



DEPARTMENT OF BOTANY
SYLLABUS FOR M.Sc BOTANY
UNDER CHOICE BASED CREDIT SYSTEM (CBCS)
FOR CANDIDATES ADMITTED IN THE ACADEMIC YEAR
2022 – 2023



Bishop Heber College (Autonomous)

(Nationally Reaccredited at the A Grade by NAAC with CGPA 3.58/4)

(Recognized by UGC as “College of Excellence”)

(Affiliated to Bharathidasan University, Tiruchirappalli)

Tiruchirappalli- 620 017.

VISION

Inculcate fundamental knowledge of the plant sciences that will transform the understanding about the planet earth, providing holistic approach on innovative teaching, entrepreneurship skills and research with social ethics that reaches the society with a focus on plants and their role in balancing and protecting the Environment.

MISSION

- Our mission is to foster an ambience of distinction by attracting and supporting the outstanding students, faculty and staff needed to sustain our vision.
- Provision of knowledge that bestows academic environment that contribute towards creating socially responsible citizens who have adequate skills in reflective thinking, leadership, team play, scientific temper with lifelong learning affinity.
- Create a stimulating environment that facilitates intellectual growth of students; provide students with the time and freedom to experience 'powerful pedagogies' such as research, service-learning and internships; encourage students with scientific approach to learning.
- To foster an environment of excellence by providing a comprehensive set of courses in Botany that enhances the understanding, fundamental and in-depth knowledge and technical competency.
- To inculcate the students with an environment that fosters nature conscious stewardship responsibility and Entrepreneurial skill development, multidisciplinary research competency through interdisciplinary learning and teaching positions in biological science.

PROGRAM OUTCOMES –M. Sc - BOTANY

On Successful completion of the Program the post grandaunt of Botany will be able to:

KNOWLEDGE

PO1- Acquire comprehensive understanding about plants in various environment, their interactions and influence with the ecosystem.

PO2- Compile the identification and systematics of plants up to species level using the floras and solve problems related to taxonomy of plants.

PO3- Perceive information on advanced biological techniques, proteomics, cellular communication and able to resolve the floral genetic problems quantitatively.

SKILLS

PO4- Develop skills in data collection, group work communication, new variant determination, utilizing the information technology to justify the resources to the maximum.

PO 5- Select appropriate plant variety for the land and evaluate antagonistic and symbiotic interactions of plant to the environment.

PO6- Analyse the green wealth using profound insight in the field of agriculture, mushroom culture, aero science, biotechnology, pathology and human diseases.

Attitudes

PO7- Evaluate phytochemical properties among plants and explain scientifically to the community promoting a life-long learning.

ETHICAL AND SOCIAL VALUES

PO 8- Justify the importance of plants as the basic components in the earth, their role in maintaining balance in nature from overexploitation, destruction and inculcate stewardship responsibility.

PO9 – Identify and conserve the indigenous flora and report on the potentialities of traditional and combination drugs using the Plants.

PROGRAM SPECIFIC OUTCOMES

PSO 1- Examine the various plant forms, vegetative structures, developmental- evolutionary pattern in plants and importance of plants in day today life.

PSO 2- Compile phytochemicals incorporating ethno-traditional medicines and design new methods for drug discovery, floral formulations using the bio-informatic tools, systematic identification of plants and solve problems related to IPR.

PSO 3- Analyse the nucleotide sequencing, metabolomics, inter- intracellular signalling in plant and Microbes. Interpret the genetic principles, variations, in plant-microbe–animal heredity and protect indigenous varieties by defending the encroachment of pests, invaders and expatriate crops.

PSO 4- Interpret the plant genus by their anatomical, physiological and ecological functions correlating with the physical, chemical forces of nature and make use of *in-vitro* propagation in plants, evaluate the ecosystem variance, net production and conservation strategies for the ecosystem.

M. Sc BOTANY PROGRAMME ARTICULATION MATRIX

COURSE NAME	COURSE CODE	CORRELATION WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES													
		P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PS O1	PS O2	PS O3	PS O4	
Plant Diversity	P21BY 101	H	H	-	L	H	H	L	M	H	H	L	H	H	
Plant Anatomy, Embryology and Morphogenesis	P21BY 102	H	M	L	L	H	H	M	L	L	M	M	M	H	
Ecology and Phytogeography	P21BY 103	H	M	L	L	H	H	L	H	M	H	M	M	H	
Plant Diversity-Practical	P21BY 1P1	H	H	-	L	H	H	L	L	L	H	L	M	H	
Plant Anatomy, Embryology and Morphogenesis-Practical	P21BY 1P2	H	M	-	M	H	H	L	L	L	L	L	M	H	
Trends in Agriculture	P22BY 1:A	H	M	-	M	H	H	L	M	L	H	L	L	L	
Entrepreneurial Botany	P21BY 1:B	H	M	-	H	H	M	L	M	-	L	L	M	L	
Biofertilizers and Bioinoculum	P22BY 1:C	H	M	-	M	H	H	L	M	L	H	L	L	L	

Plant Taxonomy and Systematics	P21BY 204	H	H	-	M	H	H	H	H	H	H	H	H	H
Cell biology, Genetics and Molecular biology	P21BY 205	-	L	H	H	L	H	M	L	M	M	L	H	H
Microbiology and Plant pathology	P21BY 206	-	M	H	H	M	M	L	-	-	M	L	H	H
Plant Systematics	P21BY 2P3	H	H	-	M	H	H	H	H	H	H	H	H	H
Cell biology, Genetics, Microbiology and Plant Pathology	P21BY 2P4	-	M	H	H	M	M	M	-	H	L	H	L	H
Tidal Forestry / Microbial food Processing/ Plant Genetics Resources	P21BY 2:A/ P21BY 2:B/ P22BY 22:C	M	M	M	H	H	H	M	H	H	L	L	L	L
Plant Physiology	P21BY 307	M	L	L	H	H	H	H	H	H	M	H	H	H
Biochemistry, Biophysics & Pharmacology	P21BY 308	M	M	L	M	M	H	M	M	M	M	M	H	H
Plant Biotechnology	P21BY 309	-	L	M	H	H	H	H	H	H	M	H	H	H
Plant Physiology	P21BY 3P5	L	L	L	M	H	H	H	M	H	H	H	H	H
Biochemistry, Pharmacology and	P21BY 3P6	L	-	L	H	M	H	H	M	H	L	H	H	H

Plant Biotechnology														
Green Wealth/	P21BY: P1/	-	-	-	H	M	M	H	L	H	-	-	-	M
Naturopathy and Traditional health care	P21BY: P2	-	-	-	M	L	M	M	M	H	L	H	-	-
Medicinal Plants and Human Welfare	P22BY: P3	-	-	-	H	M	M	H	L	H	-	-	-	M
Research Methodology	P21BY 410	M	M	-	M	H	H	H	H	H	H	H	M	H
Forestry and Conservation Biology	P21BY 4:A	H	M	-	L	H	M	L	H	L	M	-	-	M
Green Audit	P21BY 4:B	H	H	-	-	H	H	-	H	L	H	L	-	L
Wood Science Technology	P22BY 4:C	H	M	-	L	L	M	M	M	-	L	M	L	-
Propagation Techniques	P21BY 4:D	M	M	-	-	M	H	-	L	M	-	-	L	L
Soilless Agriculture	P21BY 4:E	H	M	-	L	L	M	M	M	-	L	M	L	-
Project	P21BY4PJ													

M. Sc BOTANY PROGRAMME STRUCTURE

Nature of Course	Course Title	Course Code	Hours / Week	Credits	Marks			
					CIA	ESE	Total	
I	Core I	Plant Diversity	P21BY101	6	5	25	75	100
	Core II	Plant Anatomy, Embryology & Morphogenesis	P21BY102	6	5	25	75	100
	Core III	Ecology and Phytogeography	P21BY103	6	4	25	75	100
	Core Pra. I	Plant Diversity	P21BY1P1	3	3	40	60	100
	Core Pra. II	Plant Anatomy, Embryology, Morphogenesis and Ecology	P21BY1P2	3	3	40	60	100
	Elective I	Trends in Agriculture/ Entrepreneurial Botany/ Biofertilizers and Bioinoculum	P22BY1:A/ P21BY1:B/P22BY1:C	6	4	25	75	100
		Sem. I Credits		24				
II	Core IV	Plant Taxonomy and Systematics	P21BY204	6	5	25	75	100
	Core V	Cell Biology, Genetics and Molecular Biology	P21BY205	6	5	25	75	100
	Core VI	Microbiology and Plant pathology	P21BY206	6	4	25	75	100
	Core Pra.III	Plant Systematics	P21BY2P3	3	3	40	60	100
	Core Prac.IV	Cell Biology, Genetics, Microbiology and Plant Pathology	P21BY2P4	3	3	40	60	100
	Elective II	Tidal Forestry / Microbial food Processing / Plant Genetic Resources	P21BY2:A/ P21BY2:B/P22BY2:C	4	4	25	75	100
	VLO	The Big Picture/Social Ethics	P22VLO21/ P22VLO22	2	2	25	75	100
		Sem. II Credits		26				
II I	Core VII	Plant Physiology	P21BY307	6	5	25	75	100
	Core VIII	Biophysics, Biochemistry & Pharmacognosy	P22BY308	6	4	25	75	100
	Core IX	Plant Biotechnology	P21BY309	6	4	25	75	100
	Core Prac.V	Plant Physiology	P21BY3P5	3	3	40	60	100
	Core Prac.VI	Biochemistry, Pharmacognosy and Plant Biotechnology	P21BY3P6	3	3	40	60	100
	Elective III	Green Wealth / Naturopathy and Traditional health care/ Medicinal plants and Human Welfare	P21BY:P1/ P21BY:P2/ P22BY:P3	6	3	25	75	100
	Generic Course	Bioethics and Research Publication Ethics	P22BY3G1	1	1	100	-	100
		Sem. III Credits		23				
I V	Core X	Research Methodology	P21BY410	6	4	25	75	100
	Elective IV	Forestry and Conservation Biology/ Green Audit/ Wood Science Technology	P21BY4:A/ P21BY4:B/P22BY4:C	5	4	25	75	100
	Elective V	Propagation Techniques/ Soilless Agriculture	P22BY4:D/ P22BY4:E	5	4	25	75	100
	Core Project	Project	P21BY4PJ	--	5	25	75	100
			Sem. IV Credits		17			
	TOTAL CREDITS			90				2300

