
CO4	Gain information about embryo development within the flower.	**K2 &K3**
CO5	Know about flower transition and asymmetric division in flowering.	**K1 & K4**
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **ANATOMY** **Lectures**	Tissues- meristems – Classification, structure and functions, theories on organization of shoot and root apical meristem, quiescent center. Structural diversity and phylogenetic trends of specialization of xylem and phloem, Cambium – origin, cellular structure, cell division, storied and non-storied types. Cambium in budding and grafting - wound healing role. Anomalous secondary growth in Boerhaavia & Dracaena. Trichomes, periderm and lenticels. 09 hrs

Unit II **ANATOMY** **Lectures**	Arrangement of mechanical tissues in different plant organs. Vascular differentiation, anatomical characters in primary and secondary structure of stem and root in Dicot and Monocot. Nodal anatomy, Leaf abscission, stomatal types, sap wood, heart wood and reaction wood. Origin of lateral roots - Root stem transition - Anatomy of Dicot and Monocot leaves. Anatomy in relation to taxonomy. 07 hrs
Unit III **EMBRYOLOGY** **Lectures**	Structure and development of Microsporangium - Microsporogenesis, Microspores - arrangement - morphology - ultrastructure - Microgametogenesis - Pollen - Stigma - Incompatibility - Methods to overcome incompatibility - Structure and development of Megasporangium - Megagametogenesis - Female gametophyte - Monosporic - Bisporic and Tetrasporic - Nutrition of embryo sac. 08 hrs
Unit IV **EMBRYOLOGY** **Lectures**	Endosperm - Types - Endosperm haustoria - functions - Embryo development in Dicot and Monocot, Nutrition of embryo – Double fertilization - Polyembryony - Apomixis – Apospory. **Morphogenesis**: Morphogenesis and its relation to morphology - Morphogenesis at tissue level - Differentiation, dedifferentiation and redifferentiation of vascular tissue *in vivo, in vitro* and in wounds. Developmental studies of stem, leaf and flower. Morphogenetic factors - growth regulators - genetic and environment - polarity. 07 hrs
Unit V **MORPHOGENESIS** **Lectures**	Transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*. Molecular basis of morphogenesis - Cytosol and cytoskeleton, microtubules and microfilaments - Cellular level morphogenesis - nuclear transplantation experiments with *Acetabularia* - Sach‟s and Errer‟s laws - Asymmetric divisions and their significance. Plant galls and their importance in morphogenesis. 9 hrs
Current Contour	Current developments related to the anatomy, embryology and morphogenesis during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures –	40 hrs

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	2	2	3	3	3	2
CO2	3	3	2	3	2	2	2	1	3
CO3	3	2	3	3	2	3	3	2	1
CO4	3	3	2	2	1	2	3	2	2
CO5	3	2	3	1	2	3	2	3	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	2	3	3	3	3	2	3	1
CO2	3	3	2	2	2	3	2	1	2
CO3	3	2	3	3	1	2	3	2	3
CO4	3	3	2	2	2	2	3	2	2
CO5	3	2	3	1	3	3	2	3	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

Anatomy

1. Cutter, E. G. (1978). Plant Anatomy. Edward Arnold Publishers Ltd., London.
2. Easu, K. (1953). Plant Anatomy. John Wiley & Sons Inc., New York. Fahn, A. (1989).
3. Plant Anatomy. Maxwell Pvt. Ltd., Singapore. Metcalfe and Chalk (1950).
4. Anatomy of the Dicotyledons and Monocotyledons. Vol. I and II. Clarendon Press, Oxford, UK. Pandey, B. P. (2001).
5. Evert, R. F., Eichorn S. E., . Esau‟s Plant Anatomy (3rd Ed.) 2006. John Wiley & Sons. Crang,
6. R., Lyons, Lyons-Sobaski, S., Wise, R. (2018). Plant Anatomy, Springer Publ

Embryology

1. Bhojwani, S. S. and Bhatnagar, S. P. (2015) Embryology of Angiosperms. 6th Edition. Vikas Publishing House Pvt. Ltd., New Delhi.
2. P. Maheswari (1963). An Introduction to Embryology of Angiosperms. International Society of Plant Morphologies, University of Delhi.
3. Raghavan, V. (1976) Experimental Embryogenesis in Vascular Plants. Academic Press, London.
4. Johri, B. M. (1984). Embryology aof Angiosperms. Springer Publ., Heidelberg.

Morphogenesis

1. Bard, J. (1990). Morphogenesis. Cambridge University Press, London.
2. Brouder, L. W. (1986). Development Order: A Comprehensive Treatise. Vol.2. The Cellular Basis of Morphogenesis. Plenum Press, New York. Bryant,
3. J. A. and Francis, D. (1985). The Cell Division Cycle in Plants. Cambridge University Press, London.
4. Burgess, J. (1985). An Introduction to Plant Cell Development. Cambridge University Press, London. Ebert, J. D. *et al*. (1970). Interacting Systems in Development. Holt, Reinhart & Win Inc., New York.
5. Murphy, T. M. and Thompson, W. F. (1988) Molecular Plant Development. Prentice Hall of India Pvt. Ltd., New Jersey.
6. K. V. Krishnamurthy. (2015). Growth and Developments in Plants. Scientific Publ.

Related Online Contents:

. **E-Books:**

1.https://www.abebooks.co.uk/servlet/BookDetailsPL?bi=20569837712&searchurl=tn%3Dhandbook%2Bof%2Bthe%2Bbritish%2Bflora%26sortby%3D17%26an%3Dbentham%2Bg&cm_sp=snippet-_-srp1-_-title1

2. https://trove.nla.gov.au/work/16054012

3.https://books.google.co.in/books/about/A_Text_Book_Ofbotany_Plant_Anatomy_and_E.html?id=uMOglvnKUpQC&redir_esc=y

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SEMESTER - I

CORE THEORY III: DEVELOPMENTAL BOTANY

Course Code	22PGBOTCC103	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				3	3	-	5		
Pre-requisite	To know about the developmental stages embryo to plants								

Course Objectives:

- To study the plant genome, hormones, and gene regulation.
- To study about the model plants used in molecular plant development.
- To understand the Cell lineages and cell commitment
- To discuss about shoot and leaf developments in plants
- To discuss about flower and embryo in plant

Expected Course Outcomes:

On the completion of the course the student will be able to

Cos	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Have a better understanding about plant genome, hormones, and gene regulation.	K1 & K3
CO2	Gain information on model plants used in molecular plant developments.	K2 & K1
CO3	Differentiate Cell lineages and cell commitment	K4 & K5
CO4	Clearly understand about shoot and leaf developments in plants	K1 & K2
CO5	Interpret development of Flower and embryo.	K4

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **PLANT GENOME**	The Plant Genome. An introduction to flowering plants. Mechanisms involved in plant development. The coordination of plant development. The role of hormones in molecular plant development. Regulation of gene expression by DNA/Histone modifications. Epigenetic phenomena that regulate plant growth and developmental mechanisms. Programmed cell death.
Lectures	07 hrs

Unit II **MOLECULAR PLANT DEVELOPMENT** **Lectures**	Model plants used in Molecular Plant Development. Plant transformation methods. Methods for functional genomics. Generating mutant, transgenic, cisgenic and intragenic plants/lines. Forward and reverse genetics. EMS and T-DNA mutagenesis. RNAi, Post transcriptional gene silencing (PTGS) and site-directed mutagenesis methods (Oligonucleotide-directed mutagenesis, Zinc-finger, TALEN and CRISPR genome editing). 09 hrs.
Unit III **CELL LINEAGES AND CELL COMMITMENT** **Lectures**	Cell lineages and cell commitment. Association between lineage, position, and age dependent mechanisms during cell fate determination. Case studies of genes and mutations that underline the involvement of cell-intrinsic, cell-extrinsic and age associated mechanisms during Arabidopsis thaliana plant growth, development, and differentiation. Laser ablation of cells in Arabidopsis. Green-white-green periclinal chimeras. Datura polyploid chimeras 08 hrs.
Unit IV **SHOOT AND LEAF DEVELOPMENT** **Lectures**	Shoot and leaf development: Shoot development Shoot apical meristem (SAM) organization. SAM "organizing center" and maintenance of SAM "niche" cells. Molecular genetics of shoot development. Mutants and genes affecting SAM organization, pattern formation and function. Leaf primordial initiation. Establishment of the axial polarity (asymmetry). Determination of the adaxial and abaxial identity. Involvement of miRNA in adaxial and abaxial asymmetry. Development of stomata and leaf trichomes. Molecular genetics and mutants affecting leaf development. 07 hrs.
Unit V **FLOWER AND EMBRYO DEVELOPMENT** **Lectures**	Flower and embryo development: Transition to floral development. Photoperiodic control of flowering. Molecular genetics of flower development. Meristem and Floral organ identity genes. The ABCE flowering model. Positive regulation of homeotic gene function. Mutants affecting ABCE gene function. The role of miRNAs in flower development. Early events in embryogenesis. Seed development and maturation. Complexity of gene expression in the embryo. Molecular genetics of embryogenesis. Embryo-lethal, Pattern, Apical-basal and Radial axis mutants. 09 hrs.
Current Contour	Current developments related to the developmental botany during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, social media, Webinars and so on.
Total Lectures –	40 hours

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	3	3	2	1	3
CO2	3	2	3	3	2	2	3	2	2
CO3	3	3	2	3	1	3	2	3	2
CO4	3	2	3	3	2	1	2	2	3
CO5	3	3	2	3	2	3	1	2	1

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	2	2	3	2	3	3	2	2
CO2	3	2	3	2	3	1	2	3	2
CO3	3	2	1	3	2	3	3	2	1
CO4	3	3	2	3	2	3	3	2	3
CO5	3	1	2	3	2	2	3	2	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Cutter, E.G., (1971), Plant Anatomy, Vol. I and II, Edward Arnold publishing Ltd., London.
2. Davis, P.H. and Heywood, V.M. (1973) Principles of Angiosperm Taxonomy. Robert E. Kereiger Publ. New York.
3. Esau, K. (1965) Plant Anatomy (2nd Edition) Wiley Eastern Ltd, NewDelhi. Harrison, H.J. (1971).
4. New Concepts in Flowering Plant Taxonomy. Heiman Ednl. Books. Ltd., London. Radford, A.E. (1986).
5. Fundamentals of Plant Systematics, Harper & Row Publ. USA.
6. Woodland, D.W. (1991). Contemporary Plant Systematics. Prentice Hall, New Jersey K. V. Krishnamurthy. (2015). Growth and Developments in Plants. Scientific Publ.

Related Online Contents:

1. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwi46qiol_WCAxWNzzgGHT2vCQMQFnoECAoQAQ&url=https%3A%2F%2Flink.springer.com%2Fbook%2F10.1007%2F978-3-642-02301-9&usg=AOvVaw3o6zqg_xML2GtpbomIc57P&opi=89978449
2. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=ra&uact=8&ved=2ahUKEwi2p-bdl_WCAxXx4jgGHUKVCgIQFnoECBUQAQ&url=https%3A%2F%2Fbooks.google.com%2Fbooks%2Fabout%2FDevelopmental_Biology_of_Flowering_Plant.html%3Fid%3D_HPwAAAAMAAJ&usg=AOvVaw2S35Yr3_e_OuxNm3NffxCw&opi=8997844

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SEMESTER - I

CORE THEORY IV: CELL BIOLOGY AND BIOINSTRUMENTATION

Course Code	22PGBOTCC104	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				3	1	-	5		
Pre-requisite	Knowledge about Plant Cell Organelles, their functions and techniques, instruments involved in Plant Science								

Course Objectives:

- Differentiate Prokaryote from Eukaryote
- Identify the transport methods of solids and liquids
- Summarize the Cell Organelles and their functions
- Analyze the different types of cell division
- Emphasize the calibration of instruments and understand the principles
- Understand various types of Chromatography used in Separation of Biomolecules
- Emphasize the significance of Spectroscopy in Botanical studies

Expected Course Outcomes:

On completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Describe the difference between the structure of prokaryote and Eukaryote; structure of plant cell wall	K1, K2
CO2	Understand the intercellular and intracellular transport mechanism; Understand the theories and structure of Plasma membrane	K3, K4
CO3	Enhance knowledge on Ultrastructure of cell organelles; Gain Knowledge on Cell Cycle and its Regulation	K2
CO4	Differentiate and inter relate the various chromatography techniques used in separation of biomolecules	K4
CO5	Develop a correlation between the instruments used in biological studies	K6, K7

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation

Unit I **CELL AND CELL WALL** **8 Lectures**	Ultrastructure of Prokaryotic and Eukaryotic cells, Plant Cell – Ultrastructure, Primary and Secondary cell wall, Plant cell wall components, Plasma membrane structure, Lipid bilayer, membrane proteins, cell adhesion and recognition, Plasmodesmata, Fluid transport between cells

Unit II **CELLULAR ORGANELLES AND THEIR FUNCTIONS** **7 Lectures**	[#] Ultrastructure and functions of Mitochondria, [#] Chloroplast, Nucleus, Vacuoles, Peroxisomes, Dictiosomes, endoplasmic reticulum *(Rough and Smooth), Ribosomes, Golgai apparatus.
Unit III **CYTOSKELETON** **7 Lectures**	Cytoskeleton – Microtubules, Microfilaments, Intermediate filaments – structure and function, Cell division – *Mitosis and Meiosis, Cell cycle and its regulation, DNA structure- denaturation, renaturation, methylation; RNA types and structure.
Unit IV **BIOINSTRUMENTATION** **8 Lectures**	Principle and Uses -, pH Meter, colorimeter, Preparation of Buffer, Centrifugation – Principle and types of centrifuges, Microscopy – Light and Dark field, Phase contrast, SEM and TEM, Spectrophotometer – Beer and Lambert's law – UV-Vis double beam spectrophotometer, FTIR, NMR.
Unit V **SEPARATION TECHNIQUES** **10 Lectures**	Electrophoresis – principle – native and SDS PAGE, Agarose gel electrophoresis, Isoelectric Focusing, 2-D electrophoresis, MALDI-TOF, Chromatography – Principle and procedures – PC, [#]TLC, Gel filtration, Ion exchange, Affinity chromatography, Gas Chromatography, HPLC and LCMS.
Current Contour **(For Continuous Internal Assessment only, Not for examinations)**	Current developments related to the cell biology and bioinstrumentation during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures – 40	

[*]Blended Learning, [#]Flip Learning

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1	1	3	3	2	2	3	2	3	1	
CO2	3	2	2	3	3	3	3	2	2	
CO3	2	3	2	2	3	3	2	3	1	
CO4	2	3	3	1	2	2	2	3	3	
CO5	3	2	2	1	2	2	2	3	2	
1-Low; 2-Medium; 3-Strong										

Recommended References:

1. Alberts, B. Johnson, A. Lewis, J. Raff, M., Roberts K. and Walter P. (2014). Molecular
2. Biology of the cell (6th Ed.) Garland Pub., New York.

3. Becker, Kleinsmith and Hardin (2006). The world of the cell (6th Ed.) Pearson Pub California.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (1995). Cell and Molecular Biology (8th Ed.) Waverly Publ, New Delhi.
5. Karp, G. (2019). Cell and Molecular Biology – Concepts and experiments (9th Ed.) John Wiley and Sons, New York.
6. Cooper, G.M. (2018). The Cell – A molecular approach (8th Ed.) ASM Press, Washington
7. Hardin, J., Bertoni, G., Kleismith, L. (2017). Becher's World of the Cell. Global Edition, (9th Ed.) Pearson Pub. USA.
8. Lodhish, H. et al., (2021). Molecular Cell Biology. (9th Ed.) W. H. Freeman, Publ. New York.
9. Wilson and Walker (2018). Principles and techniques of Biochemistry and Molecular Biology. (8th Ed) Cambridge University Press.

Related Online Contents:

1. https://epdf.tips/biotechnology-a-laboratory-course.html
2. https://www.amazon.in/Bioinstrumentation-Webster/dp/8126513691

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SEMESTER - I

CORE THEORY V: GENETICS, PLANT BREEDING AND EVOLUTION

Course Code	22PGBOTCC105	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs.	-	-	5		
Pre-requisite	The students should have prior knowledge on basic ideas's, concepts and techniques in Genetics and Plant breeding and also about the various theories in Evolution.								

Course Objectives:

- To study the Mendelian principles and General introductory lesson on Genetics
- To understand the concepts like Gene, Mutation and Population genetics.
- To learn about various Plant breeding techniques and the important plant breeding institutes in India
- To identify the different markers used in Plant breeding programs.
- To learn about theories on origin of life and theories on evolution.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Have a better understanding about the various concepts and terms associated with Genetics.	**K1 & K2**
CO2	Gain information on Gene families, Mutation techniques and Population genetics.	**K1 & K2**
CO3	Identify various Plant breeding techniques applied in the field.	**K2 & K3**
CO4	Differentiate the various selection markers used in Plant breeding techniques.	**KI & K4**
CO5	Clearly understand the evolution theories based on the examples.	**K2 & K5**

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I GENETICS **Lectures**	Mendelian Principles: Law of segregation and Law of Independent Assortment, Mono hybrid Cross, Dihybrid Cross, back cross, Test cross and Variation in Dominance. *Linkage and crossing over, Tetrad analysis, Chromosome Mapping - Sex determination in plants – Sex linked characters – primary, secondary and permanent, non-disjunction of sex chromosomes in Drosophila. Sex limited and sex- linked inheritance - Cytoplasmic inheritance: Male sterility Mechanisms-cytoplasmic and genetic their applications. 09 hrs.

Unit II GENETICS **Lectures**	Gene concept– IS Element – transposons One gene -One enzyme hypothesis, Benzer's concepts of Cistron, muton and recon. Types and description of gene family (housekeeping genes, transposons overlapping genes, pseudogenes, gene cluster). Gene mutation-Molecular basis of mutation, physical and chemical mutagens and their mode of action. Detection of mutation by CLB and Muller methods – Biochemical mutants in bacteria and Neurospora. Population genetics: gene frequencies, mutation, selection, migration, genetic drift. Hardy and Weingberg Law. 08 hrs.
Unit III PLANT BREEDING **Lectures**	Plant genetic resources, Principles and methods of selection: Mass, Pureline and Clonal selection. Breeding methods in self-pollinated, cross pollinated, vegetatively propagated and apomictic plants. Heterosis: Definition and Genetic causes. Breeding plants for improving yield, quality and resistance to insect pests and diseases. Plant breeding work in India with special reference to Rice, cotton and Sugarcane, Role of polyploidy in plant improvement, Germplasm maintenance of rice and sugarcane. 09 hrs.
Unit IV MARKER ASSISTED SELECTION IN BREEDING **Lectures**	RFLP (Restriction Fragment Length Polymorphism), AFLP (Amplified Fragment Length Polymorphism), MAS (Marker-Aided Selection), QTLs (Quantitative Trait Loci), Plant Breeders‟ Right and Regulations for plant variety protection and farmers rights. 06 hrs.
Unit V EVOLUTION **Lectures**	Theories on origin of life: Prebiotic environment, panspermia-Theories on evolution: Lamarkism, Darwinism and Neo Darwinism-Variation: Causes and consequences of variation, Polymorphism-Isolation mechanism and speciation: Geographical and reproductive isolation, parpatric and sympatric speciation –Micro and macro evolution. 08 hrs.
Current Contour	Current developments related to the genetics, plant breeding and evolution during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, social media, Webinars and so on.
Total Lectures –	40 hrs.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	3	3	1	3	2	3
CO2	3	3	2	2	2	1	3	2	3
CO3	3	3	2	3	3	3	3	2	3
CO4	3	3	2	3	3	3	3	2	3
CO5	3	2	2	1	1	1	2	2	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	2	2	2	2	2	2	3	3
CO2	3	1	3	2	3	2	2	3	3
CO3	3	2	3	2	2	2	3	3	3
CO4	3	1	3	2	2	2	3	3	3
CO5	3	2	1	1	1	2	1	3	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

Genetics

- Dayanasargar, V. R. (1990). Cytology and Genetics. Tata McGraw Hill Publishing Co. Ltd.,New Delhi.
- Gardner et al., (2004). Principles of Genetics. John Wiley and Sons Inc., Singapore.
- Gardner, E. J. (1972). Principles of Genetics. John Wiley & Sons Inc., New York.
- Primrose, S. B. and Twyman, R. M. (2006). Principles of Gene Manipulation and
- Genomics.7th ed. Blackwell Science, London.
- Rothwell, N. V. (1983). Genetics. Oxford University Press, London.
- Sharma, A. K. and Sharma, A. (1985). Advances in Chromosome and Cell Genetics. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Sinnot, E. W., Dunn, L. C. and Dobshansky, T. (1977). Principles of Genetics. 5th ed. Tata McGraw Hill, New Delhi.
- Strickberger, M. W. (2015). Genetics (3rd ed.). Macmillan Publishing Co., New York.
- Swanson, C. P. (1972). Cytology and Genetics. Macmillan Publishing Co., New York.
- Acquaah, G. (2020). Priniciples of plant genetics and breeding (3rd Ed.) John Wiley and Sons.
- Gardner, E. J., Snustad, D. P., Simmons, M. J. (2006). Principles of Genetics. John Wiley & Sons Inc.
- Martines-Gomez, P. (Ed). (2019). Plant Genetics and Molecular Breeding. MDPI Books.

Plant Breeding

- Allard, R. W. (1960). Principles of Plant Breeding. John Wiley & Sons Inc., New York.
- Chopra, V. L. (1989). Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Jensen, N. F. (1988). Plant Breeding Methodology. Wiley Inerscience Publications, New York.
- Sinha, V. and Sinha, S. (1986). Cytogenetics, Plant Breeding and Evolution. Vikas Publishing House Pvt. Ltd., New Delhi.
- Priyadarshan, P. M. (2020). Plant Breeding: Classical to Modern, Springer Publ.

Evolution

- Strickberger, M. W., B. K. Hall., Hallgrimsson, B. (2007). Evolution. Jones & Bartlett, India (4th Ed.)

- Strickbergers Evolution. 5th Ed. (2014). B. K. Hall & B. Hallgrimson. Jones & Bartlet Student Edition.

Related Online Contents:

1. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118313718
2. https://www.springer.com/in/book/9783642879302
3. https://trove.nla.gov.au/work/16054012?q&sort=holdings+desc&_=152750319919&versionId=23683670
4. https://www.amazon.com/ChromosomeAtlasFlowering...Darlington/dp/B0014B1YJA

SEMESTER - I

CORE PRACTICAL I: Plant Diversity I & Anatomy, Embryology and Morphogenesis/Developmental Botany

Course Code	22PGBOTCC107	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				-	-	40 hrs.	4		
Pre-requisite	The students should have prior knowledge on the procedures employed for respective experiments and also have experience in handling basic instruments in the laboratory.								

Course Objectives:

- To understand the micro slide preparation methods.
- To understand the dissection procedure in plant anatomy.
- To gain a knowledge on industrial products
- To identify different types of stomata.
- To study the various types of reproductive structural in bryophytes.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	• Know about Morphology, Reproductive structure of algae	K1
CO2	• Distinguish the morphology and reproductive structure of lichens	K2
CO3	• Identify the types of tissues, Develop about block preparation	K1 & K4
CO4	• Understand the stages of anther, Know different types of pollen grains	K2 & K3
CO5	• Know about the viability of pollen	K5 & K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Experiments

Type study and Micro slide preparation of the following:

Algae

Prochlorophyceae : *Prochloron, Prochlorococcus* and *Prochlorothrix*

Chlorophyta : *Chlorella, Ulva* and *Caulerpa*

Charophyta : *Chara*

Xanthophyta : *Borydium and Vaucheria*

Bacillariophyta : *Cocconeis placeritula and Navicula*

Phaeophyta : *Sargassum*

Rhodophyta **:** *Gracillaria*

Fungi

Mastigomycotina : *Albugo candida, Phytophthora infestans, Phythium debaryanum, Synchytrium endobioticum* and *Sporolegnia parasitica*

Zygomycotina : *Rhizopus stolonifer,Mucor*

Ascomycotina : *Taphrina, Saccharomyces*

Basidiomycotina : *Aspergillus, Penicillium, Peziza, Ustilago tritici*

Deuteromycotina : *Puccinia graminis tritici, Colletotricum, Cercospora*

Bryophytes

Marchantiales : *Marchantia*

Anthoceratales : *Anthoceros*

Sphagnales : *Sphagnum*

Funariales : *Funaria*

Polytrichales : *Polytrichum*

Anatomy

- Dissection of shoot apex in *Hydrilla* and whole mount.
- Examination of LS of shoot and root apices
- Examination of different types of pits - secondary wall thickening - annular, Helical and scalariform and pitted thickening.
- Wood structure - showing variations in vessel elements, Fibers- axial parenchyma and ray parenchyma from Permanent slides.
- Study of growth rings by specimens and slides
- Identification of different types of stomata - Monocot and Dicot types.

Embryology

- Slides showing developmental stages of anther, embryosac, endosperm and embryo.
- Study of different types of pollen grains.
- Study of ovules by hand section
- Dissection of endosperm

- Dissection of Embryo - *Abelmoschus, Cyamopsis, Tridax*

Morphogenesis

- Superficial 'V' shaped wounding of young stem and studying the wound healing response in Dicot and Monocot stems.
- Study of one fungal gall (Club - root of Cabbage) and insect gall (*Pongamia* leaf -gall).

Developmental Botany

- Study of apical meristems with the help of dissections, whole mount preparations, sections and permanent slides.
- Origin and development of epidermal structures (trichomes, glands and lenticels).
- Study of xylem and phloem elements using maceration, staining, light and electron micrographs (xerophytes, hydrophytes and halophytes).
- Study of secretory structures (nectaries and laticifers).
- Study of secondary growth (normal and unusual) of selected woods with the help of wood microtome and permanent slides.
- Pollen in vitro germination methods: Sitting drop culture, suspension culture, surface culture.
- Assessment of stigma receptivity by localizing peroxidases, non-specific esterases and phosphatases.
- Aniline blue fluorescence method to localize pollen tubes to study different aspects of pollen-pistil interaction.
- Study of post - fertilization stage with the help of permanent slides and electron micrographs.
- Dissection of embryo.
- Dissection of endosperm.

SEMESTER - I

CORE PRACTICAL II: CELL BIOLOGY AND BIOINSTRUMENTATION & GENETICS, PLANT BREEDING AND EVOLUTION

Course Code	22PGBOTCC107	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				-	-	40 hrs.	4		
Pre-requisite	The students should have prior knowledge on the procedures employed for respective experiments and also have experience in handling basic instruments in the laboratory.								

Course Objectives:

- To understand cell division process.
- To understand the principles behind basic instruments.
- To understand Mendelian genetics.
- To gain knowledge on plant breeding techniques
- To practice Mendelian principles and other concepts in Genetics
- To get familiarized with various Plant breeding techniques.
- To analyze how genes get expressed in stress-induced plants.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Develop skill on the basic techniques in plant science	K1 & K2
CO2	Recognize the application of various techniques	K2 & K3
CO3	Know the genetic inheritance and about mutation	K2
CO4	Engage them in applying theoretical concepts of Genetics in practical use.	K1 & K4
CO5	Identify suitable Plant breeding techniques in field for various crop plants.	K2 & K3
CO6	Clearly understand the idea of gene expression in plants and apply this in their further studies.	K5 & K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Experiments in Cell Biology and Bioinstrumentation:

1. Mitosis

2. Meiosis

3. Chromosomal aberrations – colchicine treatment

4. Isolation of Nucleic acids – a) Genomic DNA – *E. coli* b) Plasmid DNA c) Total RNA

5. Quantification of Nucleic acids – UV spectrophotometer

6. Quantification of Nucleic acids – UV spectrophotometer

7. Agarose gel electrophoresis

8. Preparation of buffers

9. Absorption maxima – UV visible spectrophotometer

10. Paper chromatographic separation of amino acids

11. TLC separation of lipids

12. Column chromatographic separation of Plant pigments

13. SDS –PAGE separation of proteins

Experiments and Spotters related to Genetics	**Experiments** 1. Monohybrid experiment 2. Dihybrid experiment 3. Incomplete Dominance 4. Lethal Genes eg. Maize and snapdragon 5. Chemical mutation (EMS) of seeds and seedling growth. 6. Quantification of genomic DNA 7. Estimation and calculation of salt stress effects on the expression of protein. 8. Estimation and calculation of fungal disease on the expression of pathogen related. 9. Hybridization techniques-Emasculation, Bagging 10. Induction of Polyploidy using Colchicine 11. Cytological analysis of Polyploidy in plants 12. Genome analysis in wheat/Gossypium **Spotters** 1. Back cross 2. Test cross 3. Mutagenesis 4. Hardy-Weinberg law 5. Cytoplasmic inheritance 6. Restriction digestion 7. Agarose gel 8. Distant hybridization 9. Hybrid vigour 10. RFLP

SEMESTER - II

CORE THEORY VI: PLANT DIVERSITY – II: PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

Course Code	22PGBOTCC201	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs		-	5		
Pre-requisite	Students should know about the fundaments of Pteridophytes, Gymnosperms and fossil records.								

Course Objectives:

- To study the salient features of plants belonging to Pteridophytes.
- To acquire knowledge on gymnosperm, morphology, anatomy and reproduction.
- To understand the fossilization process and formation of different types of Fossils.
- To gain knowledge on Paleobotany and Fossil types.

Expected Course Outcomes:

On the completion of the course the student will be able to

Cos	COURSEOUTCOMES	KNOWLEDGE LEVEL
CO1	Learn the morphological/anatomical organization, life history of major types of Pteridophytes and Gymnosperms. Understand the organization of pteridophytes. Interpret the gametophytes and sporophytes of pteridophytes.	K3 & K4
CO2	Recall on classification, recent trends in phylogenetic relationship, general characters of Pteridophytes and Gymnosperms.	K1 &K3
CO3	Comprehend the economic importance of Pteridophytes, Gymnosperms, and fossils.	K3 &K6
CO4	Understanding the evolutionary relationship of Pteridophytes and Gymnosperms. Understand the characteristics features of Gymnosperms. Discuss on the distribution phylogeny of Gymnosperms.	K2
CO5	Awareness on fossil types, fossilization and fossil records of Pteridophytes and Gymnosperms. Evaluate in to the geological time scale. Classify the different types of fossil plants.	K1 & K3
K1-Knowledge;K2 -Understanding;K3 -Practice;K4–Analysis;K5 –Creation; K6- Evaluation		

Unit I	**PTERIDOPHYTES** Pteridophytes – Introduction and Classification (Sporne). Origin of Pteridophytes. Fern and fern allies-Lifecycle of gametophytes and sporophytes of the following genera: *Psilotum,*Lycopodium,*Selaginella, Isoetes* and *Equisetum.*
Lectures	8 hrs.
Unit II	**PTERIDOPHYTES** Range of morphology, structure, reproduction and evolution of gametophytes and sporophytes of the following genera*: Ophioglossum, Marselia, Adiantum* and *Azolla. S*tellar evolution in pteridophytes, Heterospory and origin of seed habit. Economic importance of Pteridophytes. Apogamy and Apospory.
Lectures	8 hrs.
Unit III	**GYMNOSPERMS** A general account of the characteristic features of Gymnosperms. Origin of Gymnosperms. Classification of Gymnosperms (Sporne, 1965). General structure and interrelationships of Pteridospermales, Bennetittales, Pentoxylales and Cordaitales.
Lectures	8 hrs.
Unit IV	**GYMNOSPERMS** A general account on the distribution, morphology, anatomy, reproduction and phylogeny of **Cycas,***Pinus, Ginkgoa ,Ephedra, Welwitschia* and *Gnetum*. Economic importance of Gymnosperms.
Lectures	8 hrs.
Unit V	**PALEOBOTANY** Concepts of Pale botany, A general account on Geological Time Scale. #Age determination and methods of study of fossils carbondating. **Fossil types:**Compressions, incrustation, casts, molds, putrefactions, coalballs and compactions. Paleoclimates and fossil plants, *Rhynia*, *Calamites*, *Pentaxylon*, *Glossopteris*. Role of fossil in oil exploration and coal excavation, Paleopalynology.
Lectures	8 hrs.

Current Contour	**Current Contours:(ForContinuous Internal Assessment only, Not for examinations):** Current developments related to the plant diversity – II:Pteridophytes, gymnosperms and paleobotany during the Semester concerned to be kept a breast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Researcharticles, Review materials, Print, Internet, Interaction, SocialMedia, Webinars and soon. *BlendedLearning,#FlipLearning
Total Lectures–	**40 hrs.**

Mapping Program Outcomes with Course Outcome

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	2	3	3	2	3
CO2	3	3	2	1	3	3	3	3	2
CO3	3	3	3	3	3	3	3	2	3
CO4	3	2	3	3	2	2	3	3	2
CO5	3	3	3	3	3	3	3	3	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

Cos	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	3	2	3	3	2	3
CO2	3	3	2	1	3	3	3	3	2
CO3	3	2	1	3	3	3	3	2	3
CO4	3	2	3	3	2	2	3	3	2
CO5	3	3	3	3	3	3	3	3	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

Pteridophytes

Eames, A. J. (1936). Morphology of Vascular Plants - Lower Groups. Tata McGraw Hill, New Delhi.

Sharma,O.P.(1990).Textbook of Pteridophyta. Macmillan IndiaLtd.,India.

Smith, G. M. (1971). Cryptogamic Botany. Vol. II. Bryophytes and Pteridophytes. Tata McGraw Hill, New Delhi.

Sporne,K.R.(2018).The Morphology of Pteridophytes. Franklin Classics Publications, India.

Sundararajan, S. (2007).Introduction to Pteridophyta. New Age International Publishers, New Delhi.

Sharma,O.P.(2017).TextBook of Pteridophyta. McGrawHill Education India, NewDelhi.

Smith,G.M.(2019).Cryptogamic Botany. Vol.II.Bryophytes and Pteridophytes. Secound Edition, TataMcGraw Hill, New Delhi.

JohnT.Mickel, AlanR.Smith.(2004). The Pteridophytes of Mexico, The NewYork Botanical Garden Press, New York,USA.

Gymnosperms

Chamberlain, C. J. (1957). Gymnosperms Structure and Evolution. University Chicago Press, New York.

Sporne,K. R. (2015). The Morphology of Gymnosperm. Scientific Publishers, Jodhpur.

Pandey,S.N.,Misra,S.P.,Trivedi,P.C.(2016).A textbook of botany,Vol.II(thirteenthEdition).

Visas Publishing House Pvt. Ltd., E-28,Sector-8,Noida-201301 (U.P.) India. Singh,V., Pandey,P.C, Jain,D.K.(2017). TextBook of Botany,(Fifthedition),Rastogi Publications, Gangotri Shivaji Road, Meerut

Biswas,C. and Johri,B.M.(2004). The Gymnosperms. Nervosa Publishing House,New Delhi.

PeterH.Raven, GeorgeB. JohnsonJonathanB. Losos,KennethA. MasonandSusanR.Singer.(2008). Biology. (8thEdition),McGraw-Hill Learning Solutions, Boston.USA.

Paleobotany Nikias, K. J. (1981). Paleobotany, Paleoecology and Evolution. Praeger Publishers, USA.Seward, A. C. (1919). Fossil Plants.Vol.I, II, III and IV. Cambridge University Press, London.

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1. https://onlinelibrary.wiley.com/doi/pdf/10.1002/9781119312994.apr0486
2. https://books.google.co.in/books?id=gNjA58lm6dkC&pg=SL18-PA3&lpg=SL18-PA3&dq=Sharma,+O.P.+1990.+Textbook+of+pteridophyta.+Macmillan+India+Ltd.,+Delhi+Books&source=bl&ots=nf9QcPpfOF&sig=fVZa_BkD4bpzuuSALNaPm-uzJrY&hl=en&sa=X&ved=0ahUKEwiO4b3UsqrbAhXBp48KHTHeAHYQ6AEIODAC#v=onepage&q=Sharma%2C%20O.P.%201990.%20Textbook%20of%20pteridophyta.%20Macmillan%20India%20Ltd.%2C%20Delhi%20Books&f=false
3. https://books.google.co.in/books?id=aE414KuXu4gC&pg=PA315&lpg=PA315&dq=Biswas,+C.+and+Johri,+B.M.+1999.+The+Gymnosperms.+Narosa+publishing+House,+New+Delhi.&source=bl&ots=QzeaHK4WmR&sig=vi63kzz07WdQuUp0rdqFaQRYbXc&hl=en&sa=X&ved=0ahUKEwiM-e7zsqrbAhUEMo8KHYymAZUQ6AEINjAC#v=onepage&q=Biswas%2C%20C.%20and%20Johri%2C%20B.M.%201999.%20The%20Gymnosperms.%20Narosa%20publishing%20House%2C%20New%20Delhi.&f=fal

SEMESTER - II

CORE THEORY VII: Taxonomy of Angiosperms

Course Code	22PGBOTCC202	Course Type	Core	L	T	P	Credit	Syllabus version	2022-2023
				4	1	-	5		
Pre-requisite	Morphological features of plants								

Course Objectives:

- To establish a suitable method for correct identification and adequate characterization of plants.
- To be aware of the importance of taxonomic relationships in plant systematic studies.
- To understand the application of molecular techniques in identification of plants.
- To study the systematical & phylogeny of some important plant families.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	• List out various classifications and their basic.	K1, 2,3
CO2	• Understand various fields used in taxonomical classification.	K2
CO3	• Study the diagnostic feature to identify the plants. Summarize the economic importance.	K3 & K6
CO4	• Know the key characters and family.	K4 & K5
CO5	• Generalize the importance of Herbarium	K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **MAJOR SYSTEMS OF CLASSIFICATION** **Lectures**	Major systems of classification: Sexual system – Carolus Linnaeus Artificial Systems - Linnaeus; Natural Systems – Bentham and Hooker; Phylogenetic Systems - Hutchinson, Takhtajan. Angiosperm Phylogeny Group (APG) – Outline of APG-IV plant classification. Floras, Revision, Monograph, Construction of taxonomic keys-indented and #bracketed, International code of botanical nomenclature.