Core Theory : 10	Core Practicals : 5	Core Project : 1	Elective : 5	Value Education : 1	Total : 21
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CORE PAPER I – PLANT DIVERSITY

(ALGAE, FUNGI, LICHEN, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS)

Semester: I

Course Code : P21BY101

Credits : 5

Hours / Week: 6

COURSE OUTCOMES:

On completion of this course, the students will be able to:

No.	COURSE OUTCOMES (CO)	LEVEL	UNIT
CO 1	Distinguish and explain characteristics features of Algae and evaluate the life cycle patterns and phylogenetic trends	K4	I
CO 2	Discuss the general characteristics features of Fungi and classify the types of reproduction	K6	II
CO 3	Criticize the general characteristics, origin and evolution of sporophytes of Bryophytes	K5	III
CO 4	Analyze the characteristics of Pteridophytes and justify primitive vascular plants based on the telome theory	K4	IV

CO 5	Analyze the general characteristics and evolutionary modification occurred in Gymnosperms	K4	V
CO 6	Appraise the adaptations of plants in various habitat and their ecological and economic importance	K5	I - V

SYLLABUS

Unit 1: Algae

(18 Hours)

- 1.0 Algae - General characteristics of major classes of Algae.
- 1.1 Fritsch's Classification
- 1.2 Thallus variations
- 1.3 Reproduction, Life cycle patterns and Phylogenetic trends
- 1.4 Distribution and economic importance of major groups of Algae.
- 1.5 *In vitro* algal culture.

Unit 2: Fungi and Lichen

(18 Hours)

- 2.0 Fungi** - General characteristics of major classes of Fungi.
- 2.1 Ainsworth's classification,
- 2.2 Ecology and distribution
- 2.3 Types of Reproduction
- 2.3.1 Spore dispersal mechanisms.
- 2.4 Lichen - General account of Lichen
- 2.5 Classification
- 2.6 Structure and Reproduction
- 2.7 Economic Importance.

Unit 3: Bryophytes

(18 Hours)

- 3.0 Bryophytes**
- 3.1 General characteristics of Major classes
- 3.2 Classification -Rothmalar
- 3.3 Ecology and Distribution
- 3.4 Methods of Reproduction
- 3.5 General account on origin and evolution of sporophytes
- 3.6 Economic importance.

Unit 4: Pteridophytes

(18 Hours)

- 4.0 Pteridophytes** - General Characteristics
- 4.1 Classification (Sporne, 1975).
- 4.2 Distribution and Life Cycle pattern of major classes
- 4.3 Evolutionary trend in structures and organization
- 4.4 Heterospory and seed habit
- 4.5 Telome theory
- 4.6 Comparative study of Fossil forms –(a) Rhynia, (b) Lepidodendron, (c) Lyginopteris, (d) Calamites (e) Medullosa
- 4.7 Fern Culture and Economic importance.

Unit 5: Gymnosperms**(18 Hours)**

- 5.0 Gymnosperms - General account of major classes
- 5.1 Characteristics and distribution
- 5.2 Classification – Sporne
- 5.3 Reproduction and life cycle - Evolutionary trend and phylogenetic relationship
- 5.5 Economic importance.

Topics for Self - study:

S. No.	Self Study	References
1	Macro algae nursery	https://doi.org/10.1016/j.algal.2018.02.032 Gupta, V., Trivedi, N., Simoni, S., & Reddy, C. R. K. (2018). <i>Marine macroalgal nursery: A model for sustainable production of seedlings for large scale farming. Algal Research, 31</i> , 463–468.
2	Algal biofertilizers	https://doi.org/10.1089/ind.2018.0010 Win, T. T., Barone, G. D., Secundo, F., & Fu, P. (2018). <i>Algal Biofertilizers and Plant Growth Stimulants for Sustainable Agriculture. Industrial Biotechnology, 14(4)</i> , 203–211.
3	Mycotoxin	https://www.who.int/news-room/fact-sheets/detail/mycotoxins https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/mycotoxins
4	fungals melanin	https://doi.org/10.1016/j.fbr.2016.12.003 Cordero, R. J. B., & Casadevall, A. (2017). <i>Functions of fungal melanin beyond virulence. Fungal Biology Reviews, 31(2)</i> , 99–112. doi:10.1016/j.fbr.2016.12.003
5	Medicinal bryophytes	http://asianscientificjournals.com/new/publication/index.php/ajob/article/view/92/1768
6	Bioindicators	https://www.sciencedirect.com/topics/neuroscience/bioindicators
7	Carbon dating	https://www.britannica.com/science/carbon-14-dating https://www.who.edu/nosams/what-is-carbon-dating
8	Azolla cultivation	http://theazollafoundation.org/growing-azolla/cultivation-of-azolla-as-a-livestock-feed/ http://www.akmindia.in/azolla-cultivation/

9	Molecular phylogeny	Yang, Z., & Rannala, B. (2012). <i>Molecular phylogenetics: principles and practice. Nature Reviews Genetics</i> , 13(5), 303–314. doi:10.1038/nrg3186
10	Siphonogamy	https://en.wikipedia.org/wiki/Siphonogamy

TEXT BOOKS:

1. Vashishta, B.R., Singha, A. K. and Singh, V.P. 2005. *Botany for degree students Algae*. S.Chand and company Pvt. Ltd., New Delhi
2. Sporne. K.R. 2008. *The morphology of Pteridophytes*, Hutchinson University Library, Creative Media Partners, LLC,
3. Vashishta, B.R. and Sinha, A. K. 2007. *Botany for Degree students, Pteridophytes*. Ravindra printers Pvt. Ltd., New Delhi.
4. Rashid, A.,1999. *An Introduction to Pteridophytes*, Vikas publishing, New Delhi.
5. Vashishta, B.R and Sinha, A. K. 2007. *Botany for Degree students, Gymnosperm*. S. Chand and company Pvt. Ltd., New Delhi.
6. Singh, V., Pande, P.C. and K. Jain., 2005. *Text book of Botany Diversity of Microbes and Cryptogams*. Rastogi publications, Meerut, India.
7. Fritch, F.E., 1976. *Structure and Reproduction of Algae*. Volume I and II. BI Publishers, New Delhi.

REFERENCE BOOKS:

1. Fritch, F.E. 1976. *Structure and Reproduction of Algae*. Volume I and II. BI Publishers, New Delhi
2. Alexopoulos, C. J. and Mims, C. W. 1993. *Introductory Mycology* - Third Edition. Wiley Eastern, limited, New Delhi
3. Watson, E.V. 1964. *The structure and life of Bryophytes*. Hutchinson and Co. London
4. Sporne, K.R, 1975. *The Morphology of Pteridophytes*. Hutchinson and Co., London
5. Sporne. K.R. 2008. *The morphology of Gymnosperm*, Hutchinson University Library, Creative Media Partners, LLC, New Delhi

WEB LINK:

https://onlinecourses.swayam2.ac.in/cec20_bt11/preview

SPECIFIC LEARNING OUTCOMES (SLO):

Unit/Sections	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM' S TAXONOMI
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			C LEVEL OF TRANSACTION
I	ALGAE		
1.1	Algae general characteristics of major classes	<ul style="list-style-type: none"> List the general characteristic feature of algae Compare the diversity form of life to algae 	K1
1.2	Fritsch's Classification (1945)	<ul style="list-style-type: none"> Outline the system of Fritsch classification Classify the algae based on key characteristic features 	K2 K2
1.3	Thallus variations	<ul style="list-style-type: none"> List out the different types of thallus Compare the relationship between unicellular and multicellular thallus organization 	K1 K2
1.4	Reproduction	<ul style="list-style-type: none"> Define isogamy Interpret the types of reproduction in Algae 	K1 K2
1.5	Life cycle patterns	<ul style="list-style-type: none"> What is life cycle? Distinguish and compare haplontic and diplontic pattern of life cycle 	K1 K4
1.6	Phylogenetic trends and distribution	<ul style="list-style-type: none"> Define phylogeny Interpret phylogenetic relationship within and between algae group Compare the relationship between primitive and advanced types of algae 	K2 K4
1.7	Economic importance of major groups of Algae.	<ul style="list-style-type: none"> Explain the economic importance of Algae. Analyze the beneficial and harmful aspects of Algae 	K2 K4
1.8	<i>In vitro</i> algal culture.	<ul style="list-style-type: none"> List suitable medium for fresh and marine water algae. Illustrate the protocol for <i>in vitro</i> algal culture 	K4 K2
II	FUNGI & LICHENS		

2.1	Fungal general characteristics of major classes	<ul style="list-style-type: none"> • Explain the general characteristic features of Fungi • Compare similarities and difference between Algae and Fungi 	K2 K5
2.2	Ainsworth's classification (1973)	<ul style="list-style-type: none"> • Outline the Ainsworth's classification. • Make use of the Ainsworth classification to identify Fungi 	K2 K3
2.3	Ecology	<ul style="list-style-type: none"> • Explain the ecological relationship in fungi • Examine the lignicolous and dermatophytic fungi 	K2 K4
2.4	Types of Reproduction and Spore dispersal mechanisms.	<ul style="list-style-type: none"> • Distinguish reproduction types in fungi • Explain heterothallism • Discuss spore dispersal mechanisms in Fungi 	K4 K5 K6
2.5	Economic importance of fungi	<ul style="list-style-type: none"> • Explain the importance of Fungi • Interpret the beneficial and harmful aspects of Mycology 	K2 K4
2.6	Lichen – General account	<ul style="list-style-type: none"> • Define phycobiont and mycobiont • Summarize the general characteristic features of lichens 	K1 K2
2.7	Classification- (Bessey 1950)	<ul style="list-style-type: none"> • Classify the Lichens on the basis of characteristic features 	K2
2.8	Structure and Reproduction	<ul style="list-style-type: none"> • Determine the structure of lichen. • Evaluate the various types of reproduction in lichen. 	K5
2.9	Economic Importance	<ul style="list-style-type: none"> • Make use of lichen used as an indicator for pollution • Discuss the application of Lichens 	K3 K6
III	BRYOPHYTES		
3.1	Bryophytes general characteristics of Major classes	<ul style="list-style-type: none"> • Compare the characteristic feature of Hepaticopsida and Bryopsida 	K4
3.2	Classification(Rothmalar, 1951)	<ul style="list-style-type: none"> • Classify Bryophytes on the basis of thallus and reproduction 	K4