Unit II **TAXONOMY** **Lectures**	Phytography, Field and herbarium techniques, #Important herbaria and botanical gardens of India, Cytotaxonomy, chemotaxonomy, serotaxonomy, numerical taxonomy, DNA barcoding, Cladistics, Plant authentication and submission of plants to herbarium. Biosystematics – Anatomy, Cytology, Palynology, and Ecology, in relation to Taxonomy (each two examples).
Unit III **ANGIOSPERMS** **Lectures**	Systematic position and study of Families – *Annonaceae, Malvaceae, Zygophyllaceae, Rutaceae, Sapindaceae, Fabaceae (Faboideae, Cesealpinoideae, Mimosoidaeae), Rosaceae, Combretaceae, Cucurbitaceae.
Unit IV **ANGIOSPERMS** **Lectures**	Study of the diagnostic characters, economic importance, systematics and phylogeny of *Rubiaceae, Asteraceae, Plumbaginaceae, Apocyanaceae, Asclepediaceae, Gentianaceae, Solanaceae, Acanthaceae.
Unit V **ANGIOSPERMS** **Lectures**	Study of the diagnostic characters, economic importance, systematics and phylogeny of: *Verbenaceae, Lamiaceae, Nyctaginaceae, Amaranthaceae, Asirtolochiaceae, Piperaceae, Euphorbiaceae, Zingeberaceae, Costaceae, Dioscoreaceae, Alliaceae, Poaceae.
Unit VI **Current Contours** **Lectures**	Current developments related to the taxonomy of angiosperms during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on. ***Blended Learning, #Flip Learning**
Total Lectures – 40	

References:

Bentham, G. (1988). Hand Book of British Flora. (7th ed., revised by Rendle A.B. in 1930). Ashford, Kent.

Cronquist, A. (1988). The Evolution and Classification of Flowering Plants. (2nd ed.), New York Botanical Garden, NY, USA.

Davis, P.H. and Heywood, V.M. (2011). Principles of Angiosperm Taxonomy. Oliver & Boyed, London. Scientific Publishers, India.

Gamble, J.S. and L.E.F. Fisher (1967). The Flora of the Presidency of Madras vol - I, II, III, BSI, Calcutta.

Hutchinson, J. (1973). The Families of Flowering Plants (3rd ed.), Oxford University Press, UK.

Lawrence, G.H.M. (1961). Taxonomy of Vascular Plants. MacMillan and Co., New Delhi.

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Rendle, A.B. (1904). Classification of Flowering plants (2nd ed. Vol.1), Cambridge University Press, England.

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Woodland, D.W. (2009). Contemporary Plant Systematics (4th Edition) Prentice Hall. New Jersey.

Pullaiah, T. and Karuppusamy, S. (2018). Taxonomy of Angiosperms (4th Rev. Ed.)

E-Books:

1. https://books.google.co.in/books/about/Taxonomy_of_Angiosperms.html?id=FrdidPp6HuAC
2. https://www.abebooks.com/9788121904049/Textbook-Botany-Angiosperms-Taxonomy-Anatomy-8121904048/plp
3. https://www.schandpublishing.com/books/higher-education/biology/a-textbook-botany-angiosperms/9788121904049/#.WwwKDEiFPIU

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1	1	2	2	1	3	3	1	2	3	
CO2	3	2	3	2	3	2	1	3	2	
CO3	3	3	3	2	2	2	2	2	2	
CO4	2	1	3	3	2	3	3	2	3	
CO5	3	3	3	3	3	2	3	3	3	
1 – Basic level, 2 – Intermediate level; 3 – Advance level										

Recommended References:

Bentham, G. (1988). Hand Book of British Flora. (7th ed., revised by Rendle A.B. in 1930). Ashford, Kent.

Cronquist, A. (1988). The Evolution and Classification of Flowering Plants. (2nd ed.), New York Botanical Garden, NY, USA.

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Santapau, H and Henry, H.D. (1994). A Dictionary of Flowering plants of India C.S.N. New Delhi.

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Related Online Contents:

E-Books:

1. https://books.google.co.in/books/about/Taxonomy_of_Angiosperms.html?id=FrdidPp6HuAC
2. https://www.abebooks.com/9788121904049/Textbook-Botany-Angiosperms-Taxonomy-Anatomy-8121904048/plp

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SEMESTER - II

CORE THEORY VIII: Plant Systematics

Course Code	22PGBOTCC203	Course Type	Core	L	T	P	Credit	Syllabus version	2022-2023
				4	1	-	5		
Pre-requisite	Morphological features of plants								

Course Objectives:

- To study the different types of botanical classification
- To match the suitable method for identification & characterization of plants.
- To learn the taxonomic characters.
- To acquire the fundamental values of plant systematics.
- To know about the basic concepts and principles of plant systematics.
- To understand the application of molecular techniques in identification of plants

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Study various classification and their basic.	K1 & K2
CO2	Apply various fields used in taxonomical classification.	K3 & K4
CO3	Study the diagnostic feature to identify the plants. Understand the systematics of plants with regarding to plant identification based on their morphology.	K3, K4 & K6
CO4	Know the key characters and family.	K4 & K5
CO5	Assess the economic importance.	K4
	Demonstrate the importance of Herbarium	K2

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **BOTANICAL CLASSIFICATION**	Types of botanical classifications; Linnaeus, Betham and Hooker, Hutchinson, Engler & Prantl, APG IV classification; Floras, Revision and monographs, Construction of taxonomic keys – Indented and #bracketed.
Unit II **BOTANICAL NOMENCLATURE**	International code of Botanical nomenclature; Taxonomic Hierarchy; Species concept, Type methods (Typification), Paratype, Effective and valid publication; Phytography, Field and herbarium techniques; Important herbaria and #botanic gardens in India.
Unit III **SOURCES OF TAXONOMIC CHARACTERS**	Sources of Taxonomic characters; Morphology, Anatomy, Palynology, Embryology, Cytology; Taxonomic Species concept. Key preparation – Bracketed key, Indented Key. Modern trends in taxonomy – Cytotaxonomy, Chemotaxonomy, Numerical taxonomy, #Molecular taxonomy.
Unit IV **SYSTEMATIC POSITION**	Study of systematic position, salient features, description, distribution and economic importance – of Annonaceae, #Malvaceae, Rutaceae, Sapindaceae, Fabaceae, Rosaceae, Combretaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Apocyananceae.
Unit V **SYSTEMATIC POSITION**	Study of systematic position, salient features, description, distribution and economic importance – of Asclepiadaceae, Solanaceae, #Bignoniaceae, Acanthaceae, Verbenaceae, Lamiaceae, Amaranthaceae, Aristolochiaceae, Euphorbiaceae, Orchidaceae, Zingiberaceae, Cyperaceae, Poaceae.

UNIT VI **CURRENT CONTOURS**	Current developments related to the plant systematics during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on. ***Blended Learning, #Flip Learning**

Total Lectures – 40

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1	1	2	2	1	3	3	1	2	3	
CO2	3	2	3	2	3	2	1	3	2	
CO3	3	3	3	2	2	2	2	2	2	
CO4	2	1	3	3	2	3	3	2	3	
CO5	3	3	3	3	3	2	3	3	3	
1 – Basic level, 2 – Intermediate level; 3 – Advance level										

Recommended References:

Bensen, L.D. (1957). Plant Classification. Oxford & IBH Publishing Co., New Delhi.

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Darlington, C.D. and Wylie, A.P. (1955). Chromosome Atlas of Cultivated Plants. Allen and Unwin, London.

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Lawrence, G.H.M. (1961). Taxonomy of Vascular Plants. MacMillan and Co., New Delhi.

Mathew, K.M. (1983). The Flora of Tamil Nadu Carnatic. The Rapinat Herbarium, Trichy.

Naik, V.N. (1984). Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company Ltd., New Delhi.

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Rendle, A.B. (1904). Classification of Flowering plants (2nd ed. Vol.1), Cambridge University Press, England.

Santapau, H and H.D. Henry (1994). A Dictionary of Flowering plants of India C.S.N. New Delhi.

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Singh, G. (1999). Plant Systematics- Theory and Practice. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi.

Stace, C.A. (1989). Plant Taxonomy and Biosystematics (2nd ed.), Edward Arnold. London.

Street, H.E. (1978). Essay in Plant Taxonomy, Academic press, London.

Takhtajan, A.L. (1997). Diversity and Classification of Flowering Plants. Columbia University Press, New York.

Woodland, D.W. (1991). Contemporary Plant Systematics. Prentice Hall. New Jersey.

Related Online Contents:

1. http://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/ReferencesPapers.aspx ReferenceID=659808
2. https://www.sciencedirect.com/science/article/pii/S0024407401904760
3. https://academic.oup.com/sysbio/article/53/3/517/2842962

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SEMESTER - II

CORE THEORY IX: PLANT BIOTECHNOLOGY

Course Code	22PGBOTCC204	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40		-	5		
Pre-requisite	Basic knowledge of plant biotechnology and its related techniques								

Course Objectives:

- To acquire knowledge about plant biotechnology
- To understand the haploid production and somaclonal variation
- To improve the knowledge of plant molecular biology in the organization & and function of plant nuclear genome
- To know about molecular techniques
- To study plant biotechnology in crop improvement

Expected Course Outcomes:

On the completion of the course the student will be able to

Cos	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Understanding the role of medium components.	K2 & K3
CO2	Learn about the nuclear genome of plants.	K1 & K3
CO3	Find out the Organization and function of Plant nuclear genome	K1 & K5
CO4	Utilize the molecular techniques of plant	K5 & K4
CO5	Understand the method of raising transgenic plants.	K5 & K6

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I PLANT TISSUE CULTURE

Biotechnology – scope and potentialities. Plant tissue culture – totipotency – organization of a tissue culture laboratory. Sterilization methods – plant tissue culture media composition, types and plant hormones – surface sterilization, callus induction, subculture, suspension culture. *Micropropagation. Organogenesis – Applications of plant tissue culture in agriculture and crop improvement.

Lectures 9 hours

Unit II **HAPLOID PRODUCTION**

Production of haploids (anther, pollen and ovule culture), detection of hap (Morphology and genetic markers), uses of haploids in plant breeding and other uses. Proto isolation and culture; protoplast fusion – techniques and mechanism; selection of fused haploids, of #somatic hybrids and cybrids. *Somaclonal variation and cryopreservation.

Lectures 8 hours

Unit III **PLANT MOLECULAR BIOLOGY**

Organization and function of Plant nuclear genome (Arabidopsis thaliana), Genetic transformation of plants by Agrobacterium: Genetic organization of Ti plasmids Functions encoded by integrated T-DNA. Molecular mechanism involved in transformation of plants by Agrobacterium tumefaciens.

Lectures 10 hours

Unit IV **MOLECULAR TECHNIQUES**

*rDNA Technology Restriction enzymes, Cloning Vectors, gene library, cDNA library molecular probes. Molecular techniques: Electrophoresis, Southern, Northern, Western & Slot blots. Polymerase Chain Reaction. Plant Viruses, DNA sequencing.

Lectures 7 hours

Unit V **MOLECULAR FARMING IN PLANTS**

Agroinfiltration mediated expression; Bio-safety issues in plant molecular farming. Phytoremediation: cleaning up with plants; issues in the application of biotechnology-concept of intellectual property; *Patenting hereditary material, Patenting products of nature, patenting proteins, bioethics issues in patenting.

Lectures 6 hours

Unit VI

Current Contour

Current developments related to the plant biotechnology during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.

Total Lectures – 40 hours

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	3	3	2	3	3	3	3
CO2	3	3	2	3	2	3	3	3	3
CO3	2	3	3	3	3	2	2	3	3
CO4	2	2	3	3	3	3	3	2	3
CO5	2	3	3	3	3	3	3	3	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	2	3	3	3	2	3	3	3	3
CO2	3	2	2	3	2	3	3	3	3
CO3	3	2	2	2	3	3	3	3	3
CO4	2	3	3	2	2	2	3	3	2
CO5	2	3	2	3	3	2	3	2	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

Grierson, D and Convey, S.N. (1988). Plant Molecular Biology, Springer, New York.

Ignacimuthu, S. (2003). Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

Mascarenhas A.F., (1991). Hand book of Plant Tissue Culture. Indian Council of Agricultural Research. New Delhi.

Slater, A., Scott, N., Fowler, M. (2004). Plant Biotechnology. Oxford University Press, Oxford. Rashid, A. (2009). Molecular physiology and Biotechnology of Flowering plants. Narosa Publishing House Pvt. Ltd., New Delhi.

Usha, K., Malik, A., Kamaluddin (2020). Transgenic technology based value addition in plant biotechnology. 1st Edition., Elsevier Publ.

Prasad, B. D., Sahni, S., Kumar, P., Siddiqui, W. (Eds.) (2021). Plant Biotechnology Vol. 1, Apple Academic Press.

Related Online Contents:

E-Books:

1. https://books.google.co.in/books/about/Introduction_to_Plant_Biotechnology.html?id=RgQLISN8zT8C&redir_esc=y
2. https://onlinelibrary.wiley.com/doi/abs/10.1002/jobm.3620250714

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SEMESTER - II

CORE PRACTICAL III: PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY; TAXONOMY OF ANGIOSPERMS / PLANT SYSTEMATICS; PLANT BIOTECHNOLOGY

Course Code	22PGBOTCC205	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40		-	4		
Pre-requisite	Basic knowledge of angiosperms and plant biotechnology								

Course Objectives:

- To understand the micro slide preparation and study of fossil plants
- To learn about the type of inflorescence
- To identify plants at the species level
- To gain knowledge on herbarium preparation
- To understand the different medium and molecular techniques

Expected Course Outcomes:

On the completion of the course, the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Demonstrate practical skills of Pteridophytes and gymnosperms and understand the importance of fossil	K2&K1
CO2	1. Understand the different floral characteristics and prepare the artificial key	K3
CO3	Describe the species plant at the species and family level	K3&K4
CO4	Understand the significance of herbarium	K5&K3
CO5	Know the importance of medium and their role in tissue culture and understand the molecular techniques	K5&K3
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Experiments

Sectioning and micro slide preparation of the following:

- **Pteridophytes** - *Psilotum, Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Marattia, Angiopteris* and *Azolla*
- **Gymnosperms** - *Cycas, Pinus, Ginkgoa, Ephedra, Welwitchia* and *Gnetum*
- **Paleobotany** - Fossil plants slides- *Rhynia, Calamites, Pentaxylon* and *Glossopteris*.
- **Taxonomy**: Identification of specimens belonging to the families included in theory syllabus at family, generic and species level.
- Preparation of dichotomous artificial keys using locally available plants.

- Identification of families studied based on flowers or essential parts of the flowers
- Submission of 25 herbarium sheets during practical examination.

Plant Systematics

- Leaf shapes
- Inflorescence types
- Preparation of keys
- Systematic studies for the families (Families in theory)
- Description and identification at family, genus and species levels using Floras.
- Preparation of herbarium specimens (one each) for the families (Families in theory).

Plant biotechnology

- Preparation of MS and Modified White's Medium.
- Callus culture.
- Meristem Culture.
- Preparation of Nitsch Medium.
- Anther Culture.
- Isolation of Protoplast from leaves (mechanical method) Molecular Techniques
- Extraction and separation of plant DNA by agarose gel electrophoresis.

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SEMESTER - II

Core Elective I: Basic Microbial and Immunotechnology

Course Code	22BOTEC201	Course Type	Core	L	T	P	Credit	Syllabus version	2022-2023
				3	2	-	4		
Pre-requisite	Isolation methods of Microbes from various sources								

Course Objectives:

- Explore the history of Microorganism discovery
- Understand the principles of Microscopy
- Understand the Isolation and identification of microorganism
- Enumerate the nutritional requirements and factors affecting the growth of microorganisms
- Educate the students about the sterilization principle and the action of antimicrobial drugs
- Emphasize the importance of Immune system and salient features of antigen, antibody and their interactions
- Illustrate the principles in techniques involved in qualitative and quantitative analysis of antibody, antigen and antigen-antibody complex

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Summarize the principle of microscopy and its types; compare various staining methods used to stain microbes	K1
CO2	Relate the basic isolation procedure of microbes from various sources; Compare the growth pattern and factors affecting the growth of microorganisms	K2, K3
CO3	Understand various sterilization methods and Media preparation; Understand the role of antimicrobial drugs.	K3
CO4	Determine the basic Immune reactions	K4, K5
CO5	Emphasize the techniques to quantify the antigen, antibody interactions.	K6

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **MICROSCOPY** **8 Lectures**	Discovery of Microorganism with reference to Antony van Leeuwenhoek, Louis Pasteur, Robert Koch; Microscopy – Light, Dark field, Phase contrast, Fluorescence Microscopy, Confocal Microscopy; Simple staining, Differential staining (Gram's staining, Acid-fast staining). Bacteria – Shape, size and arrangement; Bacterial cell wall structure, Cell envelope (capsule, slime layer, biofilm); Bacterial ribosomes, Nucleoid, Plasmids, Virus- virion structure, virus multiplication
Unit II **MICROBIAL GROWTH** **7 Lectures**	Microbial growth, Bacterial cell cycle, growth curve, Factors on growth (pH, Temperature, oxygen), Measurement of microbial population (Direct measurement, viable count, measurement of cell mass), Culture media (Synthetic, Complex), functional types of media (selective, enriched, differential)
Unit III **STERILIZATION** **8 Lectures**	Microbial control – sterilization (disinfection, sanitization, antisepsis), Mechanical removal (Membrane filters – filtration, HEPA filter), Physical control – Autoclave and radiation, Chemical control – Phenols, Alcohols and halogens, Isolation of pure culture, Serial dilution, streak plate, spread and pour plate, Determining antimicrobial activity - disk diffusion, dilution test, Antibacterial drugs- Cell wall synthesis inhibitor any two, Protein synthesis inhibitor any two, metabolic antagonist any two, nucleic acid synthesis inhibitor –one, Antifungal drugs, Antiviral drugs.
Unit IV **IMMUNOLOGY** **7 Lectures**	Antigen, Antibody, Epitope, Basic structure of antibody, antibody binding site, antibody classes and biological activities, Antigenic determinants on immunoglobulins, polyclonal antibody production, monoclonal antibody production.
Unit V **IMMUNOTECHNIQUES** **10 Lectures**	Antigen-Antibody interactions, precipitation, agglutination, radioimmunoassay, ELISA, Western blotting, Immunofluorescence, Flow cytometry.

Current Contour	Recent investigations on microbial pathogenesis in plants and its interactions - knowledge on plant vaccines
Total Lectures – 40	

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1	1	3	3	1	3	3	1	2	3	
CO2	3	2	2	2	3	2	1	3	2	
CO3	3	3	3	2	2	2	2	2	2	
CO4	2	1	3	3	2	3	3	2	3	
CO5	3	3	3	3	3	2	3	3	3	
1 – Basic level, 2 – Intermediate level; 3 – Advance level										

Recommended References:

1. Prescott's Microbiology. 2020 (11th Ed.) J. Willey & K. Sandman (Eds). McGraw Hill Pub.
2. Kuby Immunology (8th Ed.) 2019. Punt et al (Eds.) W. H. Freeman Publ.
3. Microbiology and Immunology (3rd Ed.) 2016. S.C. Parija (Eds) Elsevier.

Related Online Contents:

1. https://go.openathens.net/redirector/tulane.edu?url=https://accessmedicine.mhmedical.com/Book.aspx?bookid=3123
2. http://www.malecentrum.sk/data/att/166377.pdf
3. https://www.technologynetworks.com/immunology/ebooks
4. **http://repository.poltekkeskaltim.ac.id/1154/1/Microbiology%20and%20Immunology%20Textbook%20of%202nd%20Edition%20%28%20PDFDrive%20%29.pdf**

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SEMESTER - II

CORE ELECTIVE II: PHYTOCHEMISTRY

Course Code	22PGBOTEC202	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40		-	4		
Pre-requisite	Know the modern extraction techniques, characterization and identification of the herbal drugs and phytoconstituents								

Course Objectives:

- To learn about the various types of chromatographic techniques.
- To carryout isolation and identification of phytoconstituents.
- To know phenol, flavonoid and terpenoid compounds.
- To understand the herbal drug interactions
- To understand the preparation and development of herbal formulation.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Explain a method for separation the biologically active principles from their extract.	**K4**
CO2	Acquire knowledge about the various spectroscopic methods applied in phytochemistry.	**K1 & K2**
CO3	Give an account on the chemistry, biological activity of carbohydrates, glycosides, tannins, bitter principles.	**K3 & K6**
CO4	Application of latest techniques for analysis of phytoconstituents	**K4**
CO5	Learn about the various types of medicinal plants.	**K2 &K1**
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **ISOLATION TECHNIQUES**	Introduction, Scope of Phytochemistry; Solvents Polar and Non polar, Extraction methods (Cold and hot), liquid-liquid extraction techniques, liquid-carbon dioxide extraction, concentration and evaporation techniques. Chromatography - Adsorption and Column chromatography - Paper chromatography – Thin layer chromatography, Gas chromatography& Mass Spectroscopy (GC-MS) - 2D GC-MS, Affinity chromatography - Ion exchange chromatography -Gel filtration chromatography.
Lectures	10 hrs.

Unit II **NATURAL PRODUCTS** **Lectures**	Natural products – Importance – phytochemicals – classifications - diversity of structures-preliminary phytochemicals screenings-bioassay-in Vitro and in vivo studies-antimicrobial activity-pharmacological studies like anti-inflammatory 9 hrs.
Unit III **SECONDARY METABOLITES** **Lectures**	**Phenolic compounds**- Introduction, phenol, and phenolic acids, phenylpropanoids, Flavonoid pigments, Anthocyanins, Flavonol, and flavones, Minor flavonoids xanthones, and stilbenes, Tannins and quinone pigments. **Terpenoids** - Introduction – Essential oil, Diterpenoids and gibberellins, triterpenoids and steroids, carotenoids. 8 hrs.
Unit IV **NITROGEN COMPOUNDS** **Lectures**	Introduction, Amino acids, amines. Alkaloids – Chemistry and distribution, Detection& isolation, Cyanogenic glycosides, Indoles, Purines, pyrimidines, Cytokinins, Chlorophylls. 6 hrs.
Unit V **HALLUCINATING DRUGS** **Lectures**	Introduction (definition of hallucinations, types, and stages of hallucination)-Psychoactive plants: stimulants (cocaine, caffeine), Hallucinogens (Marijauana, LSD), depressants (opium), tobacco, ergot, Khat, nutmeg, *Datura stramonium* Anticancer drugs-Introduction (definition, classification of drugs, cytostatics) -Anticancer plants: *Peganum harmala* (harmine, harmaline) *Catharanthus roseus* (vincristine, vinblastine), *Colchicum autumnale* (colchicines), *Taxus brevifolia* (taxol), *Podophyllum* resin (podophyllotoxin, etoposide). 7 hrs.
Current Contour	Current developments related to the phytochemistry during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures –	40 hrs.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	3	3	3	2	3	3	3
CO2	3	3	2	3	3	2	3	2	3
CO3	2	3	3	3	2	3	3	3	3
CO4	1	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcome

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	3	3	3	3	3	3
CO2	2	2	2	2	3	2	3	3	2
CO3	2	3	3	1	2	3	3	3	3
CO4	2	2	3	3	2	2	3	3	2
CO5	3	3	3	3	3	3	3	3	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Cordell, G.A. (2006). The alkaloids: Chemistry and Biology (1st Ed.) Elsevier, New York.
2. Gurdeep, C. (1980). Organic chemistry of natural products. 1. Himalaya Publishing house.
3. Harborne, J. B. (1998). Phytochemical methods–a guide to modern techniques of plant analysis 5th edition, Chapman and Hall, London.
4. Jarald E.E. and Jarald S. E. (2009). Textbook of Pharmacognosy and Phytochemistry. CBS Publishers & Distributors, New Delhi
5. Kalsi, P. S. and Jagtap, S., (2012). Pharmaceutical medicinal and natural product chemistry.N.K.Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
6. Karaway M.S. (1988). Column Chromatography, Gas Chromatography and Liquid Chromatography" 1st ed.Pharmacognosy Dept., Faculty of Pharmacy, Cairo University.
7. Mills S., Bone K., Corrigan D., Duke J.A. and Wright J.V. (2000). Principles and Practice of Phytotherapy: Modern Herbal Medicine. Churchill Living Stone, Edinburgh; New York.
8. Mohammad, A. (2009) Pharmacognosy, Volumes 1 & 2 CBS Publishers & Distributors Pvt. Ltd., New Delhi
9. Yesodha, D., Geetha, S and Radhakrishnan, V. (1997). Allied Biochemistry. Morgan Publications, Chennai.
10. Phytochemistry Vol. 1. (Ed.) Egbuna et l., (2019). Apple Academic Press.

Related Online Contents:

1. https://www.sapnaonline.com/books/natural-products-chemistry-applications-sujata-v-8173198241-9788173198243
2. https://www.abebooks.com/book-search/title/natural-products-chemistry-applications/author/bhat/
3. https://www.organic-chemistry.org/books/reviews/3540406697.shtm
4. https://www.amazon.com/Natural-Products-Applications-Sujata-Bhat/dp/354076383X

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SEMESTER – III

CORE THEORY X: PLANT PHYSIOLOGY AND BIOCHEMISTRTY

Course Code	22PGBOTCC301	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				5		-	5		
Pre-requisite	Physiological processes of Plants and Importance of Biomolecules								

Course Objectives:

- To learn the underlying principles of the various physiological processes of plants
- To describe the photosynthesis and respiration pathways
- Differentiation of plant growth hormones, plant growth retardants and phytochromes
- To understand the secondary metabolites and plant defense
- Study the of role and Important Biomolecules

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Evaluate the water relationship in plants	K1
CO2	Know about photosynthesis and respiration in plants.	K1 & K3
CO3	Insight on plant growth hormones and phytochromes	K2
CO4	Secondary metabolites and Stress physiology	K3 & K5
CO5	Know the importance and applications of Biomolecules	K2

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **Relationship of Water to the Plants** **Lectures** **8 Hours**	Physical properties of water (Diffusion & osmosis). *Components of Water potential - their inter relationships, Absorption of water and Ascent of Sap, Apoplast and symplast: mechanism - transport of water in the plant, pathway and mechanism - Soil Plant Air Continuum (SPAC). Transpiration: Stomatal movement and Antitranspirants. Inorganic nutrients: ion uptake - mechanism of ion uptake - passive and active, factors controlling availability of ions in the soil - Donnan's equilibrium, ion transport across the membrane - membrane transport proteins, symport and antiport, ion pumps.

Unit II **Carbon and Nitrogen metabolism** **Lectures** **12 Hours**	**Photosynthesis:** Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO_2 fixation – C_3, C_4, and CAM pathways. **Respiration and photorespiration:** Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. **Nitrogen Metabolism:** sources of nitrogen, molecular nitrogen- inorganic nitrogen-organic nitrogen, Conversion of nitrate into ammonia. Biological nitrogen fixation - Non symbiotic and symbiotic- reductive amination and Transamination
Unit III **Plant Growth Regulators and Phytochromes** **Lectures** **6 Hours**	**Plant Growth Regulators:** Auxins, Gibberellins, Cytokinins, Abscisic acid and ethylene and Brassionosteroids- their physiological effects and mode of action. Senescence and aging. **Phytochromes:** structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks
Unit IV **Plant Defense Metabolites and Stress Physiology** **Lectures** **8 Hours**	**Plant Defense Metabolites:** Terpenes- phenolic compounds -nitrogen containing compounds. Response of Plant to stresses – Biotic stress-induced plant defenses against insect herbivores and pathogen. **Stress Physiology:** Abiotic- water deficit, salinity stress - heat stress - heat shock - chilling and freezing oxidative stress – mechanism of tolerance and resistance
Unit V **Role of Biomolecules** **Lectures** **8 Hours**	**Classification and structure:** Carbohydrates**, Lipids** – structure & function of fatty acid and glycerol, Biosynthesis and oxidation of fatty acids. **Amino acids & Proteins** -chemical and physical properties of amino acids, Peptides – a structure of polypeptides primary, secondary, tertiary, and quaternary-protein structure. **Enzymes** - classification, mode of action, Km value, coenzymes, isoenzymes. Structure and functions of sterols and steroids. **Nucleic acids:** Biosynthesis of Nucleic acids
Unit –VI **Current Contour**	**(For Continuous Internal Assessment only, Not for examinations):** Current developments related to the plant physiology and biochemistry during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on. ***Blended Learning, #Flip Learning**
Total Lectures -	**42 Hours**

Mapping Program Outcomes with Course Outcome

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	3	2	2	2	3	3
CO2	3	2	1	3	2	2	1	2	1
CO3	3	2	2	1	3	3	2	2	3
CO4	2	3	2	2	1	3	2	2	2
CO5	3	2	3	3	2	1	3	2	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

Cos	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	2	1	3	1	2	1	2	2	1
CO2	3	3	3	2	3	2	1	3	2
CO3	2	2	3	2	2	3	2	2	1
CO4	2	3	2	3	3	2	1	2	2
CO5	3	3	3	2	2	1	3	2	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

Plant Physiology

Devlin, R. M. (1969). Plant Physiology. Van Nostrand, Reinhold Co., New York.

Fang, F. K. (1982). Light Reaction Path of Photosynthesis. 35. Molecular Biology, Biochemistry and Biophysics. Springer Verlag, Berlin.

Jain, V. K. (2007). Fundamentals of Plant Physiology. S. Chand & Co., New Delhi.

Leopold, A. C. (1973). Plant Growth and Development. Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Meyer, Anderson and Bonning (1965). Introduction to Plant Physiology

Palmer, J. M. (1984). The Physiology and Biochemistry of Plant Respiration. Cambridge University Press, London.

Salisbury, F. B. and Ross, E. (2005). Plant Physiology. III Ed. Wadsworth, Belmont, California, USA.

Tiaz. L., E. Zeiger, I. M. Meller, A. Murphy. (2018). Fundamentals of plant physiology, Sinauer Assoc. Ins., USA.

Van Nostrand D.. Noggle, R. and Fritz, G. I. (1989). Introductory Plant Physiology (2nd ed.). Prentice Hall, New Delhi. 49

William G. Hopkins & N. P. A. Hunner. (2008). Introduction to plant physiology (4th Ed.). J. Wiley & Sons Inc.

Plant Biochemistry

Goodwin, F. W. and Mercer, F. I. (1983). Introduction to Plant Biochemistry (2nd ed.) Pergamon Press, New York.

Lehinger, A. L. *et al.* (1993). Principles of Biochemistry. CBS Publishers, New Delhi. Stryer, L. (1995). Biochemistry (4thed.). W. H. Freeman Co., New York.

Nelson D.L, M. M. Cox (2021) Leninger Principles of Biochemistry: International Edition (8th Ed.) W. H. Freeman & Co., USA.

Related Online Contents:

E-Books:

1. http://www.esalq.usp.br/lepse/imgs/conteudo_thumb/mini/Principles-of-Biochemistry-by-ALbert-Leningher.pdf
2. https://www.cabdirect.org/cabdirect/abstract/19850773295
3. https://employees.csbsju.edu/ssaupe/biol327/references.htm

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SEMESTER - III

CORE THEORY XI : MOLECULAR PLANT PATHOLOGY

Course Code	22PGBOTCC302	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				5	-	-	5		
Pre-requisite	Molecular approaches on Plant Pathogens and Diseases								

Course Objectives:

- To acquire knowledge on Plant pathogens and their Enzymes
- Sterilization and staining of Plant pathogens
- to know the Molecular Interactions between Host and Pathogens
- To understand the Microbial diseases in crop plants and its control measures
- Identifying Plant pathogens with recent techniques

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Know the general account of plant diseases	K1&K4
CO2	Distinguish the various techniques of sterilization and staining	K2 &K3
CO3	Understand the Molecular mechanism of plant pathogens on Host plants	K1 &K 6
CO4	Assess the symptomatology of various diseases	K1
CO5	Understand molecular diagnostics of plant pathogens.	K3 & K5

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **History and Epidemiology** **Lectures 8 Hours**	History of Plant pathology, General account of diseases caused by plant pathogens, Biotic and abiotic factors of plant diseases, Plant disease epidemiology, Dispersal of plant pathogens (Direct, Indirect, Biological transmission), Pathogenesis - (direct entry through wounds, root hairs, stomata), Enzymes (Pectinase, cellulase, hemicellulase, protease, Lipase) and Toxins (Fusaric acid, Phytoalexin and Cercosporin) in plant diseases.

Unit II **Sterilization and Staining techniques** **Lectures** **8 Hours**	Sterilization techniques (Dry, wet, and filter sterilization); Culture media - types and preparation - pure culture and subculture methods; dilution technique; Culture maintenance and preservation. Microbiological stains and staining method - for bacteria & fungi; Growth measurement of bacteria and fungi; Nutritional requirements, Physical and Chemical Factors.
Unit III **Host- Pathogen Interactions** **Lectures** **6 Hours**	Isolation and identification of plant pathogens (morphological and molecular - ITS), Culture maintenance and preservation; *Host pathogen interaction, Defense mechanism - Morphological, structural, biochemical (HR response, PR proteins), molecular aspects (PR genes) - Role of elicitors in disease resistance, Induced disease resistance, *Receptors and signal transduction.
Unit IV **Plant Diseases** **Lectures** **8 Hours**	Symptometology, Diseases in agriculture and Diseases caused by Fungi #(Blast disease of rice, Tikka disease and rust disease of groundnut, powdery mildew of sunflower, Cotton wilt), Oomycetes (Rhizome rot disease of turmeric/zinger), Bacteria (Citrus canker, Blight disease of Paddy), Nematode (root knot of tomato), Virus (Cassava mosaic virus, Cucumber mosaic virus). Plant diseases caused by parasitic green algae - *Cephaleuros*.
Unit V **Disease Diagnosis and Management** **Lectures** **10 Hours**	Molecular diagnosis of plant pathogens (Western blot analysis, PCR analysis, LAMP analysis, Imaging Technology). Plant disease management - chemical and biological, Elicitors, Development of Transgenic -abiotic and biotic stress (cold tolerant, drought tolerant, PR gene), Breeding for disease resistance.
Unit VI **Current Contour**	**Current Contours: (For Continuous Internal Assessment only, Not for examinations):** Current developments related to the molecular plant pathology during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on . ***Blended Learning, #Flip Learning**
Total Lectures –	**40 Hours**

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	1	2	2	2	3	2	2
CO2	3	3	2	2	3	2	1	2	1
CO3	3	2	2	2	3	1	1	3	2
CO4	2	2	1	2	2	1	2	3	3
CO5	3	3	2	2	3	3	1	2	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	2	3	3	3	2	3	1	1	3
CO2	3	2	3	2	3	2	2	2	3
CO3	3	3	3	3	2	2	2	3	2
CO4	1	2	3	3	3	3	2	3	2
CO5	2	2	3	2	3	1	2	3	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

Agrios. G. (2004). Plant Pathology (5th Ed.) Elsevier Publ..

Dickinson, M. (2003). Molecular Plant Pathology. Garland Science Pub.

Fritig B. M. Legrand. (Eds), (2012). Mechanisms of plant defense responses. Springer Publ. India

Mehrotra, R.S. and Ashoka A. (2003). Plant Pathology. Tata McGraw Hill Publication.

Rangasami, G. (1972). Diseases of Crop Plants in India, Prentice Hall India (Private) Ltd.,New Delhi.

Smith, K.M. (1968). Viruses, Cambridge University Press, London.

Related Online Contents:

E-Books:

1. https://www.crcpress.com/Molecular-Plant-Pathology/Dickinson Beynon/p/book/9780849305108

2. http://www.scientificpub.com/book-details/Physiological-and-Molecular-Plant Pathology-866.html

3. http://www.garlandscience.com/product/isbn/9781859960448

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SEMESTER - III

CORE THEORY XII : ECOLOGY AND PHYTOGEOGRAPHY

Course Code	22PGBOTCC303	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs.			5		
Pre-requisite	To comprehend the ideas of phytogeography, ecology, and the significance of plant biodiversity.								

Course Objectives:

- To acquire knowledge on autecological concept-population ecology.
- To know more about synecological concept-community ecology.
- To elaborate the dynamic ecology-ecological succession
- To prioritize the principle & concept of phytogeography.
- To apply the knowledge about plant biodiversity and its importance.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Learnt more about the autecological concept.	**K1 & K2**
CO2	Understood the synecological concepts.	**K3 & K4**
CO3	Description of the succession of ecology.	**K3 & K6**
CO4	Proper application of the principles of phytogeography	**K4 & K5**
CO5	Accumulation of the knowledge on plant biodiversity and its importance	**K5 & K6**

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **AUTECOLOGICAL CONCEPTS - POPULATION ECOLOGY**	Characteristics of populations - size and density, *dispersion, age structure, natality and mortality. Survivorship Curves, Life Table, Age Structure. Concept of Carrying Capacity and Environmental Resistance. Ecological consequence of overpopulations. Genecology - ecological amplitude, ecads, ecotypes, ecospecies, coeno species, k-selection and selection populations.
Lectures	7 hrs.