3.3	Ecology and Distribution	<ul style="list-style-type: none"> Define epiphyllous determine the ecological relationship Bryophytes 	K1 K4
3.4	Methods of Reproduction	<ul style="list-style-type: none"> Explain vegetative reproduction of Bryophytes Evaluate the methods of reproduction in Bryophytes 	K2 K5
3.5	Origin and evolution of sporophytes	<ul style="list-style-type: none"> Compare the origin and evolution of sporophytes Interpret the phylogenetic relations in sporophytes of Bryophytes 	K5 K4
3.6	Economic importance	<ul style="list-style-type: none"> Explain the economic and ecological importance of Bryophytes 	K2
IV	PTERIDOPHYTES		
	General Characteristics	<ul style="list-style-type: none"> Recall the habit and habitat List the characteristic feature related with morphological and anatomical 	K1 K4
4.1	Classification (Sporne 1975)	<ul style="list-style-type: none"> Classify plants in Pteridophytes based on habit stele and types and development of spore 	K2
4.2	Distribution and Life cycle Pattern of Major classes	<ul style="list-style-type: none"> Outline the life cycle pattern of Homosporous and Heterosporous 	K2
4.3	Evolutionary trend in structures and organization	<ul style="list-style-type: none"> Analyze the structures in organization of Pteridophytes in relation to evolution 	K4
4.4	Heterospory and Seed Habit	<ul style="list-style-type: none"> Discuss the Heterospory and seed habit 	K2
4.5	Telome theory	<ul style="list-style-type: none"> Analyze the Evolution of sporophyte 	K4
4.6	Comparative study of Fossil Forms – (a) <i>Rhynia</i> (b) <i>Lepidodendron</i> (c) <i>Lyginopteris</i> (d) <i>Calamites</i> (e) <i>Medullosa</i>	<ul style="list-style-type: none"> Compare the anatomical features of fossil 	K2
4.7	Fern Culture and Economic Importance	<ul style="list-style-type: none"> Discuss the biotechnological applications in Pteridophytes 	K2
V	GYMNOSPERM		

5.0	General account on Major classes	<ul style="list-style-type: none"> Analyze the general characteristic features on major classes 	K4
5.1	Characteristics and distribution	<ul style="list-style-type: none"> Examine the Characteristics features and distribution of Gymnosperms 	K4
5.2	Classification -Sporne	<ul style="list-style-type: none"> Outline of the Classification of Pteridophytes 	K2
5.3	Reproduction and Life cycle	<ul style="list-style-type: none"> Identify the mode of Reproduction and life cycle pattern 	K3
5.4	Evolutionary trend and Phylogenetic relationship	<ul style="list-style-type: none"> Analyse the evolutionary Pattern of Pteridophytes 	K4
5.5	Economic Importance	<ul style="list-style-type: none"> Recognize the economic and ecological importance 	K2

Mapping Scheme for the Course Code: P21BY101

P21BY 101	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	H	L	M	M	L	H	M	M	L	H	-
CO2	H	M	L	-	-	L	L	-	L	H	M	H	-
CO3	H	L	-	M	L	-	M	H	M	H	L	H	L
CO4	H	L	L	-	M	-	-	-	M	M	-	H	L
CO5	M	L	-	M	-	L	M	H	-	M	H	-	L
CO6	M	-	L	L	L	M	L	L	M	-	H	L	-

L-Low M-Medium H-High

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

CORE PAPER- II
PLANT ANATOMY, EMBRYOLOGY AND MORPHOGENESIS

Semester : I
Credits : 5
Course Outcome

Course Code: P21BY102
Hours/week : 6

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

No.	COURSE OUTCOMES (CO)	LEVEL	UNIT
CO 1	Explain the structure, function, types and theories of meristematic tissues, tissue differentiation and Theories of root meristem	K2	I
CO 2	Interpret the transition to flowering, growth and formation of organs	K5	I
CO 3	Categorize the Wood Structure Types Sapwood, Heartwood	K4	II
CO 4	Evaluate the structure and development of microsporangium	K5	III
CO 5	Determine the various ovule structures and modifications in Angiosperms.	K5	IV
CO 6	Explain the morphogenetic factors, molecular basis of morphogenesis and seed germination	K5	V

SYLLABUS

Unit 1: DEVELOPMENTAL PLANT ANATOMY

(15 Hours)

- 1.1. Shoot apex
- 1.2. Meristem –Definition, structure, types and theories; Apical meristem - Definition, structure, types and theories
- 1.3. Primordium initiation
- 1.4. Transition to Flowering
- 1.5. Growth and formation of organs
- 1.6. Organization of root apical meristem (RAM)
 - 1.6.1. Cell fate and lineages
 - 1.6.2. Vascular tissue differentiation
 - 1.6.3. Lateral roots
 - 1.6.4. Root hairs
 - 1.6.5. Theories of root meristem

Unit 2: WOOD DEVELOPMENT

(15 Hours)

- 2.1. Secondary tissue differentiation
- 2.2. Role of cambium
 - 2.2.1. Secondary xylem
 - 2.2.2. secondary phloem
- 2.3. Wood
 - 2.3.1. Structure
 - 2.3.2. Types – Sapwood, Heartwood
 - 2.3.3. Functions
- 2.4. Wood development in relation to environmental factors

Unit 3: EMBRYOLOGY – DEVELOPMENT OF MALE AND FEMALE GAMETES

(15 Hours)

- 3.1. Microsporangium - Anther wall, sporogenous tissue
- 3.2. Microsporogenesis – Meiosis, Microspore tetrad
- 3.3. Male gametophyte
 - 3.3.1. Morphology- Pollen wall features, preparation of pollen grains
 - 3.3.2. Development – Formation of vegetative and generative cells, Inheritance of cytoplasmic traits, Pollen wall, Abnormal features
- 3.4. Female gametophyte
 - 3.4.1. Ovule development, megasporogenesis, organization of the embryo sac, structure of the embryo sac.
- 3.5. Pollination- Definition, Floral characteristics, pollination mechanisms and vectors, breeding systems, commercial considerations.
- 3.6. Sexual incompatibility – Pollen stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects)

Unit 4: EMBRYOLOGY – FERTILIZATION AND POST FERTILIZATION CHANGES

(15 Hours)

- 4.0. Pollen germination, pollen tube growth and guidance, pollen allergy, pollen embryos
- 4.1. Double fertilization- Definition, importance and uniqueness of angiosperms
- 4.2. Endosperm development - Early maturation and desiccation stages
- 4.3. Embryogenesis – Definition, ultrastructure, cell lineages during late embryo development
- 4.4. Storage proteins of endosperm and embryo, polyembryony and apomixes.
- 4.5. Dynamics of fruit growth, biochemistry
- 4.6. Molecular biology of fruit maturation

Unit 5: MORPHOGENESIS

(15 Hours)

- 5.1. Morphogenesis – Definition, scope and importance
- 5.2. Correlation, polarity, symmetry, differentiation, regeneration
- 5.3. Morphogenetic factors - Physical, mechanical, chemical and genetic factors
- 5.4. Molecular basis of morphogenesis in *Arabidopsis*.
- 5.5. Seed germination
- 5.6. Seedling growth

Topics for Self-Study:

S. No.	Self Study	References
1	Axial organ	https://www.frontiersin.org/articles/10.3389/fimmu.2019.00870/full Kutschera, U. (1995). <i>Tissue Pressure and Cell Turgor in Axial Plant Organs: Implications for the Organismal Theory of Multicellularity</i> . <i>Journal of Plant Physiology</i> , 146(1-2), 126–132. doi:10.1016/s0176-1617(11)81978-4
2	Callose	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/callose https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/callose/pdf
3	Crassula	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/crassula/pdf
4	Gonophyll	http://content.inflibnet.ac.in/data-server/eacharya-documents/57189ee98ae36c5c22225878_INFIEP_307/110/ET/307-110-ET-V1-S1_file1.pdf
5	Morphogenesis	https://www.researchgate.net/publication/275833295_Plant_morphogenesis_theoretical_bases/link/5548193e0cf2e2031b386378/download
6	Gynophore	Moctezuma, E. (2003). <i>The peanut gynophore: a developmental and physiological perspective</i> . <i>Canadian Journal of Botany</i> , 81(3), 183–190. doi:10.1139/b03-024
7	Tegmen	https://www.biologydiscussion.com/plants/seeds-and-their-morphological-features-with-diagram/6334

TEXT BOOKS:

1. Pandey, B. P. 2011. *Plant Anatomy*. S. Chand and company Pvt. Ltd. New Delhi.
2. Bhojwani, S.S. and Bhatnagar, S.P. 2011. *Embryology of Angiosperms (5th Edt.)*. Vikas Publication House Pvt. Ltd. New Delhi.
3. Pandey, S.N. and Chadha, A. 1997. *Plant Anatomy and Embryology*. Sangam Books Ltd. New Delhi.
4. Mauseth, J.D. 1988. *Plant Anatomy*. The Benjamin/Cummings Publisher, USA.
5. Cutter, E.G.1989.*Plant Anatomy –Part I-Addison –Wesley Publishing Co.*
6. Maheswari, P.1991. *An Introduction to Embryology of Angiosperms*. Tata McGraw hill Publishing Co. Ltd. India.

7. Erdtman, G. 1954. *An introduction to pollen analysis*. Chronica Botanica, Waltham, Mass. USA.
8. Swamy. B.G.L. & Krishnamoorthy. K.V., 1980. *From flower to fruit*, Tata McGraw Hill Publishing Co., Ltd., New Delhi.