Unit II **SYNECOLOGICAL CONCEPTS - COMMUNITY ECOLOGY** **Lectures**	Ecological processes of community formation, ecotone and edge effect. #Classification of communities -criteria of classification, dynamic system of classification by Clement. Concept of Community and Basic Terms. Community Structure, Composition and Stratification. Dynamic community characteristics - cyclic replacement changes and cyclic no-replacement change 8 hrs.
Unit III **DYNAMIC ECOLOGY - ECOLOGICAL SUCCESSION** **Lectures**	The concept, definition and reasons of succession. Classification of succession: Changes – autogenic and allogenic, primary and * secondary, autotrophic and heterotrophic. Concept of climax or stable communities, resilience of communities, ecological balance and survival thresholds. Biosphere and Ecosystem: Significance of habitat, biodiversity, ecological niche, trophic level, primary and secondary productivity, food chains, food webs, ecological pyramids, energy flow and nutrient cycles, Climate change impact on plants and microbes. 9 hrs.
Unit IV **PHYTOGEOGRAPHY** **Lectures**	#Definition, principles governing plant distribution, factors affecting plant distribution, theories of distribution, different types of distribution of vegetations on the earth, continuous and discontinuous distribution, Plant environment interaction. 9 hrs.
Unit V **PLANT BIODIVERSITY AND ITS IMPORTANCE** **Lectures**	Plant Biodiversity and its importance: #Definition, levels of biodiversity – genetic, species and ecosystem. Biodiversity hotspots – criteria, biodiversity hotspots in India. Loss of biodiversity – causes and conservation * (In situ and ex situ methods). Seed banks – conservation of genetic resources and their importance. 7 hrs.
Current Contour	Current developments related to the ecology, phytogeography and evolution during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures –	40 hrs.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	1	2	1	2	3
CO2	3	2	2	1	1	3	2	3	3
CO3	3	3	3	3	2	3	2	3	2
CO4	3	3	2	3	3	3	3	1	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	2	3	2	2	2	3	2	3
CO2	2	3	3	3	2	1	3	2	2
CO3	3	2	2	3	3	3	3	3	3
CO4	2	1	3	3	3	2	3	2	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

1. Clarke, G.L. (1954). Elements of Ecology. John Wiley Pub.
2. Dash, M.C. (1993). Fundamentals of Ecology. Tata McGraw Hill.
3. Jones H G, Vaugham R A. (2010). Remote sensing of vegetation. Oxford university press.
4. Kormondy E J (Ed) (1999). Concept of ecology. Prentice Hall.

Related Online Contents:

1. https://www.crcpress.com/Functional-Plant-Ecology-Second-Edition/Pugnaire Valladares/p/book/9780849374883.
2. https://www.bookdepository.com/category/1626/Plant-Ecology.
3. http://www.esalq.usp.br/lepse/imgs/conteudo_thumb/Plant-Ecology-by-Ernst-Detlef-Schulze- -2005-.pd.

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SEMESTER - III

CORE THEORY XIII : GENERAL ECOLOGY

Course Code	22PGBOTCC304	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs.		-	5		
Pre-requisite	The students should have adequate understanding of ecology and its interaction with plant and species community								

Course Objectives:

- To be aware of the history and scope of ecology.
- To gather information on plant community & population characters, growth curves, regulation & history.
- To comprehend the levels of organization and the fundamental and practical components of environmental botany.
- To get understanding of different types of ecosystems.
- To comprehend the effect of pollution and its effect.
- To be knowledgeable of the factors affecting plant distribution.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Understand the idea of auto ecology.	**K1 & K2**
CO2	Evaluate the ecology of communities and species interactions.	**K2 & K3**
CO3	Explain the ecosystem's composition and purpose in brief.	**K1 & K6**
CO4	Recognize the ecology of the community and popularity.	**K4 & K5**
CO5	Describe the fundamentals of phytogeography.	**K1 & K5**
CO6	Examine the ecological succession in comparison.	**K4 & K6**
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **ECOLOGY HISTORY & SCOPE**	*History and scope of Ecology, Concept and function of ecosystem, Ecological factors, Edaphic, climatic, Topographic, biotic and abiotic factors, Habitat and niche, Energy flow in Ecosystems. Water: importance of water in distribution of plants, Adaptation of plants, Energetics, productivity, Food chain, food web, trophic levels, ecological pyramids.
Lectures	9 hrs

Unit II **PLANT COMMUNITY** **Lectures**	* Plant community, quadrants, transects abundance, density cover, ecotone, community, species diversity and dominance, community dynamics, Ecological life cycle, Regulation of Population ecology. study of different population - Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection). 8 hrs.
Unit III **SPECIES INTERACTION** **Lectures**	Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis; #Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones; Ecological succession: Types; mechanisms; changes involved in succession; concept of climax. 9 hrs.
Unit IV **ECOSYSTEM** **Lectures**	*Ecosystem: Structure and function; energy flow and mineral cycling (CNP); Primary production and productivity. and decomposition; # structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). * Environmental pollution; global environmental change. 7 hrs.
Unit V **BIOGEOGRAPHY** **Lectures**	Principles and importance of plant geography, phytogeographic regions of India, and patterns of distribution, continental drift hypothesis, endemism. #Biogeography: Major terrestrial biomes; theory of island biogeography. 7 hrs.
Current Contour	Current developments related to the general ecology during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures –	40 hrs.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	3	2	1	2	2
CO2	3	2	2	2	1	3	2	3	3
CO3	2	1	3	3	2	3	2	3	2
CO4	3	3	1	3	3	2	3	2	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	2	2	3	2	2	3	2	3
CO2	2	3	2	3	2	2	3	2	2
CO3	3	2	3	3	3	2	3	3	3
CO4	2	2	3	2	3	2	3	3	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

1. Clarke, G.L. (1954).Elements of Ecology. John Wiley Pub.
2. Dash, M.C. (1993). Fundamentals of Ecology. Tata McGraw Hill.
3. Jones, H.G., Vaugham R A. (2010). Remote sensing of vegetation. Oxford university press. Kormondy, E.J. (Ed) (1965). Reading in ecology. Prentice Hall.
4. Kormondy E J (Ed) (1999). Concept of ecology. Prentice Hall.

Related Online Contents:

1. https://www.crcpress.com/Functional-Plant-Ecology-Second-Edition/Pugnaire Valladares/p/book/
2. https://www.bookdepository.com/category/1626/Plant-Ecology
3. http://www.esalq.usp.br/lepse/imgs/conteudo_thumb/Plant-Ecology-by-Ernst-DetlefSchulze--2005-.pdf

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SEMESTER - III

CORE PRACTICAL IV: PLANT PHYSIOLOGY AND BIOCHEMISTRY; MOLECULAR PLANT PATHOLOGY; ECOLOGY AND PHYTOGEOGRAPHY/GENERAL ECOLOGY

Course Code	22PGBOTCC305	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				-	-	20 hrs.	4		
Pre-requisite	The students should be acquainted with the methods used in the relevant studies and have some experience using the basic lab equipment.								

Course Objectives:

- To understand the importance of nutrients in medium preparation.
- To gain knowledge on PR proteins.
- To gain knowledge on protein and DNA separation.
- To know about the principles of protein estimation.
- To state the extraction and estimation of lipid

Expected Course Outcomes:

On the completion of the course the student will be able to

Cos	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Know about the plant diseases and their control measures.	**K1, 2**
CO2	Identify the Plant pathogens by morphological and molecular methods	**K2, K3 & K4**
CO3	Understand the pigment separation.	**K4 & K5**
	Understand the autoecological concept and plant succession.	**K4**
CO4	Acknowledge the idea of autoecology and plant succession.	**K4 & K5**
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Ecology and phytogeography	• Study of vegetation by quadrat method and line transect method • Determination of dissolved oxygen in water sample by winkler's method • Primary production • Examination of stomata index on high temperature plants.

	• Estimation of carbonate • Estimation of total organic carbon content • Ecological instruments and their working.
Phytogeography	• Tropical vegetation • Temperate vegetation • Polar Vegetation • Botanical regions of India
Plant Physiology	• Determination of water potential in different tissues. • Determination of chlorophyll-a, chlorophyll-b and total chlorophyll by the Arnon's method. • Determination of carotenoids. • Estimation of protein by Lowry's method. • *Estimation of total phenols. • Hill reaction – demonstration
Biochemistry	• Extraction and estimation of lipid • Determination of reducing sugars in (grapes) fruit • *Estimation of amino acids by ninhydrin
Molecular Plant pathology	• Cleaning and sterilization methods (Laminar Air Flow Chamber, autoclave and Oven) • Preparation of culture Media, agar slant - agar plate. • Isolation of microbes by streak and pour plate method. • Isolation of Bacteria and Fungi from infected plants. • Simple staining of bacteria (Methylene blue/crystal violet) • Staining of fungi (Cotton blue) • Identification of plant pathogens – morphological • DNA isolation from Fungi • ITS amplification • Enzyme (cellulase) localization on PAGE • Plant disease (paddy blast, wilt of tomato) • Lignification • Isolation of PR protein and qualitative assay

	• Western blot/dot blot analysis **Spotters** • Commensalism • Mutualism • Predation • Raunkiaer's life forms • Parasitism • Xerophytes • Halophytes • Hydrophytes • Air pollution • Green House effect.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	3	2	1	2	2
CO2	3	2	2	2	1	3	2	3	3
CO3	2	1	3	3	2	3	2	3	2
CO4	3	3	1	3	3	2	3	2	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	2	2	3	3	3	3	2	3
CO2	2	3	2	3	2	2	3	2	2
CO3	3	2	2	3	3	3	2	3	3
CO4	2	2	3	2	3	2	3	3	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

SEMESTER - III

CORE ELECTIVE III: ECONOMIC BOTANY

Course Code	22PGBOTEC301	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs.		-	4		
Pre-requisite	The students should have basic knowledge on various economically important plants.								

Course Objectives:

- To know the origin and history of commercial crops.
- To gain information about the general characters, morphology and importance of cereals, legumes, sugars and starches.
- To identify various spices and drug yielding plants.
- To learn about the oil extraction methods and their applications in various field.
- To engage the students in understanding the natural rubber and timber yielding plants in India.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Understand the Origin of Cultivated Plants	**K1 & K2**
CO2	Obtain information on the cereals, legumes, sugars and starches	**K2 & K4**
CO3	Evaluate the importance of spices and drug yielding plants.	**K3 & K6**
CO4	Learn about the oil extraction process and their uses.	**K1 & K4**
CO5	Understand the economic importance of rubber, timber and fibers.	**K2 & K6**

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I ORIGIN OF CULTIVATED PLANTS	Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov‟s work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops / varieties, importance of germplasm diversity. Vegetables: Nutritional and Commercial values of root crops, leafy and fruit vegetables.
Lectures	9 hrs.

Unit II CEREALS, LEGUMES, SUGARS & STARCHES **Lectures**	(i)Cereals: Brief account of Wheat, Rice and millets. (ii)Legumes: General account, importance to man and ecosystem. (iii)Sugars & Starches: Morphology and processing of sugarcane, products and by products of sugarcane industry. Potato – morphology, propagation & uses. 8 hrs.
Unit III SPICES, DRUG – YIELDING PLANTS **Lectures**	(i)Spices: Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper Beverages: Tea, Coffee (morphology, processing & uses) (ii) Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis. (iii)Tobacco: Tobacco (Morphology, processing, uses and health hazards) 9 hrs.
Unit IV OILS AND FATS **Lectures**	(i)Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and Brassica (Botanical name, family & uses). (ii) Essential Oils: General account, extraction methods, comparison with fatty oils & their uses. 7 hrs.
Unit V NATURAL RUBBER & TIMBER PLANTS **Lectures**	(i)Natural Rubber: Para-rubber: tapping, processing and uses. (ii) Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers, Cotton and Jute (morphology, extraction and uses). 7 hrs.
Current Contour	Current developments related to the Economic Botany during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures –	40 hrs.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	1	2	1	2	3
CO2	3	2	2	2	1	3	2	3	3
CO3	3	1	3	3	2	3	2	3	2
CO4	3	3	1	3	3	3	3	2	3
CO5	3	1	2	2	1	2	3	1	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	2	3	2	2	3	2	3
CO2	2	3	2	3	2	2	3	2	3
CO3	3	2	3	3	3	2	3	3	3
CO4	2	2	3	3	3	2	3	3	3
CO5	2	1	3	3	3	2	3	3	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi,India.
2. Samba Murty and Subrahmanyam (2011). Text Book of Modern Economic Botany, CBS Publishers and Distributors, New Delhi.
3. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
4. Singh, Pandey and Jain (2017). Economic Botany, Rastogi Publication, Meerut.
5. B. P. Pandey (2017) Economic Botany. S. Chand Publication, New Delhi.

Related Online Contents:

5. https://www.kopykitab.com/Herbal-Science
6. https://www.nfsm.gov.in/BriefNote/BN_Jute.pdf
7. https://content.kopykitab.com/ebooks/2014/06/3256/sample/sample_3256.pdf

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SEMESTER - III

CORE ELECTIVE IV: MUSHROOM TECHNOLOGY

Course Code	22PGBOTCC302	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs.		-	4		
Pre-requisite	Students should possess a sufficient understanding of growing mushrooms as well as a foundational understanding of food preparation.								

Course Objectives:

- To impart knowledge about mushroom farming to the students..
- To be knowledgeable of the preparations for culture.
- To comprehend technology used in mushroom growing
- To discover more about how food is stored
- To discover how food is prepared.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Distinguish between poisonous and edible mushrooms.	**K1 & K2**
CO2	Understand the techniques used in mushroom farming.	**K2 & K3**
CO3	Describe the technique used after harvest..	**K4 & K6**
CO4	Acquire specialization about mushroom cultivation at a lower cost..	**K4 & K5**
CO5	Learn how to prepare products with additional value made from mushrooms.	**K1 & K2**
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **Introduction**	* Introduction – history - scope of edible mushroom cultivation - Types of edible mushrooms available in India – Agaricusbisporus, # Plerotus citrinopileatus and Volvariellavolvacea
Lectures	9 hrs

Unit II **Media Preparation** **Lectures**	* Pure culture – preparation of medium (PDA and Oatmeal agar medium) sterilization – preparation of test tube slants to store mother culture – culturing of Pleurotus mycelium on petriplates, preparation of mother spawn in saline bottle and polypropylene bag and their *multiplication. 8 hrs.
Unit III **Mushroom cultivation technology** **Lectures 7hrs**	Cultivation technology: Infrastructure: Sibstates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag, Mushroom bed preparation - paddy straw, sugarcane trash, #maize straw, banana leaves.
Unit IV **Storage** **Lectures**	* Storage and nutrition: Short – term storage (Refrigeration – up to 24 hours) Long term Storage (Canning, pickles, papads), drying, storage in salt solutions. Nutrition – Proteins – amino acids, mineral elements nutrition – *Carbohydrates, Crude fibre content – Vitamins. Diseases of mushroom.. 7 hrs.
Unit V **Food Preparation methods** **Lectures**	Food Preparation: Types of foods prepared from mushroom: Soup, Cutlet, Omelets, Samosa Research Centers – National level and Regional level Cost benefit ratio – Marketing in India and Abroad, # Export Value. 9 hrs.
Current Contour	Current developments related to the Mushroom Technology during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures –	40 hrs.

Mapping Program Outcomes with Course Outcome

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	3	2	1	2	2
CO2	3	2	2	2	1	3	2	3	3
CO3	2	1	3	3	2	3	2	3	2
CO4	3	3	1	3	3	2	3	2	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

Cos	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	2	2	3	2	2	3	2	3
CO2	2	3	2	3	2	2	3	2	2
CO3	3	2	3	3	3	2	3	3	3
CO4	2	2	3	2	3	2	3	3	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

1. Nita Bahl (1984 – 1988). Hand book of Mushrooms, II Edition, I & II. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi
2. Swaminathan, M. (1990). Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No.88, Mysore Road, Bangalore – 560018.
3. Tewari and Pankaj K. (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. T. Lynch (2018). Mushroomcultivation: An illustrated guide to growing your own mushrooms at home. Quarry Books, III Ed.

Related Online Contents

1. https://christuniversity.in/uploads/MUSooks, HROOM%20CULTIVATION%20TECHNIQUE.pdf
2. http://info.dorrancepublishing.com/google-publishing-get-started video?utm_source=google&utm_medium=search&utm_campaign=NB-Top-Alpha-KWBook-Publishing BM&keyword=to%20%2Bpublishing%20%2Bbook&gclid=Cj0KCQjw9LPYBRDSARIsA HL7J5mTW6gcFZGwPvuZmHm0bOaXKtqsbbUfVUor_dlr7u9b_UGnXOqyQOgaAsbEALw_wcB

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Semester IV

CORE – Project Work

Course Code	22PGBOTPW01	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs.		-	4		
Pre-requisite	Able to handle basic laboratory techniques								

Course Outcome:

COs	COURSE OUTCOMES
CO1	Identify a topic based on their interest in advanced areas of Botany, Identify the gaps and define the objectives and scope of the topic
CO2	Review the literature to employ the ideas and develop research Methodology to meet the objectives
CO3	Identify the materials and methods for carry/execute the experiments with a concern for society, environment and ethics
CO4	Analyze and discuss the results to draw conclusions
CO5	Prepare the report and explore the possibility to publish in peer reviewed journals/conference.

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
CO1		3	3		3	3	1	2	3	
CO2	3	2	2	2	3	2		3	2	
CO3	3	3	3	2	2	2	2	2	2	
CO4	2		3	3	2	3	3	2	3	
CO5	3	3	3	3	3	2	3	3	3	
1 – Basic level, 2 – Intermediate level; 3 – Advance level										

Other Courses offered in Department of Botany

Course	Course Title	h/ Weeks Ins.	Credits	Exam hrs.	Marks		Total
					Int.	Ext.	
FIRST SEMESTER							
22PGBOTVAC101	Algal Technology		2				
22PGBOTVAC102	Mushroom Cultivation		2				
22PGBOTSSC101	Economic Potential of Lower Plants		2				
SECOND SEMESTER							
22PGBOTVAC201	Organic farming		2				
22PGBOTVAC202	Nursery gardening		2				
22PGBOTSSC201	History of Science		2				
22PGBOTED201	Biofertilizers	3	2	3	25	75	100
22PGBOTED202	Food Processing and Preservation	3	2	3	25	75	100
THIRD SEMESTER							
22PGBOTVAC301	Terrace gardening		2				
22PGBOTVAC302	Principles of Horticulture		2				
22PGBOTSSC301	Bio Resource Management		2				
22PGBOTED301	Seaweed farming	3	2	3	25	75	100
22PGBOTED302	Herbal cosmetics	3	2	3	25	75	100
FOURTH SEMESTER							
22PGBOTSSC401	IPR & Patenting		2				

VAC- Value added Course; SSC- Self Study Course; ED- Extra Disciplinary Course

SEMESTER – I

Value Added Course

ALGAL TECHNOLOGY

Course Code	22PGBOTVAC101	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				2	-	-	2		
Pre requisite	Cultivation of Marine Algae and the Role in environment								

Course Objectives:

- Understand the role of seaweed in liquid fertilizers
- Understand the importance of algal products for sustainable world.
- Study the multiple techniques involved in algae cultivation.
- Study the cultivation of the macroalgae.
- Know the economic importance of algae

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Understand the applied facet of botany and acquire a complete knowledge about the cultivation methods in Algae.	K1
CO2	To learn more information about Algal genetics	K3
CO3	Understand the preparation of Seaweed liquid fertilizers and their applications in agriculture and horticulture	K7
CO4	To obtain an in-depth knowledge on economic importance of Algae	K2
CO5	Realization of the commercial potential of Algal products	K3 &K6

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation

Unit I **General Principles & Culture of Algae** **Lectures** **4 Hours**	Micro and macroalgae of fresh water and marine habitats-descriptions and taxonomic identification General principles of Culturing Algae in Laboratory and growth measurement. Isolation and Culture of Algae of different forms (single cell, colonial, filamentous and thallus forms). Chemical composition of Culture media for fresh water and marine algae.