REFERENCE BOOKS:

- 1 Esau, K.1985. *Anatomy of seed plants*. John Willey, Wiley Eastern Ltd., New Delhi, Bangalore, Bombay.
- 2 Nels. R. Lersten, 2004. *Flowering Plant Embryology*, Willy Black well Publication,
- 3 Batygina, T. B., 2009. *Embryology of flowering plants terminology and concepts*, CRC Press.

Web Link:

<https://www.easybiologyclass.com/plant-anatomy-online-tutorials-lecture-notes-study-materials/https://nptel.ac.in/courses/102/107/102107075/>

SPECIFIC LEARNING OUTCOME (SLO):

UNIT/ Section	CONTENTS	LEARNING OUTCOMES	Highest blooms taxonomic level of transaction
I	DEVELOPMENTAL PLANT ANATOMY		
1.1 1.2	Shoot apex, Definition, structure, types and theories	<ul style="list-style-type: none"> • Recall the apical cell theories 	K1
1.3. 1.4 1.5	Primordium initiation Transition to Flowering -Growth and formation of organs	<ul style="list-style-type: none"> • Interpret the transition to Flowering in plants • Compare the growth and formation of organs in various plants 	K5 K2
1.6 1.6.1	Organization of root apical meristem - cell fate and lineages	<ul style="list-style-type: none"> • Interpret the cell fate and lineages 	K2
1.6.2 1.6.3 1.6.4 1.6.5	Vascular tissue differentiation Lateral roots Root Hairs Theories of root meristem	<ul style="list-style-type: none"> • Compare the Vascular tissue differentiation • Identify the root apical meristem in plants • Explain the root hairs, lateral roots 	K2 K3 K2
II	WOOD DEVELOPMENT		

2.1	Secondary tissue differentiation	<ul style="list-style-type: none"> • Compare the primary and Secondary tissue differentiation • Examine the Role of cambium • Make use of the wood identification and utilize the same • Relate wood development and environmental factors 	K2	
2.2	Role of cambium- secondary xylem, secondary phloem		K4	
2.3	Wood- Structure		K3	
2.3.2	Types Sapwood, Heartwood-			
2.3.3	Functions			
2.4	Wood development in relation to environmental factors	K2		
III	EMBRYOLOGY – DEVELOPMENT OF MALE AND FEMALE GAMETES			
3.1	Microsporogenesis,	<ul style="list-style-type: none"> • Distinguish the anther wall and sporogenous tissue • Compare the male and female gametophyte structure • Discuss the various types of pollination. • Explain the development and maturation of female gametophyte. • Interpret the accessory cells in the development of gametophytes. • Identify the sexual incompatibility in plants 	K4	
3.2	Microsporangium - Anther wall, sporogenous tissue		K5	
	Microsporogenesis – Meiosis, Microspore tetrad		K2	
3.3	Male gametophyte		K2	
3.3.1.	Morphology- Pollen wall features, preparation of pollen grains			
3.3.2.	Development – Formation of vegetative and generative cells, Inheritance of cytoplasmic traits, Pollen wall, Abnormal features		K5	
3.4	Female gametophyte		K2	
3.4.1.	Ovule development, megasporogenesis, organization of the embryo sac, structure of the embryo sac.			
3.5	Pollination- Definition, Floral characteristics, pollination mechanisms and vectors, breeding systems, commercial considerations.			K3
3.6	Sexual incompatibility – Pollen stigma interactions, sporophytic and gametophytic self - incompatibility (cytological, biochemical and molecular aspects)			
IV	EMBRYOLOGY – FERTILIZATION AND POST FERTILIZATION CHANGES			
4.0	Pollen germination, pollen tube growth and guidance, pollen allergy, pollen embryos		<ul style="list-style-type: none"> • Experiment with pollen germination test • Examine the pollen allergy 	K3
4.1				K4

4.2	Double fertilization- Definition, importance and uniqueness of angiosperms	<ul style="list-style-type: none"> Infer the double fertilization in plants Perceive the knowledge about the endosperm development Estimate the storage proteins of endoderm and embryo 	K2
4.3	Endosperm development - Early maturation and desiccation stages		K5
4.4	Embryogenesis – Definition, ultrastructure, cell lineages during late embryo development		K4
4.5	-Storage proteins of endosperm and embryo, polyembryony and apomixes		
4.6	Dynamics of fruit growth, biochemistry		
	Molecular biology of fruit maturation		
V	MORPHOGENESIS		
5.1	Morphogenesis – Definition, scope and importance	<ul style="list-style-type: none"> Explain the Morphogenesis Scope and importance Estimate the polarity, differentiation and regeneration Analyze the morphogenetic factors Make use the <i>Arabidopsis</i> for the molecular studies Examine with seed germination and seedling growth 	K5
5.2	Correlation, polarity, symmetry, differentiation, regeneration		K4
5.3	Morphogenetic factors - Physical, mechanical, chemical and genetic factors		K4
5.4	Molecular basis of morphogenesis in <i>Arabidopsis</i> .		K3
5.5	Seed germination,		K4
5.6	Seedling growth		

Mapping Scheme for the COURSE CODE: P21BY102.

P21BY102	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	M	M	M	H	M	H	H	-	L	H
CO2	M	-	L	L	L	L	-	L	L	H	M	L	H
CO3	L	-	L	L	L	M	-	L	-	M	L	M	H
CO4	M	H	-	-	M	L	-	-	L	M	L	-	H
CO5	M	-	L	L	L	-	L	-	M	H	M	-	H
CO6	H	L	M	-	-	-	L	-	M	M	-	L	H

L-Low M-Medium H-High

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

CORE PAPER III: ECOLOGY AND PHYTOGEOGRAPHY

Semester: I
Credits: 4

Course Code : P21BY103
Hours/Week : 6

Course Outcomes:

On completion of this course the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Explain the Edaphic factors and Topographic factors in relation to the environment	K5	I
CO 2	Evaluate hydrological and water Resource management for future conservation	K4	II
CO 3	Analyze the Biosphere and its interaction with the abiotic factors	K4	III
CO 4	Examine the inter-relationship among organisms in a population and communities.	K4	III
CO 5	Value Phytogeography and its importance in plant distribution	K5	IV
CO 6	Discuss the process for the control of global warming, phytoremediation and disaster management.	K6	V

SYLLABUS:

Unit 1: Geology, Pedology, Topography and Biogeochemical Cycles (18 Hours)

- 1.1 Geology – introduction
- 1.2 Earth – structure and degradation
 - 1.2.1 Land distribution, use pattern
 - 1.2.2 Rock formation and Types of Rocks
 - (a) Igneous Rocks (b) Sedimentary Rocks (c) Metamorphic Rocks
- 1.3 Soil – Definition, Origin (Pedogenesis: Definition), Concept, Composition and Types
- 1.4 Classification of soils: Urvara [fertile] and Usara [sterile]
- 1.5 Soil profile- Organic matter, Surface soil, Parent rock, Bedrock.
- 1.6 Edaphic factors – moisture, reaction, temperature, nutrients and organisms.
- 1.7 Types of soil erosion: Normal and Accelerated soil erosion
- 1.8 Soil Degradation and Reclamation
- 1.9 Topographic factors: Definition, height, direction and Steepness of the slope
- 1.10 Biogeochemical cycles: Gaseous cycles and Sedimentary cycles

Unit 2: Climatology and Hydrology (18 hours)

- 2.1 Structure and composition of Atmosphere
- 2.2 Climatology: Definition and Climate changes
 - 2.2.1 Weather forecast
 - 2.2.2 Types of precipitation
 - 2.2.2 Climatological factors regulating plants
- 2.3 Hydrological cycle
 - 2.3.1 Distribution of water on earth
 - 2.3.2 Lentic and lotic system
 - 2.3.3 Water resource and quality abuses
 - 2.3.4 Wetland management
- 2.4 Oceanography and marine resources management.

Unit 3: Ecological approaches and biotic interaction (18 Hours)

- 3.1 Species and its characteristics
 - 3.1.1 Speciation
- 3.2 Population Ecology
 - 3.2.1 Population structure and Interaction
 - 3.2.2 Ecads (Ecophenes) and Ecotypes
- 3.3 Community Ecology
 - 3.3.1 Composition, Dynamics, classification and physiognomy
 - 3.3.2 Plant communities
- 3.4 Plant Succession
 - 3.4.1 Causes and Kinds of succession
 - 3.4.2 Climax concept and Secondary succession
- 3.5 Plant Adaptations
 - 3.5.1 Types and Factors influencing the plants
- 3.6 Ecosystem
 - 3.6.1 Definition, structures, component and functions.
 - 3.6.2 Biosphere and its interaction with abiotic factors.

Unit 4: Phytogeography (18Hours)

- 4.1 Phytogeography
 - 4.1.1 Definition, Importance, Types and Principles.
 - 4.1.2 Environment and Plant responses
- 4.2 Migration, Ecesis and Colonization
- 4.3 Distribution of flora
 - 4.3.1 Wides and endemics
 - 4.3.2 Factors affecting Distribution of species
- 4.4 Vegetation of World, India and Tamil Nadu (Altitudinal and Longitudinal variations).
- 4.5 Phytogeographic regions of India

Unit 5: Applied Ecology

(18 Hours)

- 5.1 Applied Ecology - overview
- 5.2 Carbon foot print and Carbon sequestration
- 5.3 Temperature regulation and Control of global warming
- 5.4 Phytoremediation
- 5.5 Erosion control and Disaster management
- 5.6 Advanced ecological studies in the developing and developed nations

Topics for Self- Study:

S. no.	Self Study	References
1	Soil complex	https://www.biologydiscussion.com/soil/soil-definition-components-and-role-of-soil-organisms-with-diagram/7155
2	Monsoon of India	https://www.britannica.com/science/Indian-monsoon
3	Ecological energetics	https://biologyboom.com/ecological-energetic/
4	Plant population Dynamics	Crawley, M. J., & Ross, G. J. S. (1990). <i>The Population Dynamics of Plants [and Discussion]</i> . <i>Philosophical Transactions of the Royal Society B: Biological Sciences</i> , 330(1257), 125–140. doi:10.1098/rstb.1990.0187
5	forest management in India and Global warming	https://medcraveonline.com/MOJES/MOJES-03-00106.pdf

TEXT BOOKS:

1. Saha, K. R., 2010. *Ecology and Environmental Biology*, Arunnabha Sen, Books and Allied P Ltd. Kolkata.

- Sharma, P.D. 2015. *Ecology and Environment* (12th Edt.). Rastogi Publications, Meerut, Uttar Pradesh.
- Pandey, P. B. 2007. *Botany for Degree students*. S. Chand and Company Pvt. Ltd., New Delhi.
- Schulze, E.D., Beck, E. and Muller-Hohenstein, K. 2005. *Plant Ecology*. Springer, Heidelberg, New York.
- Sharma, P. D.2019. *Plant Ecology and Phytogeography* (1st Edt.). Rastogi Publications, Meerut, Uttar Pradesh.

REFERENCE BOOKS

- Odum, E.P. 1983. *Basic Ecology*, CBS College Publishing, New York.
- Geiger, R., Aron, R. H. and Tod hunter, P. 2003. *The Climate near the Ground*, 6th Edn. Rowman and Littlefield Publishers, Lanham, MD, USA.
- Mishra, R.1991. *Planning for environmentally Sustainable Development*. Keynote Lecturer-Symposium of School of Environmental science, J.N.U. New Delhi.

Web Links:

<https://nptel.ac.in/courses/105/105/105105106/>

<https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce47/>

SPECIFIC LEARNING OUTCOMES (SLO):

UNIT	CONTENT	LEARNING OUTCOME	HIGHEST BLOOMS TAXONOMIC LEVEL OF TRANSACTION
I	GEOLOGY, PEDOLOGY, TOPOGRAPHY AND BIOGEOCHEMICAL CYCLES		
1.1 1.2.1 1.2.2 1.2.3	Earth – structure and degradation Land distribution, use pattern Rock formation and Types of Rocks (a) Igneous Rocks (b) Sedimentary Rocks (c) Metamorphic Rocks	<ul style="list-style-type: none"> Explain the structure and types of rocks. 	K2
1.3	Soil – Definition, Origin (Pedogenesis), Concept, Composition and Types	<ul style="list-style-type: none"> Explain soil types 	K2

1.4	Soil – Definition, Origin (Pedogenesis: Definition), Concept, Composition and Types	<ul style="list-style-type: none"> • Explain the process of pedogenesis • Describe the soil composition and soil types. 	K2
1.5	Classification of soils: Urvara [fertile] and Usara [sterile]	<ul style="list-style-type: none"> • Classify the soils 	K2
1.6	Soil profile- Organic matter, Surface soil, Parent rock, Bedrock.	<ul style="list-style-type: none"> • Interpret the different layers of soil 	K2
1.7	Edaphic factors – moisture, reaction, temperature, nutrients and organisms	<ul style="list-style-type: none"> • Explain the soil factors for plant growth 	K2
1.8	Types of soil erosion: Normal and Accelerated soil erosion	<ul style="list-style-type: none"> • Define the mechanism of soil erosion and its types. • Explain the soil degradation process and necessary action to be taken 	K2 K5
1.9	Soil Degradation and Reclamation		
1.10	Topographic factors: Definition, height, direction and Steepness of the slope	<ul style="list-style-type: none"> • Define Topographic factors 	K2
1.11	Biogeochemical cycles: Gaseous cycles and Sedimentary cycles	<ul style="list-style-type: none"> • Outline the process of chemical cycle through Lithosphere, hydrosphere, atmosphere and biosphere. 	K2
II	CLIMATOLOGY AND HYDROLOGY		
2.1	Structure and composition of Atmosphere	<ul style="list-style-type: none"> • Recall the structure and composition of atmosphere • Classify the different layers of atmosphere 	K2 K2
2.2	Climatology: Definition and Climate changes	<ul style="list-style-type: none"> • Describe the climatology, weather forecast 	K2 K2
2.2.1	Weather forecast Types of precipitation	<ul style="list-style-type: none"> • Illustrate the weather forecasting system 	K2

		<ul style="list-style-type: none"> • Explain the different types of precipitation 	
2.2.2	Climatological factors regulating plants	<ul style="list-style-type: none"> • Illustrate the various Climatological factors regulating plant growth and development 	K2
2.3	Hydrological cycle	<ul style="list-style-type: none"> • Recall the hydrological cycle and distribution of water on earth 	K2
2.3.1	-Distribution of water on earth	<ul style="list-style-type: none"> • Distinguish the lentic and lotic water system 	K4
2.3.2	-Lentic and lotic system		
2.3.3	Water resource and quality abuses	<ul style="list-style-type: none"> • Identify various water resource and its quality abuses 	K3
2.3.4	-Wetland management	<ul style="list-style-type: none"> • Plan suitable management practice for wetland 	K3
2.4	-Oceanography and marine resources management.	<ul style="list-style-type: none"> • Explain marine resources 	K2
III	ECOLOGICAL APPROACHES AND BIOTIC INTERACTIONS		
3.1	-Species and its characteristics	<ul style="list-style-type: none"> • Define species and its characters • Explain the process of speciation 	K2
3.1.1	-Speciation		
3.2	Population Ecology	<ul style="list-style-type: none"> • Describe the Population ecology, Structure and interactions 	K2
3.2.1	Population structure and Interaction	<ul style="list-style-type: none"> • Explain Ecads and Ecotypes 	K2
3.2.2	Ecads (Ecophenes) and Ecotypes		
3.3	Community Ecology	<ul style="list-style-type: none"> • Explain community ecology • Classify the plant communities 	K2
3.3.1	-Composition, Dynamics, classification and physiognomy		K4

3.3.2	-Plant communities		
3.4	Plant succession	<ul style="list-style-type: none"> • Explain the plant succession • Identify the different kind of plant succession 	K2
3.4.1	-Causes and Kinds of succession		K3
3.4.2	-Climax concept and Secondary succession		
3.5	Plant Adaptations	<ul style="list-style-type: none"> • Conclude the plant adaptation • Infer the various factors influencing the plants 	K4
3.5.1	-Types and Factors influencing the plants		K2
3.6	Ecosystem	<ul style="list-style-type: none"> • Define Ecosystem, Structure, component and functions • Examine the Biosphere and its interaction with abiotic factors 	K2
3.6.1	Definition, structures, component and functions.		K4
3.6.2	Biosphere and its interaction with abiotic factors		
IV	PHYTOGEOGRAPHY		
4.1	Phytogeography	<ul style="list-style-type: none"> • Describe Phytogeography and its importance 	K2
4.1.1	-Definition, Importance, Types and Principles.		
4.1.2	-Environment and Plant responses	<ul style="list-style-type: none"> • Illustrate the response of plant to environment 	K2
4.2	-Migration, Ecesis and Colonization	<ul style="list-style-type: none"> • Explain the process of Migration, Ecesis and Colonization 	K5
4.3	Distribution of flora	<ul style="list-style-type: none"> • Illustrate the distribution of flora. • Examine the factors affecting the distribution of species 	K2
4.3.1	Wides and endemics		K4
4.3.2	Factors affecting Distribution of species		
4.4	Vegetation of World, India and Tamil Nadu (Altitudinal and Longitudinal variations).	<ul style="list-style-type: none"> • Classify the different Plant vegetation types. • Compare the vegetation types of world and India. 	K2

		<ul style="list-style-type: none"> Inspect the influence of altitudinal and longitudinal variation in plants. 	
4.5	Phytogeography regions of India	<ul style="list-style-type: none"> Summarize the different phytogeographical regions of India 	K2
V	Applied Ecology		
5.1	Applied Ecology – overview	<ul style="list-style-type: none"> Define applied Ecology 	K2
5.2	Carbon foot print and Carbon sequestration	<ul style="list-style-type: none"> Analyze the source of carbon Assess carbon sequestration 	K4
5.3	Temperature regulation and Control of global warming	<ul style="list-style-type: none"> Formulate methods for temperature regulations and control of global warming 	K6
5.4	Phytoremediation	<ul style="list-style-type: none"> Make use of plants for remediation of soil pollutions 	K3
5.5	Erosion control and Disaster management	<ul style="list-style-type: none"> Develop strategies to encounter disaster and manage the situation. 	K6
5.6	Advanced ecological studies in the developing and developed nations.	<ul style="list-style-type: none"> Relate the ecological studies in developing and developed nations Make use of advanced ecological strategies from developed nations. 	K2 K3

Mapping scheme for the Course code: P21BY103

P21BY103	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	M	H	-	M	-	L	H	-	L	H
CO2	H	-	L	H	H	L	L	-	-	M	-	L	H
CO3	M	L	L	H	M	H	M	M	-	M	M	M	H
CO4	M	-	-	M	M	M	L	M	L	M	M	M	H
CO5	M	-	M	L	M	L	-	H	L	L	L	H	H
CO6	M	-	-	H	M	-	-	H	L	H	L	L	H

COURSE ASSESSMENT METHODS:**Direct**

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

CORE PRACTICAL I - PLANT DIVERSITY**Semester : I****Course code : P21BY1P1****Credits : 3****Hours/Week: 3****Course Outcomes:**

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Examine and discriminate the diversified Algae in the Plant Kingdom	K4	I
CO 2	Identify the vegetative and fruiting structures of various fungi and <i>Usnea</i> sp.	K4	II,III
CO 3	Compare the anatomical and morphological structures of Bryophytes plants	K4	IV
CO 4	Differentiate various Pteridophytes and their stellar structures	K4	V
CO 5	Predict the method of fossilization and fossil identification	K2	VI
CO 6	Compare the anatomical and reproductive structures of various Gymnosperms	K4	VII

SYLLABUS:**Unit- 1: Algae****(9 Hours)**

Thallus and reproductive structure of the following, *Caulerpa*, *Nostoc*, *Oscillatoria*, *Chlamydomonas*, *Volvox*, *Oedogonium*

Unit-2: Fungi (6 Hours)

Mycelium and reproductive structure of the following, *Plasmodiophora*, *Saprolegnia*, *Pilobolus*, *Claviceps*, *Xylaria*, *Aspergillus*, *Penicillium*, *Alternaria*, *Fusarium*.