Unit II **Cultivation of Micro Algae** **Lectures** **4 Hours**	Photobioreactor Technology in Microalgae Cultivation and their components – Light system, Optical transmission system, Air handling & gas exchange systems, Mixing system, Nutrient system, Instrumentation system and Electrical system. Cultivation of micro algae: Algae for biodiesel, Process, strains, Sources of contamination. Bio-pond – Production in Open Ponds – Harvesting. Principles and methods of Oil Extraction.
Unit III **Seaweed Farming** **Lectures** **4 Hours**	Seaweeds farming – Objectives – Site selection, Installation of test plants and Kinds of test planting. Preparation of the farm site and other culture activities – construction of farm – Line method, Rope & Raft methods, Net method – Floating bamboo method – Mangrove stakes and nets-method. Tying of seedings, Planting, Harvesting, Pre-harvest activities, harvesting procedures and drying. Maintenance of the farm. Marking of seaweeds.
Unit IV **Role of Algae in Environmental Health** **Lectures** **4 Hours**	Role of algae in environmental health - Sewage treatment, treating industrial effluent, Phytoremediation- heavy metal removal, algae as indicators in assessing water quality and pollution; Saprobic index; Monitoring, assessment, restoration and management of coastal and marine ecosystem environment. Algal culture collection centers in India and abroad and their importance.
Unit-V **Uses of Seaweeds** **Lectures** **4 Hours**	Economical uses of seaweeds, Human food, Seaweed Baths, Cosmetics. Seaweed as agricultural fertilizers, Liquid Seaweed Extracts, Seaweed industrial gums: Alginates, Agars, Carrageenans, other polysaccharides and their Medicinal Uses.
Current Contour	Current developments related to the molecular plant pathology during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on . ***Blended Learning, #Flip Learning**
Total Lectures –	20

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	2	2	2	3	3	2
CO2	3	2	2	2	3	3	1	2	1
CO3	2	2	2	3	3	1	2	3	2
CO4	3	2	2	2	2	1	3	3	3
CO5	3	3	3	2	1	3	1	2	2
1 – Basic level; 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	2	3	1	3	2	2	1	1	3
CO2	2	2	3	1	3	2	2	2	3
CO3	3	3	3	3	1	2	2	1	2
CO4	2	2	2	3	3	3	2	3	3
CO5	3	2	3	3	3	1	2	3	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

Text Books.

1. H Stein (1973) Handbook of Phycological methods. Culture methods and growth measurements, Cambridge University Press.
2. Christopher S. Lobban and Michael James Wynne (1981) The Biology of seaweeds, University of California Press

References:

1. David Sieg (2011) Making algae biodiesel at Home.
2. Gavino C. Trono, Jr.(1988) Manual on seaweed culture – FAO Manual
3. Klaus Lüning (1990) Seaweeds: their environment, biogeography and ecophysiology, Wiley-IEEE
4. Clinton J. Dawes (1998) Marine Botany, 2nd ed, John Wiley & Sons, Inc.
5. Jha, B., Reddy, C.R.K., Thakur, M.C., Rao (2009) Seaweeds of India: The Diversity and Distribution of Seaweeds of Gujarat Coast Series: Developments in Applied Phycology, Vol. 3.

Related Online Contents:

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SEMESTER – I

Value Added Course

MUSHROOM CULTIVATION

Course Code	22PGBOTVAC102	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				2	-	-	2		
Pre requisite	Cultivation Practices of Edible Mushrooms								

Course Objectives:

- Attain the Knowledge classifying an Indian Mushrooms.
- Acquire knowledge about construction of Mushroom house.
- Know about various methods of mushroom cultivation.
- Study about culture preparation and cultivation techniques.
- understand the post - harvest technology

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Differentiate an edible and poisonous mushrooms	K2
CO2	Insight a construction of mushroom house.	K1 & K4
CO3	Apply the methods of mushroom cultivation.	K3 & K5
CO4	Understand the isolation and preparation of spawns.	K3
CO5	Explain post-harvest technology	K4

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation

Unit I **Introduction on Mushrooms** **Lectures 4 Hours**	History and classification of *Indian Mushrooms: Edible and Poisonous Mushroom, Mushroom Classification: Based on occurrence, Morphology and edibility and poisonous properties.
Unit II **Mushroom House Construction** **Lectures 4 Hours**	Structure and construction of Mushroom House -Layout of #traditional and green house method. Isolation of spawn, growth media.

Unit III **Methods of Mushroom Cultivation** **Lectures 4 Hours**	Methods of Mushroom cultivation: #Bed Method, Polythene Bag Method, Breeding conditions of mushroom strains: temperate conditions
Unit IV **Culture Preparation and Spawn Cultivation** **Lectures 4 Hours**	Cultivation of Oyster, Button mushroom - Preparation of Pure Culture and spawn cultivation methods and harvesting.
Unit V **Post-Harvest Technology** **Lectures 4 Hours**	Post-harvest technology: #Storage-Freezing, dry Freezing, drying, canning, quality assurance and entrepreneurship.
Current Contour	Current developments related to the mushroom cultivation during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on. ***Blended Learning, #Flip Learning**
Total Lectures – 20	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	3	2	2	2	2	2
CO2	2	3	2	2	2	2	1	3	1
CO3	3	3	2	2	2	1	2	3	2
CO4	2	2	1	2	2	2	2	3	3
CO5	3	3	1	2	3	3	2	2	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	2	3	3	2	2	3	1	2	3
CO2	3	2	3	1	3	2	2	2	2
CO3	3	1	3	3	2	2	2	1	2
CO4	1	2	2	3	3	3	2	3	2
CO5	2	3	3	2	3	2	2	3	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

Chang, T.S. and Hayes, W.A., (1978). The Biology and Cultivation of Edible Mushrooms.Academic Press, New York.

Hand Book of Mushroom Cultivation, (1999). TNAU publications.
Nair, M.C. Gokulapalan C. and Lulu das, (1997). Topics on Mushroom cultivation, Scientific Publishers, Jodhpur, India.
Nita, B. (2002). Hand Book on Mushroom 4th edn. Vijay Primlani for Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
Tripathi, D.P. (2005.) Mushroom Cultivation. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi. T. Lynch. (2018). Mushroom cultivation: An illustrated guide to growing your own mushrooms at Home. Quarry Books, China.

Related Online Contents:

http://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Mushroom.html
http://www.tnuniv.ac.in/report/Botany%20Education%20in%20the%2021st%20Century.Pdf

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SEMESTER – I

Self-Study Course

ECONOMIC POTENTIAL OF LOWER PLANTS

Course Code	22PGBOTSSC101	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				-	-	-	2		
Pre requisite	Acquire knowledge about economic importance of lower plants								

Course Objectives:

- Apply Algal sources to the disciplines
- Know about Lichens.
- Study about Bryophytes.
- Learn the economic importance of Bryophytes.
- Knowledge about Economic importance of Pteridophytes.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Know about importance of algae and their industrial application	K1
CO2	Create awareness about role in environmental pollution of lichens.	K6
CO3	Know about role of antibiotics in disease control in agricultural crops	K3
CO4	Understand economic importance of Bryophytes.	K2
CO5	Gain the knowledge on economic importance of Pteridophytes	K2

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation

Unit I ALGAE	*Role in algae as Fish Culture, reclamation, Sewage Treatment, Origin of Petroleum and Gas production - Limestone Formation - Space Research - Food - Fodder - Fertilizers and Medicine - Industrial Utilization of Algae.
Unit II Lichens	Role in environmental pollution - Food and Fodder - Medicines – Industry - Tanning and dyeing – Cosmetics- perfumes - Brewing - distillation – Minerals extraction.

Unit III Fungi	Role in food and Alcohol, enzyme, organic acids, Gibberellins, Cheese, proteins, vitamins, Industry, Manufacture of Proteins, Vitamins and Antibiotics. Role in disease control in agricultural crops
Unit IV Bryophytes	Economic importance of bryophytes- Peat - Packing Material- Bedding Stock – Composting and Medicines.
Unit V Pteridophytes	Economic importance of Pteridophytes - Ornamental values – Drugs – Foods - *Biofertlizers.
Current Contour	Current developments related to the economic importance of lower plants during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures –	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	2	2	2	1	2	2
CO2	3	2	2	2	2	2	1	2	2
CO3	2	2	2	2	2	1	2	3	2
CO4	2	2	1	3	2	1	2	1	3
CO5	3	2	2	2	3	3	1	2	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	2	3	2	3	2	3	1	2	3
CO2	3	2	3	3	3	2	2	2	2
CO3	3	3	3	3	2	2	2	3	2
CO4	1	2	2	3	3	3	2	3	1
CO5	3	2	3	2	2	1	2	3	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

References:

Afroz Alam . (2015). Textbook of Bryophyta Paperback – Import, Ik International Publishing House Pvt Ltd.

Alexopoulos, (2007). Introductory Mycology, 4th Ed - John Wiley & Sons,

Massee and George (1906). Text book of fungi - London Duckworth.

Rajni G. A (2004). Textbook of Fungi - APH Publishing.

Reddy, S.M. (2001). University Botany I: (Algae, Fungi, Bryophyta and Pteridophyta), Volume 1 New Age International.

Sambamurty, A.V.S.S. (2005). A Textbook of Algae, 1/e ik international publishing house Pvt ltd.

Sambamurty, A.V.S.S. (2006). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, 1/e - ik international publishing house pvt ltd.

Sharma, O. P. (1986). Textbook of Algae -Tata McGraw-Hill Education.

Related Online Contents:

https://www.wiley.com/en-us/Introductory+Mycology%2C+4th+Edition-p-9780471522294
https://books.google.co.in/books/about/University_Botany_I_Algae_Fungi_Bryophyt.html?id=jvr_zSG_KU8C
https://www.ikbooks.com/books/book/life-sciences/botany/a-textbook-bryophytes-pteridophytes-gymnosperms-paleobotany/9788188237456/

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SEMESTER – II

Value Added Course

ORGANIC FARMING

Course Code	22PGBOTVAC201	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				2	-	-	2		
Pre requisite	Create knowledge about organic farming systems.								

Course Objectives:

- Study about Organic farming importance
- knowledge about organic farming systems.
- Know about organic horticulture in quality improvement.
- Understand the nutrient sources for organic horticulture.
- Describe good agricultural practices.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Know about the importance of organic farming.	K1
CO2	Create knowledge about organic farming systems.	K6
CO3	Gain knowledge on indigenous practices of organic farming.	K1
CO4	Discuss the sources of nutrients for organic farming.	K4
CO5	Acquire knowledge on Good agricultural practices	K2

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation

Unit I **Introduction of Organic Farming** **Lectures** **4 Hours**	Principles and objectives of organic farming. Choice of crops and various types of organic farming; merits and demerits. Integrated Farming system, Mixed farming – Soil reclamation – Weed management.

Unit II **Plant Nutrients** **Lectures** **4 Hours**	Plant nutrients – functions of nutrients in plant growth and development of crops – Nutrient uptake and utilization by plants. Role of biofertilizers and impact of chemical fertilizers. Restrictions to nutrient use in organic farming
Unit III **Effective Microorganism Technology** **Lectures** **4 Hours**	EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management. Fundamentals of insect, pest, disease and weed management under organic mode of production; Quality improvement for organic horticulture.
Unit IV **Nutrient Sources** **Lectures** **4 Hours**	Sources of nutrients for Organic agriculture – (a) Organic Manure (FYM / Rural compost, urban compost, oil cakes, Animal waste, vermicompost). (b) Green Manure (Green manure with Leguminous crops in crop rotation). (c) non leguminous Nitrogen contributing plants. (d) Liquid manure.
Unit V **Certification Process** **Lectures** **4 Hours**	Initiatives taken by Central and state Government, NGOs and other organizations for promotion of organic agriculture. GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies. Certification process and standards of organic farming
Current Contour	Current developments related to the Mushroom Technology during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on. ***Blended Learning, #Flip Learning**
Total Lectures – 20	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	2	2	2	2	2	3	2	2
CO2	3	3	2	2	3	2	1	2	2
CO3	2	2	2	2	3	1	2	3	2
CO4	2	2	1	2	3	1	2	2	3
CO5	3	3	2	2	3	3	1	2	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	2	3	3	2	2	3	1	2	3
CO2	3	2	3	1	3	2	1	2	3
CO3	2	3	3	3	2	3	2	3	2
CO4	1	2	2	3	3	3	3	3	2
CO5	2	3	3	2	3	2	2	3	2
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

Claude A, Vandana S, Sultan I, Vijaya L, Korah M & Bernard D. 2000. *The Organic Farming Reader*. Other Indian Press, Goa.

Gaur AC, Neblakantan S & Dargan KS. 1984 *Organic Manures*. ICAR. Lampkin N & Ipswich. 1990. *Organic Farming*. Farming Press. London.

Lampkin NH &Padel S. 1992. *The Economics of Organic Farming – An International Perspective.* CABI.

Palaniappan& Annadurai. 2008. *Organic Farming- Theory and Practise*. Scientific Publ. Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency. New Delhi.

Rao S. 1977. *Soil Microorganism and Plant Growth*. Oxford & IBH.

References:

1. Annadurai, K. and Palaniappan, S.P. (2018). Organic Farming. Scientific Publishers (India).
2. Dubey, R.C. (2005). A Textbook of Biotechnology. S. Chand & Co. Ltd., New Delhi.
3. Juneja, A.C. (2015). Biofertilizers and Organic Farming. Satyam Publishers and Distributors.
4. Mamta Bansal (2018). Basics of Organic Farming. Publishers and Distributors Pvt. Ltd.
5. Natarajan, T. (2010). Organic Farming for Business. Swastik Publication.
6. Reddy, S.R. (2017). Principles of Organic Farming. Kalyani Publishers.
7. Satha , T.V. (2004). Vermiculture & Organic farming. Daya Publishers.
8. Subba Rao, N.S. (2000). Soil Microbiology. Oxford & IBH Publishers, New Delhi.
9. Vayas, S.C., Vayas, S. and Modi, H.A. (1998). Biofertilizers and Organic Farming. AktaPrakashan, Nadiad.
10. Walia, S.S. and Nanwal, R.K. (2018). Principles of Organic Farming. New Delhi Publishing Agency – Nipa.

Related Online Contents:

1.https://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Compilation_techniques_organic_agriculture_rev.pdf

2. https://www.jaivikkheti.in/DMS/Production%20Technology%20of%20Organic%20Inputs.pdf

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SEMESTER – II

Value Added Course

NURSERY GARDENING

Course Code	22PGBOTVAC 202	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Students learn about nursery gardening and how to influence crop yield.								

Course Objectives:

- Acquire understanding of greenhouse maintenance and safety measures.
- To understand plant nutritional needs and watering strategies.
- Knowledge of pest and disease control approaches.
- Investigate soil requirements, irrigation techniques, and plant propagation.
- To understand safety measurements and environmental assessment of nursery gardening.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Acquire knowledge on design, construct and maintain a greenhouse.	K4
CO2	Aware of rooting medium and water quality	K3
CO3	Employ proper nutritional and irrigation techniques for greenhouse cultivation.	K5
CO4	Aware of health and safety issues and checks in greenhouse management	K6
CO5	Solve problems related to horticultural diseases, post-harvest management	K2

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **NURSERY PLANT TYPES**	Types of Nursery Plants: annuals, biennials, perennials, herbaceous, woody perennials and bulbous plants. Identification, classification and growth habits of ornamental trees, shrubs and climbers used for their ornamental value as well as vegetables and fruits.

Unit II **NURSERY OPERATIONS**	Equipment and tools in nursery operations Methods of Propagation of nursery plants, Potting, repotting. Nursery irrigation system. Methods of application of fertilizers, Harvesting, Packing, Storage and Marketing of Nursery Stock.
Unit III **GREEN HOUSE CONSTRUCTION**	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.
Unit IV **MEDIA COMPONENTS**	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.
Unit V **SAFETY MEASUREMENTS**	Health and 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.
Total Lectures – 20	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	3	1	3	3	3	3	2
CO2	3	3	2	3	3	3	3	3	1
CO3	3	1	2	1	3	3	3	1	1
CO4	1	3	1	2	3	3	3	3	1
CO5	3	1	1	1	3	3	3	3	1

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	2	2	3	3	2	1
CO2	3	3	2	3	3	2	3	2	2
CO3	1	2	1	1	1	3	2	1	3
CO4	2	2	2	2	2	2	2	2	2
CO5	1	2	1	1	3	1	3	3	1

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended 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. Singer,C., Holmyard,E.J.,Hall,A.R. and William ,T.I. 1954-1958.The history of Technology.5 vol .,Clarendon press ,Oxford.

Related Online Contents:

1. https://www.fdcm.nic.in/PDF/horticulture%20plant%20nursery.pdf
2. https://www.sciencedirect.com/science/article/abs/pii/B9780128140079000116?via%3Dihub

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SEMESTER – II
Self-study Course

HISTORY OF SCIENCE

Course Code	22PGBOTSSC201	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Students learn about natural science via historical science.								

Course Objectives:

- To develop students scientific thinking skills.
- Discuss the cosmos and Earth.
- Acquire understanding of matter and energy.
- To learn about the agricultural and industrial revolutions
- To understand environment and agricultural revolution.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Create the scientific thoughts and ideas of students.	K1
CO2	Describe about Universe and Earth.	K2
CO3	Acquire knowledge on Matters and Energy.	K4
CO4	Discuss the Human body in health and disease.	K3
CO5	Know about the Agricultural revolution, Industrial revolution	K6

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **HISTORY**	Scientific Thought – History, History of evolution, Methods and scientist: Factor that influenced science through history – #Introduction, Religious dogma, Philosophy, Political Factors, Ethical factors, Industrial Revolution, Other Factors, and the Indian scene.