Unit- 3: Lichen (3 Hours)

Usnea – Thallus and fruit body.

Unit- 4: Bryophytes (6 Hours)

Study of morphological, anatomical and reproductive structures of the following *Marchantia*, *Anthoceros* and *Polytrichum*.

Unit- 5: Pteridophytes (9 Hours)

Comparative anatomy and sporangial organization in *Lycopodium*, *Seleginella*, *Equisetum*, *Adiantum* and *Marsilea*.

Unit- 6: Fossils – (3 Hours)

Study of the anatomical features of the following fossils specimens *Rhynia*, *Lepidodendron*, *Lyginopteris*, *Calamites* and *Medullosa*.

Unit- 7: Gymnosperms- (9 Hours)

Comparative study of the wood and cone structures by *Cycas*, *Cupressus*, *Araucaria* and *Gnetum*. Field Trip to a place of botanical interest to study the habit and habitat of the genera mentioned in the syllabus.

Topics for Self- Study:

Sl No.	Topics	Reference Links
1.	Algal Purification Techniques	https://link.springer.com/article/10.1134/S0026261716040159
2	<i>Azolla</i> cultivation	http://www.akmindia.in/azolla-cultivation/
3.	Contribution of Birbal Sahni	https://palaeobotany.org/index.php/palaeobotanist-biographies/sahni-birbal-1891-1949/
4.	Connecting fossil Gymnosperms	https://www.britannica.com/plant/Cycadeoidophyta

TEXT BOOKS:

1. Vashishta, B.R., Singha, A.K. and Singh, V.P. 2005. *Botany for degree students Algae*. S. Chand and company Pvt. Ltd., New Delhi.

2. Vashishta, B.R., Singha, A.K. and Singh, V.P. 2005. *Botany for degree students Fungi*. S. Chand and company Pvt. Ltd. New Delhi.
3. Vashishta, B.R., Singha, A.K. and Singh, V.P. 2005. *Botany for degree students Bryophytes*. S. Chand and company Pvt. Ltd. New Delhi.
4. Vashishta, B.R. and Sinha, A.K. 2007. *Botany for Degree students Pteridophytes*. Rajendra Ravindra printers Pvt. Ltd., New Delhi.
5. Vashishta, B.R and Sinha, A. K. 2007. *Botany for Degree students Gymnosperm*. S. Chand and company Pvt. Ltd., New Delhi.

REFERENCE BOOKS:

1. Smith, G. M. 1951. *Manual of Phycology*. Waltham Mass, USA, Chronica Botanica Company.
2. Athar Hussain Shah, 2020. *Laboratory Manual (Plant Diversity)*, ILMI, Kitab Khana, Lahore.
3. Bendre, A. M., 2008. *Practical Botany*, Rastogi Publications, Meerut, India.
4. Pandey, B.P. 2015. *College Botany Volume II*. S. Chand and company Pvt. Ltd., New Delhi.
5. Pandey, B.P. 1993. *The Text of Botany Fungi*. S. Chand and company Pvt. Ltd., New Delhi.
6. Bhatnagar, S.P and Alok Moitra. 2003. *Gymnosperms*. K.K Gupta for New International Pvt. Ltd, New Delhi.
7. Fritch, F.E., 1976. *Structure and Reproduction of Algae*. Volume I and II. BI Publishers, New Delhi.

Web Links:

<https://www.coursera.org/learn/plantknows>
https://cms.botany.org/home/resources/online_resources.html

SPECIFIC LEARNING OUTCOMES (SLO):

UNIT	CONTENT	LEARNING OUTCOME	Highest level of blooms taxonomic transaction
I	Algae		
	Thallus and reproductive structure of the following <i>Caulerpa, Nostoc,</i>	<ul style="list-style-type: none"> • Compare the diversity form of algae 	K2

	<i>Oscillatoria, Chlamydomonas, Volvox and Oedogonium</i>	<ul style="list-style-type: none"> Distinguish the habit, external and internal structure of algae 	K4
II	Fungi		
	Mycelium and reproductive structure of the following <i>Plasmodiophora, Saprolegnia, Pilobolus, Claviceps, Xylaria, Aspergillus, Penicillium, Alternaria, Fusarium.</i>	<ul style="list-style-type: none"> Compare the morphological structures of fungi Identify the fruiting body of various fungi Recall the diseases caused by fungi 	K4 K2 K1
III	Lichen		
	<i>Usnea</i> – Thallus and fruit body.	<ul style="list-style-type: none"> Infer the morphological and internal association of Algae and Fungi 	K4
IV	Bryophytes		
	Study of morphological, anatomical and reproductive structures of the following <i>Marchantia, Anthoceros and Polytrichum</i>	<ul style="list-style-type: none"> Identify the internal and external structures of Bryophytes Analyze the ecological importance of Bryophytes 	K2 K4
V	Pteridophytes		
	Comparative anatomy and sporangial organization in <i>Lycopodium, Seleginella, Equisetum, Adiantum and Marsilea</i>	<ul style="list-style-type: none"> Explain the internal and stellar variation in Pteridophytes Analyse and Compare the structures of various Pteridophytes 	K2 K4
VI	Paleobotany		
	Fossils Study of the anatomical features of the following fossils specimens <i>Rhynia, Lepidodendron, Lyginopteris, Calamites and Medullosa</i>	<ul style="list-style-type: none"> Interpret the fossilization methods and fossil plants 	K2
VII	Gymnosperms		

	Comparative study of the wood and cone structures by <i>Cycas, Cupressus, Araucaria and Gentum</i>	<ul style="list-style-type: none"> Compare the morphological and anatomical features in Gymnosperms 	K4
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Mapping Scheme for the Course Code: P21BY1P1

P21BY 1P1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PS O1	PS O2	PS O3	PS O4
CO1	H	L	H	L	M	M	L	H	M	M	L	H	-
CO2	H	M	L	-	-	L	L	-	L	H	M	H	-
CO3	H	L	-	M	L	-	M	H	M	H	L	H	L
CO4	H	L	L	-	M	-	-	-	M	M	-	H	L
CO5	M	L	-	M	-	L	M	H	-	M	H	-	L
CO6	M	-	L	L	L	M	L	L	M	-	H	L	-

L-Low (1) M-Medium (2) H-High (3)

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment in Practical works, sectioning, record submission.
2. Practical tests, Records etc.
3. End Semester Examination

Indirect

1. Course-end survey

CORE PRACTICAL – II ANATOMY, EMBRYOLOGY, MORPHOGENESIS AND ECOLOGY

Semester: I

Course code: P21BY1P2

Credits : 3

Hours/Week :3

Course Outcomes:

On completion of this course, the students will be able to:

No	Course Outcomes	Level	Unit
CO 1	Identify the unique anatomical structures in Angiosperms	K3	I
CO 2	Compare and distinguish the anatomical structures of plants	K4	II
CO 3	Conclude on the reproductive structures like anther, pollen, style and stigma	K4	II
CO 4	Evaluate the pollination methods in plants	K5	II
CO 5	Justify the Ecological principles and conclude with reasons	K5	III
CO 6	Apply the parameters of ecological estimation in fields	K3	III

SYLLABUS:

Unit- 1: Anatomy

(15 Hours)

1. Study of cambium - non storied and storied.
2. Study the anomalous primary and secondary features in, *Amaranthus*, *Boerhaavia*, *Mirabilis*, *Nyctanthes*, *Piper* and *Strychnos*.
3. Study of stomata, trichomes, and laticifers. Determination of stomatal index.
4. Study the anatomical peculiarities of C4 and CAM plants (Leaf/Stem).
5. Study of nodal patterns.
6. Prepare a histo-taxonomic key.
7. Study the pericarp anatomy of a legume, follicle and berry.
8. Identification of wood - soft wood and hard wood.

Unit-2: Embryology and Morphogenesis

(15 Hours)

1. Study of microsporogenesis and gametogenesis in sections of anthers.
2. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa*, *Crotolaria*, *Tradescantia*, *Brassica*, *Petunia*, *Solanum melongena*, etc.)
3. Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
4. Estimating percentage and average pollen tube length *in vitro*.
5. Pollen storage, pollen-pistil interaction, self-incompatibility, *in vitro* pollination.
6. Study of ovules in cleared preparations, study of monosporic, bisporic and tetrasporic types of embryo sac development through examination of permanent, stained serial sections.
7. Field study of several types of flower with different pollination mechanisms (Wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
8. Emasculation, bagging and hand pollination to study pollen germination, seed and fruit development using self-compatible and obligate outcrossing systems
9. Study of cleistogamous flowers and their adaptations.
10. Study of nuclear and cellular endosperm through dissections and staining.
11. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in Citrus, Jamun (*Syzygium cumini*) etc. by dissections.
12. Study of seed dormancy and methods to break dormancy.

Unit- 3: Ecology

(15 Hours)

1. Study of atmosphere – Temperature, Humidity, wind velocity, light intensity.
2. Study of geographical position, altitude, latitude, longitude.
3. Study of water - Temp. pH, EC, DO and Salinity.
4. Study of soil – pH, EC, Porosity, Retentivity, Minerals (spot test) nature of soil, profile.
5. Study of individual species – Plant dimensions - length, wt. R/s ratio, leaf area, chl. Phenology, dissemination and regeneration.
6. Study of plant community – Quadrat, Transect, point methods and determination of Den, Fr, Ab, IVA and Phytograph.
7. Study of an ecosystem – Abiotic and biotic components
8. Morphometry of water bodies lentic / lotic – Productivity.

Topics for Self-Study:

S. no	Self Study	References
1	Soil complex	https://www.biologydiscussion.com/soil/soil-definition-components-and-role-of-soil-organisms-with-diagram/7155
2	Monsoon of India	https://www.britannica.com/science/Indian-monsoon
3	Ecological energetics	https://biologyboom.com/ecological-energetic/
4	Plant population Dynamics	Crawley, M. J., & Ross, G. J. S. (1990). <i>The Population Dynamics of Plants [and Discussion]. Philosophical Transactions of the Royal Society B: Biological Sciences</i> , 330(1257), 125–140. doi:10.1098/rstb.1990.0187
5	forest management in India and Global warming	https://medcraveonline.com/MOJES/MOJES-03-00106.pdf

TEXT BOOKS:

- 1 Shivanna, K.R. and Rangaswamy, N.S. 1992. *Pollen Biology: A Laboratory Manual*. Springer-Verlag, Berlin
- 2 Soetaert, Karline, Herman and Peter, M. J.2009. *A Practical Guide to Ecological Modelling*. Springer.
- 3 Varghese, 1984. T. M. *An Introduction to experimental and applied embryology of Angiosperms*. Oxford and IBH Publishing Co., New Delhi.

REFERENCES BOOKS:

- 1 Ambasht, R.S. 1974. *Text Book of Plant Ecology* (3rd Edition) Students & Friends Co., Varanasi.
- 2 Odum, E.P. 1975. *Ecology*, Holt, Rinert & Winston.
- 3 Kochhar, P.L. 1975. *Plant Ecology* (9th Edition) S.Nagi & Co, Jullandhar.
- 4 Shukla, R.S. and Chandel. P.S. *Plant Ecology & Soil Science*. S. Chand & Co., New Delhi.

Web Links:

<https://www.nature.com/articles/135008d0>
<https://www.acs.edu.au/courses/plant-ecology-381.aspx>

SPECIFIC LEARNING OUTCOME (SLO):

UNIT/ Section	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
I	Anatomy		
	1. Study of cambia - non storied and storied regions	<ul style="list-style-type: none"> Identify the cambial structures 	K3
	2. Study the anomalous primary and secondary features in <i>Amaranthus</i> , <i>Boerhaavia</i> , <i>Mirabilis</i> , <i>Nyctanthes</i> , <i>Piper</i> and <i>Strychnos</i>	<ul style="list-style-type: none"> Identify the anomalous structures in plants Interpret the secondary growth with reasons 	K2
	3. Study of stomata, trichomes, and laticifers. Determination of stomatal index	<ul style="list-style-type: none"> Explain and determine the stomata 	K2
	4. Study the anatomical peculiarities of C4 and CAM plants (Leaf/Stem)	<ul style="list-style-type: none"> Compare C4 and CAM plants 	K2
	5. Study of nodal patterns.	<ul style="list-style-type: none"> Compare the nodal patterns 	K2
	6. Prepare a histotaxonomic key	<ul style="list-style-type: none"> Develop idea about histotaxonomic key 	K3
	7. Study the pericarp anatomy of a legume, follicle and berry.	<ul style="list-style-type: none"> Compare the internal structures of pericarp 	K2
	8. Identification of wood - soft wood and hard wood.	<ul style="list-style-type: none"> Interpret the differences between hard and soft wood 	K2
II	Embryology		
	1. Study of microsporogenesis and gametogenesis in sections of anthers	<ul style="list-style-type: none"> Analyse the cross sections of anther 	K4
	2. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, <i>Cannabis sativa</i> , <i>Crotolaria</i> , <i>Tradescantia</i> , <i>Brassica</i> , <i>Petunia</i> , <i>Solanum melongena</i> , etc.)	<ul style="list-style-type: none"> Compare the different types of pollen grains in the species mentioned 	K4

3. Tests for pollen viability using stains and <i>in vitro</i> germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.	<ul style="list-style-type: none"> • Interpret in detail about pollen grains • Experiment with the pollen grains with various parameters 	K5
4. Estimating percentage and average pollen tube length <i>in vitro</i> .		K3
5. Pollen storage, pollen-pistil interaction, self-incompatibility, <i>in vitro</i> pollination.		
6. Study of ovules in cleared preparations, study of monosporic, bisporic and tetrasporic types of embryo sac development thorough examination of permanent, stained serial sections.	<ul style="list-style-type: none"> • Compare and experiment the different types of ovule structures in the species mentioned 	K2
7. Field study of several types of flower with different pollination mechanisms (Wind pollination, thrips pollination, bee/butterfly pollination, bird pollination)	<ul style="list-style-type: none"> • Assess the different pollination methods 	K5
8. Emasculation, bagging and hand pollination to study pollen germination, seed et and fruit development using self-compatible and obligate outcrossing systems	<ul style="list-style-type: none"> • Summarise the learned techniques 	K2
9. Study of cleistogamous flowers and their adaptations.	<ul style="list-style-type: none"> • Understand and outline their adaptations 	K2
10. Study of nuclear and cellular endosperm through dissections and staining	<ul style="list-style-type: none"> • Examine the internal structures 	K4

	11. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, Jamun (<i>Syzygium cumini</i>) etc., by dissections	<ul style="list-style-type: none"> Examine the internal structures 	K4
	12. Study of seed dormancy and methods to break dormancy	<ul style="list-style-type: none"> Understand and outline seed dormancy 	K2
III	Ecology		
	1. Study of atmosphere – Temperature, Humidity, wind velocity, light intensity	<ul style="list-style-type: none"> Understand and outline the methodology Conclude the results for any given sample or site of study with proofs Assess the cultivable land according to the physical parameters 	K2
	2. Study of geographical position, altitude, latitude, longitude		K5
	3. Study of water - Temp. pH, EC, DO and Salinity		K4
	Study of soil – pH, EC, Porosity, Retentivity, Minerals (spot test) nature of soil and profile.		
	4. Study of individual species – Plant dimensions - length, wt. R/s ratio, leaf area, chl. Phenology, dissemination and regeneration		
	5. Study of plant community – Quadrat, Transect, point methods and determination of Density, Fr, Ab, IVA and Phytograph.		
	6. Study of an ecosystem – Abiotic and biotic components.		
	7. Morphometry of water bodies lentic / lotic – Productivity		

Mapping Scheme for the Course Code: P21BY1P2

P21BY 1P2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	-	-	-	-	L	-	-	-	-	-	M	H
CO2	L	-	-	-	-	L	-	-	-	-	-	M	H

CO3	M	L	-	-	M	-	-	-	-	L	-	M	H
CO4	M	L	-	-	M	-	-	-	-	L	-	-	H
CO5	-	-	-	-	H	-		M	-	-	-	-	H
CO6	-	-	-	-	H	-	-	M	-	M	-	-	H

L-Low (1) M-Medium (2) H-High (3)

COURSE ASSESSMENT METHODS:

Direct

- 1. Continuous Assessment in Practical works, sectioning, record submission.**
- 2. Practical tests, Records etc.**
- 3. End Semester Examination**

Indirect

- 1. Course-end survey**

Elective I - TRENDS IN AGRICULTURE

Semester : I
Credits : 4

Course Code : P22BY1:A
Total Hours : 90

On the completion of this course, the students will be able to:

S. no	Course Outcomes	Level	Unit
1	Evaluate and compare traditional and modern farm practices and threat to agriculture	K5	I
2	Apply knowledge on self-sufficient agriculture system which would rely as much as possible biological processes in natural eco-systems	K3	II
3	Improve the production with the application of crop rotation, mixed farming and intercropping for sustainable organic agricultural production and development	K6	III
4	Apply of agriculture concerned with intensively cultivated plants directly used by man with the application of compost and organic residues will allow the substitution of chemical and mineral fertilizers	K4	IV
5	Elaborate the knowledge of modern farming system, Precision farming sustainable organic agricultural production and development	K5	V
6	Developing innovative processes, products, and technologies to meet the challenges in agriculture and farming practices.	K5	VI

SYLLABUS:

Unit I: History of Agriculture Development : 15 Hours

- 1.1 Agriculture :- Definition, Importance and scope,
- 1.2 Branches of agriculture
- 1.3 History of Agricultural development in world and India.
- 1.4 Agricultural heritage – Agriculture in ancient India
- 1.5 Traditional, Modern with special reference to India.
- 1.6 Agronomic classification of crops
- 1.7 Women in agriculture and empowerment

Unit II: Farm Practices 15 Hours

- 2.1 Irrigation: definition and objectives-water management and watershed management.
- 2.2 Water resources of India- Rainfed farming, dry farming and dryland farming
- 2.3 Irrigation methods –
Traditional- dam, kanmai/oorani, ayakattu, anicut, ponds, lakes, channel, well, check dams
Modern - surface irrigation, flooding, furrow, border and basin irrigation, sub irrigation, Drip irrigation- Sprinkler irrigation, surge and bubbler irrigation
- 2.4 Weeds -characteristics of weeds- harmful and beneficial effects –uses
- 2.5 Classification of weeds — Propagation and Dissemination
- 2.6 Crop and weed association and competition

Unit III Cropping pattern: 15 Hours

- 3.1 Weather based cropping (Kharif, rabi and zadi)
- 3.2 Agroclimatic zones of India and Tamilnadu
- 3.3 Multiple cropping and various forms advantages and disadvantages
- 3.4 Intercropping- ecological basis of intercropping systems
- 3.5 Crop rotation
- 3.6 Mixed farming

Unit IV Green Revolution: 15 Hours

- 4.1 History -Famines in India
- 4.2 Green revolution and its impact

- 4.3 Fertilizers and pesticide industries , high yielding varieties, rural banks, road seed banks and wild relatives of cultivars
- 4.4 Contributions of Indian Scientists – IRRI, IARI, ICAR and TNAU
- 4.5 - National agriculture setup in India
- 4.6 Government policies – Price policy
- 4.7 Role of Extension in Agricultural

Unit V Modern practices in Agriculture: 15 Hours

- 5.1 Mechanization (seeding, weeding, manuring, harvesting)
- 5.2 Agricultural information forecasting systems
- 5.3 Water saving devices – rain water harvesting
- 5.4 Biofertilizers – underutilized crops for food security
- 5.5 Organic and vertical farming, hydroponics and aquaponics
- 5.6 Scope for agriculture in space.
- 5.7 Precision farming – Definition, principles and importance of cultivation