Unit II **UNIVERSE AND EARTH**	Universe and Earth: our solar system- Development of the basic concept of the solar system, Distance from the earth to the sun, the planet of our solar system-*Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto: Star, Comets, Asteroids, and Universe: Origin of The Universe and solar system - Nebular Hypothesis, The "Big Bang Theory", Steady state Universe Theory.
Unit III **MATTERS AND ENERGY**	Matters and Energy –Introduction, Atoms and elements, Light and heat, Electricity verb, Magnetism, the relationship between (Atoms and elements, Light and heat, Electricity verb, Magnetism) Atomic and Subatomic Particles, Quantum Era And Atomic energy: Life and its secrets – Introduction, Origin of Life, #Evolution of life and living organism, Language of Life.
Unit IV **HUMAN BODY HEALTH AND DISEASE**	Human body health and disease - Introduction, History, Circulation of blood, another aspect of the human body, Digestion and reproduction. Pathology and medicine – Introduction, *Metabolic disease, chemotheraphy, Dietary Disease, and genetic disorders. Pathology in India.
Unit V **ENVIRONMENT**	Environment - Introduction, Hunter-Gatherer stage, Agricultural revolution, Industrial revolution #(global warming, ozone depletion, atomic energy, El Nino Phenomenon, sustainable development & Earth summit and convention on Biological Diversity) *Globalization revolution. Science in relation to technology and Human welfare.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	3	1	3	3	1	2	1
CO2	3	3	1	3	3	2	3	3	2
CO3	2	1	2	1	2	3	3	2	2
CO4	1	3	1	2	3	2	2	3	2
CO5	3	1	1	1	3	3	3	3	1

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	3	3	1	1	3	1
CO2	3	3	3	1	1	3	1	2	3
CO3	1	2	1	1	1	3	3	1	1
CO4	2	2	2	1	2	3	2	2	3
CO5	1	3	3	3	3	3	3	1	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Asimov, I.1989.Asimov‟s Chronology of Science and Discovery.Harper and Row, UK
2. Bose, D. M. Sen, S.N. and subbarayappa,. Atoms and elements, Light and heat, Electricity verb, Magnetism. B.V (Eds.)1971.A.Coinse History of science in India.Indian National Science Academy, New Delhi
3. Bronowski,. 1973.The Ascent of Man BBC and Little Brown & Co.,USA
4. Brown, R.H.1986.The Wisdom of Science. Cambridge Univ. Press, Cambridge.
5. Dampier, W .C.1982.A History of Science (Indian edition)S.Chand & Co Ltd., New Delhi.
6. Lindberg, D.C.1992.The Beginning of Westen science: The European Science Tradition in Philosophical,
7. Mason, S.F.1962A History of Rivision.Revised Edition.Collier Books,New York.
8. Sylla,e.and Mc Vaugh,.m .1997>text and contexts in ancient and medical science
9. Spangerburg,R.and Moser,D.K.1999.The history of science.5 vols. Universities press(india) ,Ltd.Hyderabad,India
10. Singer,C., Holmyard,E.J.,Hall,A.R. and William ,T.I. 1954-1958.The history of Technology.5 vol .,Clarendon press ,Oxford.
11. K. V. Krishnamurthy (2006). History of Science.

Related Online Contents:

1. https://www.sciencedirect.com/science/article/pii/S1279770723002294
2. https://www.nature.com/articles/255015a0
3. https://www.currentscience.ac.in/Volumes/2/03/0086.pdf

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SEMESTER - II

Non Major Elective: BIOFERTILIZERS

Course Code	22PGBOTED201	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Students learn about Biofertilizers field to manipulate crop productivity								

Course Objectives:

- To know about importance of biofertilizers.
- To acquire knowledge about production of biofertilizers.
- To assess the knowledge about biological nitrogen fixation.
- To know about the mass cultivation of various biofertilizers.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Study that different organism used as bio fertilizer.	K1
CO2	Know the bio fertilizer application methods.	K1, 2
CO3	Evaluate nitrogen fixation and its importance.	K3, K4 & K6
CO4	Know the importance of bio fertilizer to protect biodiversity.	K2
CO5	Study the mass production of biofertilizers.	K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **INTRODUCTION** **6 Lectures**	Classification of fertilizers (Synthetic and Natural fertilizer), Organic fertilizers, Biofertilizers – General account and importance, Fertilizer application method (Foliar, seed dressing, soil drenching), Dry and wet formulation.
Unit II **BIOFERTILIZERS** **7 Lectures**	Biofertilizers – green manuring, farm yard manuring, compost manuring; Role of bacteria, cyanobacteria and mycorrhizae as biofertilizers, Importance of biofertilizers, Bioferlizers used in agriculture – *Anabaena, Azospirillum, Phosphobacteria*, blue green algae, *Azolla*, *mycorrhiza*, #*Rhizobium.*

Unit III **NITROGEN FIXATION** **7 Lectures**	Biological #Nitrogen fixation, Biotechnology of symbiotic nitrogen fixation in blue green algae, Asymbiotic nitrogen fixing organisms, Phosphate solublisation and mobilization, Preparation of vermicompost.
Unit IV **DESIGN OF NAEROBIC DIGESTER** **6 Lectures**	Simplified anaerobic digesters for *biofertilizer production, Modified anaerobic fertilizer, operating conditions for anaerobic digestion of biofertilizer.
Unit V **MASS PRODUCTION** **6 Lectures**	Mass production of #biofertilizer and methods of field application; Organic farming and waste recycling; Integrated approach in biofertilizer use, Biofertilizers and agricultural productivity.
Current Contour	Current developments related to the biofertilizers during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on. ***Blended Learning, #Flip Learning**
Total Lectures – 30	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	2	3	2	3	3	3	3	2
CO2	3	3	2	3	3	3	3	3	1
CO3	3	2	1	2	3	3	3	1	1
CO4	2	3	2	1	3	3	3	3	1
CO5	3	2	2	2	3	3	3	3	1

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	3	3	2	2	3	2
CO2	3	3	3	2	2	3	2	2	3
CO3	2	1	2	2	2	3	3	2	2
CO4	1	1	2	2	1	3	3	2	3
CO5	2	3	3	2	3	3	3	2	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Deshmukh, Khobragade, Dixit (2007) Hand book of Biofertilizers and Biopesticides, Oxford Book Publ., India.
12. Dubey, R.C. (2008). A text book of biotechnology, Chand & Co., New Delhi.
13. Kumar, H.D. (2004). A text book of biotechnology (2nd Ed) East West Press Pvt. Ltd., London
14. NIIR Board (2006) Bio fertilizer and Organic farming.

Related Online Contents:

1. https://www.elsevier.com/books/algal-culturing-techniques/andersen/978-0-12- 088426-1.
2. https://www.springer.com/in/book/9789400958081
3. http://lib.du.ac.ir/documents/10157/60227/Algal+Culturing+Techniques.pdf

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SEMESTER – II

Non Major Elective: FOOD PROCESSING AND PRESERVATION

Course Code	22PGBOTED202	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Students gain more information in the field of food processing and preservation methods based FCI								

Course Objectives:

- To assess the historical evolution of food processing.
- To acquire knowledge about methods of food processing.
- To classify the fats and oils.
- To learn the analytical methods to evaluate nutritional composition.
- To know about Importance of preservation of food

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Explain the various food preservation technology.	K1 & K3
CO2	Understand the importance processing of the foods.	K2
CO3	Analyze the types of oil refining.	K4
CO4	Assess the nutrients composition of fruits and vegetables.	K4, 6
CO5	Know about food industries	K5

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **INTRODUCTION** **7 Lectures**	Principles of Food processing, preservation and pasteurization methods. Definition, temperature combination and equipments: blanching and canning. Packaging: Metal Containers, Glass Containers, Rigid Plastic Containers and Retortable Pouches.

Unit II **PROCESSING TECHNIQUES** **8 Lectures**	Processing techniques for cereals, millets and pulses: parboiling, malting, gelatinization of starch, types of browning- Maillard & caramelization. Pulses- processing of pulses- soaking, germination, decortications, cooking and fermentation.Food Freezing: Air freezing, plate freezing, liquid immersion freezing and cryogenic freezing. Advantages and disadvantages of freezing.and changes in food during freezing storage.
Unit III **FOOD DEHYDRATION** **6 Lectures**	Definition, moisture content (wet basis and dry basis), Cabinet drying, tunnel dryer, spray dryer, freeze dryer and fluidized bed dryer. Nutritional, physico-chemical changes during drying.
Unit IV **ANALYSIS OF NUTRITIONAL COMPOSITION** **7 Lectures**	Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments; Analytical methods for evaluation of chemical and nutritional composition of fruits and vegetables; *Dietary fiber.
Unit V **QUALITY CONTROL** **7 Lectures**	Food Standardization and regulatory agencies in India: Central Committee for Food Standards, Food and Drug Administration and Food Corporation of India. Quality Control in India: Prevention of Food Adulteration act
Current Contour	Current developments related to the food processing and preservation during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on. *__Blended Learning, #Flip Learning__
Total Lectures – 35	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	2	2	3	2	3	3	3	2
CO2	2	2	2	3	2	3	3	3	2
CO3	1	2	1	2	1	1	2	2	1
CO4	3	2	2	3	3	3	2	3	2
CO5	1	1	1	2	3	3	3	3	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	2	2	3	2	3	3	3	2	2
CO2	3	3	3	2	3	3	3	2	3
CO3	1	2	3	1	1	1	3	1	2
CO4	3	3	3	2	3	3	3	2	2
CO5	3	3	3	2	3	2	3	2	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Bawa. A.S, O.P Chauhan et. al. (2013). Food Science. New India Publishing agency.
2. Meyer, (2004). Food Chemistry, New Age.
3. Roday, S. (2011). Food Science, Oxford publication.
4. Srilakshmi, B. (2002). Food science, New Age Publishers.
5. Sukumar, D. (2007). Outlines of Dairy Technology, Oxford University Press.

Related Online Contents:

1. http://discoverfoodtech.com/food-technology-ebooks/
2. http://www.fao.org/docrep/011/a1549e/a1549e01.pdf
3. https://www.researchgate.net/publication/226177792_Methods_of_Food_Preservation

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SEMESTER - III

Value Added Course: Terrace gardening

Course Code	22PGBOTVAC 301	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Building a terrace garden is ideal for students living in tropical climates.								

Course Objectives:

- To acquire knowledge about importance of gardening.
- To know about techniques involved in terrace gardening.
- To identify and management of pest.
- To get knowledge about various planting methods.
- To construct the Ornamental Garden.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Gain knowledge about terrace gardening.	K4
CO2	Apply a variety of propagation techniques.	K3
CO3	Recognize pest control.	K1
CO4	Learn about Ornamental Gardens.	K6
CO5	The elements of cultural activity in attractive gardens	K5

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **INTRODUCTION**	Importance of Organic gardening – Natural parameters – Seed – Soil – Sun – Season – Air – Water - Placement. Garden implements – Mulching – Pruning – Bolting – Chitting – Companion planting – crop rotation.

Unit II **TECHNIQUES INVOLVED IN TERRACE GARDENING**	Techniques involved in terrace gardening – Preparing Potting Soil – Preparation of seedling – Transplantation – Watering seedling – Techniques of watering plants – Filling soil in different containers. Plant disease management –Viral infections – Fungal diseases.
Unit III **PEST MANAGEMENT**	Pest Management - Leaf Miners - White Flies – Aphids – Mealybugs - Spider Mites – Caterpillars – Cutworms. Organic Pest Control Methods - Creating repellents - Using Neem Oil - Encouraging beneficial Insects. Benefits of Garden pests – Bees – Wasps - Lady Bugs - Aphid Parasite - Green Lacewing - Praying Mantis - Soldier Fly - Mealybug Destroyer.
Unit IV **PLANTING**	Plants for planting–Spinach–Tomato - Bottle Gourd – Corn – Pudina – Coriander – Radish - Spring Onions - Sweet Potatoes. Propagation techniques: Cutting: Root, stem and leaf cutting. Layering: Ground and airlayering. Budding and Grafting.
Unit V **ORNAMENTAL GARDEN**	Ornamental garden and its components: Rock Garden – Water garden - Hedges and Edges – Lawn. Indoor garden: Choice of plants and maintenance –Hanging pots – Bonsai –Kitchen Garden: layout and choice of plants.
Unit-VI **Current Contour**	(For Continuous Internal Assessment only, Not forexaminations): Current developments related to the terrace gardeningduring the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures – 20	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	3	1	3	3	3	3	1
CO2	3	3	1	3	3	3	3	3	2
CO3	3	2	2	1	2	3	3	2	1
CO4	1	3	1	2	3	3	3	3	2
CO5	3	1	1	1	3	3	3	3	1

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	3	3	1	2	3	1
CO2	3	3	3	1	2	3	1	1	3
CO3	1	2	1	2	1	3	3	2	3
CO4	2	2	2	3	2	2	2	1	3
CO5	2	3	2	1	3	3	3	2	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Arora, J.S. (1990). Introductory Ornamental Horticulture, Kalyani Publication. Bailey, L.H. (1901). The Standard cyclopedia of Horticulture, volume 1,2 and 3 Macmillan Publications.
2. Bose, T.K. and Mukerjee D. (1987). Gardening in India, Oxford Book House.
3. Chauhan, D.V .S. (1972). Vegetable Production in India. Ram Prasad and Sons.
4. Kumar, N. (1989). Introduction to Horticulture, Rajalakshmi Publications. Manibhushan Rao (1991). Text book of Horticulture, Macmillan Publications.
5. Shujnrnoto, (1982). The Essentials of Bonsai, David & Charles, Newton.
6. Richard L. A. (2002). Elements of Planting Design, John Wiley & Sons, Inc., New York.
7. Randhawa, M .S. (1957). Flowering Trees. National Book Trust, New Delhi.
8. Navin P. (1993).The Garden of Life: An Introduction to the Healing Plants of India, Doubleday.

Related Online Contents:

1. https://www.biblio.com/the-standard-cyclopedia-by-bailey-l-h/work/31031
2. http://shodhganga.inflibnet.ac.in/bitstream/10603/25966/11/11_bibliography.pdf
3. https://www.sapnaonline.com/books/flowering-trees-ms-randhawa-8123701497-9788123701493

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SEMESTER - III

Value Added Course - PRINCIPLES OF HORTICULTURE

Course Code	22PGBOTVAC302	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Students learn about horticulture techniques to manipulate different cultural practices.								

Course Objectives:

- To get an understanding of the fundamentals of gardening.
- To get knowledgeable about various propagation techniques.
- To acquire understanding of practical approaches for garden design.
- To comprehend how garden plants should be maintained.
- To begin working with popular blooming plants.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Able to design landscape.	K5
CO2	Demonstrate indoor and outdoor gardening.	K3
CO3	Analyze the environment effect on plant growth and development.	K6
CO4	Gain the knowledge on the importance of floriculture.	K1
CO5	Practice floriculture of important flowers	K2

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **HISTORY**	#History, Scope and Importance of horticulture, Divisions of horticulture, Climate, soil and nutritional needs, water irrigation.
Unit II **PROPAGATION METHODS**	*Plant propagation method – cutting, layering, grafting and budding, #stock – scion relationship micropropagation by induction of rooting, role of growth hormone in horticultural crops.

Unit III **GRADEN TYPES**	Types of garden, methods of designing outdoor garden –hedges, edges, fences, *trees, climbers, rockeries, archies, terrace garden, lawn making and maintenance, water garden- cultivation of water plants.
Unit IV **GARDENING**	Herbal garden, ornamental, aesthetic values, crotons, medicinal, indoor gardening, foliage plants, flowering plants, hanging basket, bonsai, training and pruning.
Unit V **FLORICULTURE**	Floriculture – cultivation of commercial flower crops – rose, jasmine and chrysanthemum, flower decoration, Dry and wet decoration.
Total Lectures – 20	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	3	3	3	3	3	3	2
CO2	3	3	1	3	2	3	3	3	1
CO3	3	1	2	1	3	3	3	2	2
CO4	1	3	1	2	3	3	3	3	1
CO5	3	1	1	1	2	3	3	3	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	3	3	1	2	3	1
CO2	3	3	3	3	2	3	3	2	3
CO3	1	2	1	2	3	3	3	1	1
CO4	2	2	1	1	2	2	3	1	3
CO5	1	3	3	2	3	3	3	1	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Arora, J.S. (1990). Introductory Ornamental Horticulture, Kalyani Publication.
2. Bailey, L.H. (1901). The Standard cyclopedia of Horticulture, volume 1, 2 and 3 Macmillan Publications.
3. Bose, T.K. and Mukerjee, D. (1987). Gardening in India, Oxford Book House.
4. Chauhan, D.V. S. (1972). Vegetable Production in India.RamPrasad and Sons.
5. Kumar, N. (1989). Introduction to Horticulture, Rajalakshmi Publications.
6. Manibhushan Rao (1991). Text book of Horticulture, Macmillan Publications.
7. Shujnrnoto, (1982).The Essentials of Bonsai, David & Charles, Newton.

Related Online Contents:

1. https://link.springer.com/content/pdf/bfm%3A978-94-017-2157-8%2F1.pdf
2. https://www.bonsaitree.co.za/products/practical-guide-to-bonsai-styles-of-the-world
3. http://nkcs.org.np/cdc/library/opac_css/index.php?lvl=publisher_see&id=563

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SEMESTER - III

Self-study Course: BIO RESOURCE MANAGEMENT

Course Code	22PGBOTSSC 301	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Students get an understanding of natural resources and bio-resource management.								

Course Objectives:

- To get an understanding of natural resources and their maintenance.
- To acquire knowledge about forest resources, preservation, and their dietary needs.
- Knowledge of the consequences of using non-renewable and renewable energy sources excessively.
- To comprehend the resources of land and water.
- To investigate the financial aspect of resource management.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Understand the knowledge on natural resource bases.	K1
CO2	Acquire knowledge on forest biodiversity.	K2
CO3	Formulate a strategy towards the social, ecological, economic, cultural and environmental purpose of forest.	K4
CO4	Evaluate the strategies and appreciate uses of land and water resources.	K3
CO5	Solve problems related to resource management.	K6
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I

INTRODUCTION

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Inter-relationships among different types of natural resources. Ecological, social and

economic dimension of resource management. Natural resources and development.

Unit II **FOREST RESOURCES**	Forest vegetation, status and distribution, contribution as resource. Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people, Forest products.
Unit III **ENERGY & FOOD RESOURCES**	Renewable and non-renewable energy sources, use of alternate energy sources. World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, salinity and case studies.
Unit IV **LAND & WATER RESOURCES**	Land use classification, Dry land, land use planning and desertification. Land resource management and major issues. Use and over-utilization of surface and ground water, drought, conflicts over water, dams-benefits and problems. Water ecology and management.
Unit V **APPROACHES IN RESOURCE MANAGEMENT**	Approaches in Resource Management: Ecological and economical approaches. Integrated resource management strategies. Poverty and implications in resource management in developing countries – poverty in developing countries, causes and link with resources scarcity and poverty. Resource conflicts: Resource extraction, access and control system.
Total Lectures – 20	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	3	1	3	3	3	3	2
CO2	1	2	1	2	2	1	3	3	1
CO3	3	1	2	1	3	3	3	2	2
CO4	2	2	2	2	2	2	3	3	1
CO5	3	3	1	1	3	3	3	3	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	3	3	1	2	3	1
CO2	3	1	2	1	3	3	1	1	2
CO3	1	2	1	3	2	3	3	2	2
CO4	2	2	1	2	2	2	2	3	2
CO5	1	3	3	3	3	3	3	2	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. Francois Ramade 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
2. Harikesh N Mishra 2014 Managing Natural Resources- Focus on Land and Water.PHI Lerning Publication.
3. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.
4. Townsend C., Harper J, and Michael Begon. Essentials of Ecology, Blackwell Science.

Related Online Contents:
https://www.nature.com/articles/s41538-024-00260-3
https://www.nature.com/articles/nclimate1462
https://www.sciencedirect.com/science/article/pii/S1389934124000790

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SEMESTER - III

Non-Major Elective : SEAWEED FARMING

Course Code	22PGBOTED301	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
				40 hrs.		-	2		
Pre-requisite	To learn the basic principles of seaweed farming, seaweed, and its use as biofertilizers.								

Course Objectives:

- To gain learning about cultivation of seaweeds.
- To understand about the uses of seaweeds.
- To be informed about maintenance of seaweed farm.
- To be familiar with the uses of biofertilizers.
- To recognize a value-added product from seaweed.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Identify the seaweed research in India.	**K1 & K2**
CO2	Distinguish between different seaweed farming techniques.	**K3 & K5**
CO3	Acknowledge the harvesting process.	**K3 & K6**
CO4	Analyze the seaweed-derived, value-added products.	**K4 & K5**
CO5	The specifics about using it as a biofertilizer.	**K2 & K5**

K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation

Unit I **INTRODUCTION**	Introduction-Uses of seaweeds- * Seaweed resources in India-Why Seaweed Farming-Site selection- Installation of test plants- Kinds of test planting-Introduction of test plants Seaweed forming in India: Preparation of the farm site and other culture activities Environmental interactions on Seaweeds.
Lectures	7 hrs.

Unit II **METHODS OF SEAWEED FARMING** **Lectures**	Net method- Floating bamboo method- Mangrove stakes and nets- Bottom monoline method- Single Rope Floating Raft method (Coir Rope & Nylon Rope).-. Fixed Bottom long line method (Coir Rope & Nylon Rope). Integrated Multi Trophic Aquaculture (IMTA) method-Seaweed Farming in India. 8 hrs.
Unit III **FARM MANAGEMENT** **Lectures**	Seed selection and preparation- Tying of seedlings- Planting- Harvesting- Pre-harvest activities- Harvesting procedures- Drying-packaging of seaweed for the local market. Maintenance of the * farm-Seaweed Cultivation Policy Statement-Commercial cultivation policies-Development size-Small-medium (0-50 x 200m lines)- Large (>50 x 200m lines)- IMTA-farming: Accomplishments and challenges- Contributions to cross-cutting themes 9 hrs.
Unit IV **BIOFERTILIZERS** **Lectures**	* Seaweeds granules preparation, foliar application, soil mixing, growth hormone assays, estimation of vitamins, amino acids, prolein, butanine, and manitol in Seaweeds granules nanoparticles synthesis from seaweeds and its #*application as Biofertilizers, biofungicides and biobactericides. 9hrs
Unit V **VALUE ADDED PRODUCTS** **Lectures**	#*Seaweeds value added product- pakkoda, murukku, chocolate, pickles, jelly, jam and payasam preparations from edible seaweeds. Feed and medicinal important compounds - agar agar, Carrageenan, alginic acid, antibiotics substances, enzyme extraction, feed preparation and drugs formulation# 7 hrs.
Current Contour	Current developments related to the seaweed farming during the Semester concerned to be kept abreast of continuously and cumulatively through collection, discussion and evaluation from news and events over the world collected through multiple reliable informative sources- Research articles, Review materials, Print, Internet, Interaction, Social Media, Webinars and so on.
Total Lectures –	40 hrs.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	3	1	2	1	2	3
CO2	3	2	3	1	1	2	2	3	3
CO3	3	3	3	3	3	2	2	3	2
CO4	3	3	1	3	3	3	2	1	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	2	3	2	2	2	3	2	3
CO2	2	3	3	2	2	1	3	2	2
CO3	3	2	2	3	2	3	3	3	3
CO4	2	1	3	3	3	2	3	2	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

1. Richard M. K, (1989). Algae and Human Affairs. Carole A. Lembi, J. Robert Waaland, The Quarterly Review of Biology 64: 4 503.
2. Maxwell S. D, (1951). Seaweeds and Their Uses. V. J. Chapman, The Quarterly Review of Biology 26:4 397-398.
3. Palmer, C.M. (1980). Algae & water pollution. Castle House Publishers Ltd., England.

Related Online Contents:

1. http://admin.cambridge.org/academic/subjects/life-sciences/plant-science/algae-and-humanaffairs?format=PB&isbn=9780521044400
3. https://onlinelibrary.wiley.com/doi/pdf/10.1002/iroh.19640490102
2. https://trove.nla.gov.au/work/21290883?q&versionId=25437661

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SEMESTER - III

Non-Major Elective: HERBAL COSMETICS

Course Code	22PGBOTED 302	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Students learn about herbal cosmetics and applied to a health care								

Course Objectives:

- To understand the role of herbs as a source of natural and safe cosmetics.
- To learn various herbal preparations of cosmetics.
- Description of several ingredients involved in the production process
- To increase their ease of understanding of cosmetic product manufacturing.
- To identify the Principles of Quality control and standardization of cosmetics

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Acquire knowledge about role of herbs as a source of natural and safe cosmetics.	K1
CO2	Learn the various herbal preparations of cosmetics.	K2
CO3	Understand the preparation of cosmetic drugs.	K2 & K3
CO4	Know about Face care, skin care and hair care.	K4
CO5	Students will learn about the raw materials used in herbal cosmetics and get exposed	K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **INTRODUCTION** **7 Lectures**	Introduction to cosmetics, Botanicals in cosmetics, Need and advantages of Herbal cosmetics, Effect of chemical cosmetics, Cosmetics nomenclature: Emulsion, cream, lotion, face wash, face mask, sunscreen; oils and fats used in cosmetics, different bases and raw materials used in cosmetics.

Unit II **HERBAL PRODUCTS** **8 Lectures**	Extraction of herbal products, A brief account of following herbals or herb extracts of cosmetic importance such as *Acacia concinna* pods, Aloe Vera, Almond oil, Neem, *Citrus aurantium* peels, Henna, Turmeric, Liquorice, Olive oil, tea tree oil and wheat germ oil with special emphasis on their source, active principles and cosmetic properties. Anti aging herbs.
Unit III **PREPARATION METHODS** **8 Lectures**	Face care: Face cleanser, Ache - pimple cream, Preparation of Face pack- any two, Skin care: Skin beauty through panchakaruma, Turmeric - Milk lotion, Aloe vera, Anti – wrinkle cream, Moisturizing cream, Preparation of Herbal Bathing powder, Hair care : Hair oil components and preparation of oil, Role of Karisalan kanni, Amla in hair oil preparation, Henna uses, Herbal shampoo, hair dye, preparation of hair spray using essential oils, Foot Care Preparation of foot cream
Unit IV **NATURAL COLORANTS** **7 Lectures**	Natural colorants: Biological Source, coloring principles, chemical nature and usage of the following Annato, Cochineal, Caramel, Henna, Indigo, Madder, Saffron, Turmeric Flavors and Perfumes: Sandal wood oil, Orange oil, Lemon oil, Vanilla, Palmarosa, geranium oil.
Unit V **QUALITY CONTROL** **6 Lectures**	General Principles of Quality control and standardization of cosmetics-Raw material control, Packaging material control, finished product control, Shelf testing. Quality control in cosmetic preparation and guidelines.
Total Lectures – 36	

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	3	3	3	3	3	3	3
CO2	3	1	2	2	3	3	3	3	1
CO3	2	2	3	3	3	3	3	3	2
CO4	2	2	2	2	3	3	3	3	2
CO5	2	2	2	2	3	3	3	3	2

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
CO1	3	3	3	2	3	3	3	2	1
CO2	3	3	3	2	2	3	3	2	3
CO3	3	3	3	3	2	3	3	2	3
CO4	3	3	3	2	3	1	2	2	3
CO5	3	3	3	3	2	3	2	2	3
1 – Basic level, 2 – Intermediate level; 3 – Advance level									

Recommended References:

1. Andre O. Barel et al., (2009). Handbook of Cosmetic Science and Technology, Informa Healthcare USA.
2. Mitchell L. Schlossman (Ed.) (2002). The Chemistry and Manufacture of Cosmetics, Allured Publishing Corporation.
3. Meyer R. Rosen (Ed) (2015). Harry's Cosmeticology, 9th Ed. Chemical Publ. Co.
4. Vimaladevi M. (2018). Textbook of Herbal Cosmetics, CBS Publ.
5. International Cosmetic Ingredient Dictionary & Handbook- by The Personal Care Products Council.
6. P.P. Sharma (5th Ed., 2014). Cosmetics- Formulation, Manufacturing and Quality control. Vandana Publ.
7. H. Panda (2015). Herbal Cosmetics Hand Book, Asia Pacific Business Press Inc.
8. P. K Chattopadhyay (2015). Herbal Cosmetics: NIIR. Project Consultancy Services.
9. H. Panda (2016). The Complete Technology Book on Herbal Perfumes and Cosmetics

Related Online Contents:

1. https://formulabotanica.com/natural-skincare-training-videos/
2. https://theherbalhub.com/product-category/online-video-courses/
3. https://theherbalhub.com/online-course-natural-cosmetic-making-at-home-with-herbs/
4. https://www.teachmint.com/tfile/studymaterial/b-sc/pharmacognosy/herbalcosmetics/2bde78aa-eabd-4d43-908f-1c66009084e8
5. https://www.iomcworld.com/open-access/herbal-cosmetics-and-cosmeceuticals-an-overview-43325.html

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SEMESTER - IV

Self-study Course: INTELLECTUAL PROPERTY RIGHTS AND PATENTING

Course Code	22PGBOTSSC401	Course Type	Core	L	T	P	C	Syllabus version	2022-2023
						-	2		
Pre-requisite	Students get an understanding of natural resources and bio-resource management.								

Course Objectives:

- To get an understanding of intellectual property rights.
- To be informed on the development process, patents, and licences.
- To recognize the traditional knowledge and biodiversity.
- To learn more about national and international governing organizations.
- To utilizing expertise in synthetic biology and patent issues.

Expected Course Outcomes:

On the completion of the course the student will be able to

COs	COURSE OUTCOMES	KNOWLEDGE LEVEL
CO1	Deal with several sorts of intellectual property and patent rights.	K6
CO2	Identify various types of patents.	K4
CO3	Understand how to conserve traditional knowledge in biodiversity.	K2
CO4	Make knowledgeable about patent-related actions.	K1
CO5	Solve problems about biotechnological products and processes.	K3 & K5
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 – Creation; K6- Evaluation		

Unit I **INTRODUCTION TO IPR**	*Introduction to IPR – Types of IPR: Patents, Copyrights, Trademarks, Plant Breeder‟s rights – Importance of IPRs In Today‟s Technological World, Budapest Treaty – Application of IPR in Bio-Inventions.

Unit II **PATENTING AND TRADE SECRETS**	Patenting – Types of Patents – Exclusive Rights and Licencing – Inventions vs. Discoveries: International and National Perspectives – Technology – Development – Patent Process and Filing Procedure – PCT route – Patent vs. Trade Secret.
Unit III **THE ETHICAL CONCERNS**	Biodiversity and Traditional Knowledge Protection – Cases: San People, Hoodia Plant, Bt. Cotton in India and GMOs – Decision Making and MNCs.
Unit IV **INTERNATIONAL AND NATIONAL GOVERNANCE OF BIODIVERSITY**	WIPO – IGC – TRIPS – CBD – NBD – SSB – Plant Varieties for Food Agriculture – UPOV – FAO Treaty – * The African Model Law.
Unit V **SYNTHETIC BIOLOGY**	Synthetic Biology, patenting issues with special reference to biotech products and activities.

Mapping Program Outcomes with Course Outcome

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	3	2	3	3	3	1
CO2	2	1	2	1	1	2	3	2	2
CO3	1	2	1	2	3	3	2	1	1
CO4	1	1	1	1	1	1	3	3	2
CO5	3	3	2	2	3	3	1	3	1

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Mapping Program Specific Outcomes with Course Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3	2	2	3	3	2
CO2	3	2	1	2	2	2	2	2	1
CO3	2	2	2	3	1	3	3	3	2
CO4	1	1	2	1	1	1	1	3	1
CO5	2	3	3	3	3	3	3	1	3

1 – Basic level, 2 – Intermediate level; 3 – Advance level

Recommended References:

1. May, C. and Sell, S.K. (2005). Intellectual Property Rights: A critical history. Lynne Rienner Publications.
2. Padmanabhan, A. (2012). Intellectual Property Rights-Infringement and Remedies.

Related Online Contents:

https://www.rienner.com/title/Intellectual_Property_Rights_A_Critical_History
http://journals.sagepub.com/doi/10.1177/030981680608800103

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EVALUATION

Evaluation of each course (other than summer Mini Project, Main project work, and extra-disciplinary courses) shall comprise of Continuous Internal Assessment (**CIA**) for 25 marks and End Semester Examination (**ESE**) for 75 marks. The Q.P setting and evaluation of ESE will be done by external examiners, appointed for the purpose and while the CIA components will be evaluated by respective course teachers.

A) Question paper pattern*for **ESE**

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

Section	No. of Questions	Marks/Question	Total Marks	Remarks
A	05	03	15	Answer any Five questions out of seven (minimum of one question from each unit)
B	05	06	30	Answer all with Internal Choice (one set of question from each Unit)
C	03	10	30	Answer any Three out of five questions (one question from each Unit)
		Total	**75**	

*QP setters are requested to follow the **'RUPASCE'** level in setting the question papers by giving proper weightage to test the Reasoning, Understanding, Practice, Analysis, Synthesis, Creation and Evaluation ability at the introductory level, reinforcement level, and mastery level.

B) The components of **CIA** marks are as follows

For Theory:

Evaluation Pattern	Marks
TEST (Two) & one Model Exam (Best Two)	10
Seminar	5
Assignments	5
Field trip/Study tour/Industry visit/Institutional visit Report	5
Total Marks	**25**

For Practical[#]:

Evaluation Pattern	Marks
Continuous Performance (including Attendance)	15
Model Exam	10
Total Marks	**25**

Students fail to bring the Record note for the Model/ University Practical Examinations are not eligible for the respective examinations.

For Mini project/Internship and End Semester Project (II & IV Semester), 75% External Assessment and 25% Internal Assessment will be done.

The students who have opted for an Internship must undergo industrial training in the reputed organizations to acquire industrial knowledge during the summer vacation for a minimum of forty five days. The student has to find the industry related to their discipline (Public limited/Private Limited) in consultation with the faculty in charge and get approval from the head of the department.

The candidate should submit three copies of the dissertation/project and submit the same for the evaluation of examiners. After evaluation, one copy will be retained in the department library, one copy will be retained by the guide and the student shall hold one copy.

Passing Minimum:

A candidate shall be declared to have passed in each course (including mini/ end semester project) if he/she secures not less than 40% marks in the University Examinations and 40% marks in the CIA individually and not less than 50% in the aggregate, including CIA and University Examination marks.

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Format to be followed for dissertation/project

Title Page
Certificate
Acknowledgement
Content as follows:

Content	Page Number
Introduction	
Aim and Objectives	
Review of Literature	
Materials and methods	
Results	
Discussion	
Summary/Conclusion	
References	

For Miniproject/End Semester Project

Title followed by
Mini project report/Dissertation submitted in partial fulfillment of the requirement for the degree of Master of Science to Bharathidasan Univeristy, Tiruchirappalli 620024.

By
Student Name
Register Number
University Logo

Department of Botany
Bharathidasan University

Month and Year

Format of Certificate

Certificate - Guide

This is to certify that the Dissertation/Project entitled " ---------- " submitted to Bharathidasan University, Tiruchirappalli 24 in partial fulfilment for the degree of Master of Science in ---------- by Mr/Miss ----------(Reg. No. --)under my supervision. This is based on the results of studies carried out by him/her in the Department of----------, Bharathidasan University, Tiruchirappalli. This dissertation/Project or any part of this work has not been submitted elsewhere for any other degree, diploma, fellowship, or any other similar titles or record of any University or Institution.

Place Research Supervisor
Date

Certificate – HOD

This is to certify that the thesis entitled "----------" submitted by Mr/Ms ----------(Reg. No----------) to the Bharathidasan University, in partial fulfillment for the award of the degree of Master of Science in ---------- is a Bonafide record of research work done under the supervision of Dr.----------, Professor, Department of----------, Bharathidasan University. This is to further certify that the thesis or any part thereof has not formed the basis of the award to the student of any degree, diploma, fellowship, or any other similar title of any University or Institution.

Place: Head of the Department
Date:

Declaration (student)

I hereby declare that the dissertation entitled "----------" submitted to the Bharathidasan University for the award of the degree of Master of Science in ----------has been carried out by me under the guidance of Dr. ----------, Professor, Department of ----------, Bharathidasan University, Tiruchirappalli 620024. This is my
Original and independent work and has not previously formed the basis of the award of any degree, diploma, associateship, fellowship, or any other similar title of any University or Institution.

Place Signature
Date

Format for the Record Note

BHARATHIDASAN UNIVERSITY

TIRUCHIRAPPALLI – 620 024

DEPARTMENT OF BOTANY

I/II M.Sc. BOTANY

Subject

PRACTICAL RECORD NOTE BOOK

NAME :
REG. NO :

BHARATHIDASAN UNIVERSITY

TIRUCHIRAPPALLI – 620 024

CERTIFICATE

This is certified as the bona-fide record of work done by **Mr/Ms. ----------** **Reg.No:----------**in the first/second year **M.Sc. (Botany)**programme for the subject of **----------** during the --------- semester of the year ---------.

STAFF IN-CHARGE **PROFESSOR AND HEAD**

This record is submitted for the **M.Sc.** practical examination in **Department of Botany** held on **--------** at Bharathidasan University, Tiruchirappalli – 620 024.

INTERNAL EXAMINER **EXTERNAL EXAMINER**