Unit VI Practicals 15 Hours

- 6.1 Filed Visit – seeding, weeding, manuring & Harvesting practices
- 6.2 Hydroponics Model system – Demonstration and Model making
- 6.3 Cultivation of Biofertilizers – Ex: Azolla
- 6.4 Preparation of Panjakavya
- 6.5 Rain water harvesting System – Demonstration and Model making
- 6.6 Vertical farming practices
- 6.7 Field Visit - Water saving devices
- 6.8 Soil analysis by using Munsel chart
- 6.9 Field exposure – Various Irrigation methods
- 6.10 Preparation of Green Manure

Topics for Self Study:

S. no	Self Study	References
1	Green Revolution	https://www.nationalgeographic.com/foodfeatures/green-revolution/
2	Agriculture acts in India	http://www.indiaagronet.com/indiaagronet/AGRI_LAW/agri_laws.htm
3	Organic farming	https://www.britannica.com/topic/organic-farming
4	Biofertilizer	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/biofertilizer
5	Nitrogen fixation	https://www.britannica.com/science/nitrogen-fixation

6	Mass cultivation	file:///C:/Users/Admin/Documents/Self%20study%20-OBE-References/MasscultivationofMicroalgaeMasojidekandTorzilloCopy.pdf
7	Plant Breeding	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/plant-breeding
8	Nursery management and Landscaping	https://www.canr.msu.edu/iat/landscape_and_nursery_management_1
9	Farm management system and Irrigation system	https://agriculture.vic.gov.au/farm-management/water/irrigation/irrigation-management

Text Books:

1. Arun Katyayan, 2020. Fundamental of Agriculture Vol 1 and 2. Kusha Publications, Bangalore.
2. Vyas, A.K and Rishi Raj, 2006. An Introduction to Agriculture, Jain Brother publications, New Delhi.
3. Maheshwari, D.K. 2014. *Composting for Sustainable Agriculture*. Springer International Publishing, Switzerland.
4. Gupta, P.K. 2010. *Vermicomposting for sustainable Agriculture*. Agrobios, Jodhpur, India.

Reference Books

1. Anonymous, 2011, Hand book of Agriculture, 6th ed. ICAR, New Delhi, ISBN 81-7164-050-8
2. Chandrasekaran, B., K. Annadurai, and E. Somasundaram, 2010. A Text Book of Agronomy, New Age International (P) Limited Publishers, ISBN (13) : 978-81-224-2859-9
3. Carson, R., 1962. Silent spring, Mariner Books. ISBN 0-618-24906-0
4. Toffler, A. 1980. The Third Wave, Bantam books, United States ISBN 0-517-32719-8 (Hard cover), ISBN 0-553-24698-4 (paperback).
5. Raychaudhuri, S.P. and Roy, M., 1993. Agriculture in Ancient India: A Report, ICAR Publication, New Delhi

Web links:

<https://www.futurelearn.com/subjects/nature-and-environment-courses/agriculture>

<https://www.coursera.org/courses?query=agriculture>

SPECIFIC LEARNING OUTCOMES (SLO):

UNIT/SECTION	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMI C LEVEL OF TRANSACTI ON
1	History of Agriculture Development		
1.1	Agriculture :- Definition, Importance and scope	<ul style="list-style-type: none"> • Explain the importance and branches in agriculture 	K2

1.2	Branches of agriculture	<ul style="list-style-type: none"> Distinguish different types of farming system 	K4
1.3	History of Agricultural development in world and India	<ul style="list-style-type: none"> Explain the origin of Agriculture in the world 	K2
1.4	Agricultural heritage – Agriculture in ancient India	<ul style="list-style-type: none"> Explain various agriculture systems in ancient days 	K5
1.5	Traditional and Modern farming with special reference to India	<ul style="list-style-type: none"> Compare the conventional and modern farming system Discuss agriculture revolution in India 	K2 K2
1.6	Agronomic classification of crops	<ul style="list-style-type: none"> Classify the crops based on human needs 	K2
1.7	Women in agriculture and empowerment	<ul style="list-style-type: none"> Explain the role of women in agriculture 	K5
Unit II: Farm Practices 15 Hours			
2.1	Irrigation: definition and objectives-water management and watershed management.	<ul style="list-style-type: none"> Explain various irrigation pattern and mode of irrigation in Indian 	K5
2.2	Water resources of India- Rainfed farming, dry farming and dryland farming	<ul style="list-style-type: none"> Compare and analysis the water resources for farming 	K4
2.3	Irrigation methods – Traditional- dam, kanmai/oorani, ayakattu, anicut, ponds, lakes, channel, well, check dams Modern - surface irrigation, flooding, furrow, border and basin irrigation, sub irrigation, Drip irrigation- Sprinkler irrigation, surge and bubbler irrigation	Explain various irrigation methods in Indian including traditional and modern	K5

2.4	Weeds -characteristics of weeds- harmful and beneficial effects –uses	<ul style="list-style-type: none"> • Explain the characteristics features of weeds 	K5
2.5	Classification of weeds — Propagation and Dissemination	<ul style="list-style-type: none"> • Classify the weeds in farm land 	K2
2.6	Crop and weed association and competition	<ul style="list-style-type: none"> • Explain the crop and weed association 	K2
III	Cropping pattern		
3.1	Weather based cropping (Kharif, rabi and zadi)	<ul style="list-style-type: none"> • Recall the cropping pattern 	K1
3.2	Agroclimatic zones of India and Tamilnadu	<ul style="list-style-type: none"> • Distinguish the different zone based on climate 	K4
3.3	Multiple cropping and various forms advantages and disadvantages	<ul style="list-style-type: none"> • Evaluates the basic features of multi cropping systems 	K5
3.4	Intercropping- ecological basis of intercropping systems	<ul style="list-style-type: none"> • Analyse the importance of intercropping 	K4
3.5	Crop rotation	<ul style="list-style-type: none"> • Examine the importance of Crop rotation 	K4
3.6	Mixed farming	<ul style="list-style-type: none"> • Explain the importance of mixed Farming 	K5
IV	Green Revolution		
4.1	4.1 History -Famines in India	<ul style="list-style-type: none"> • Explain the causes of Famines 	K5
	4.2 Green revolution and its impact	<ul style="list-style-type: none"> • Explain the importance and impact of Green Revolution 	K5
	4.3 Fertilizers and pesticide industries, high yielding varieties, rural banks, road seed banks and wild relatives of cultivars	<ul style="list-style-type: none"> • Compare the usage of chemical and organic fertilizer • Develop a suitable protocol for mass production of biofertilizer 	K4 K6

	4.4 Contributions of Indian Scientists – IRRI, IARI, ICAR and TNAU	<ul style="list-style-type: none"> Recall the role of various agriculture institution 	K1
	4.5 National agriculture setup in India		
	4.6 Government policies – Price policy	<ul style="list-style-type: none"> Analyse the policies of agriculture 	K4
	4.7 Role of Extension in Agricultural	<ul style="list-style-type: none"> Examine the importance of extension activities 	K4
V	Modern practices in Agriculture		
5.1	Mechanization (seeding, weeding, manuring, harvesting)	<ul style="list-style-type: none"> Distinguish between the different mechanise based on the utilization 	K4
5.2	5.2 Agricultural information forecasting systems	<ul style="list-style-type: none"> Evaluate the need of forecasting system for sustainable farming 	K5
5.3	5.3 Water saving devices – rain water harvesting	<ul style="list-style-type: none"> Analyze forms of wate saving electronic devices 	K4
5.4	Biofertilizers – underutilized crops for food security	<ul style="list-style-type: none"> Compare the usage of chemical and organic fertilizer Develop a suitable protocol for mass production of biofertilizer 	K4 K6
5.5	5.5 Organic and vertical farming, hydroponics and aquaponics	<ul style="list-style-type: none"> Examine the use of modern farming system 	K4
5.6	5.6 Scope for agriculture in space.	<ul style="list-style-type: none"> Explain the principles of agriculture in space 	K2

5.7	5.7 Precision farming – Definition, principles and importance of cultivation	<ul style="list-style-type: none"> Evaluates the basic features of precision farming 	K3
VI	Practicals		
6.1	Field Visit – seeding, weeding, manuring & Harvesting practices 6.11	<ul style="list-style-type: none"> Illustrate the various techniques in agriculture system 	K2
6.2	Hydroponics Model system – Demonstration and Model making Cultivation of		
6.3	Biofertilizers – Ex: Azolla		
6.4	Preparation of Panjakavya		
6.5	Rain water harvesting System – Demonstration and Model making		
6.6	Vertical farming practices		
6.7	Field Visit - Water saving devices		
6.8	Soil analysis by using Munsel chart		
6.9	Field exposure – Various Irrigation methods		
6.10	Preparation of Green Manure		

Mapping Scheme for the PO, PSOs and COs (Course Code: P22BY1:A)

P21BY1:A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	M	-	-	-	-	-	-	L	-	-	-
CO2	M	-	L	M	M	H	M	L	-	M	L	L	M
CO3	L	-	L	M	L	H	M	L	-	-	L	M	-
CO4	H	M	H	-	-	-	L	L	-	M	M	M	-

CO5	M	M	M	-	-	M	-	-	-	-	-	-	-
CO6	M	-	H	-	-	M	M	M	-	M	L	M	M

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

Elective I – ENTREPRENEURIAL BOTANY

Semester : I
Credits : 4

Course Code : P21BY1:B
Hours/Week : 6

Course Outcomes:

On completion of this course, the students will be able to:

No.	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Explain the policies developed by government for small scale industries	K2	I
CO 2	Make use of the plant products.	K3	II
CO 3	Assess the use of various techniques used in Bonsai, cactus cultivation	K4	III
CO 4	Compare the use of various fertilizers.	K2	IV
CO 5	Explain the mushroom cultivation in detail	K5	V
CO 6	Determine the importance of plant products in economy	K5	II, IV, V, VI

SYLLABUS

UNIT I: Plant trade**(15 Hours)****1.1. Trade opportunities – Becoming an Entrepreneur****1.2. Guidance from MSME and SME****1.2.1. Finance from banks****1.2.2. SME –MSMED act - plan and proposal****1.2.3. Training in the concerned field****1.2.4. Trade license and registration marks****1.2.5. Marketing strategies.****1.3. Food safety****1.3.1. Food certification (FAO, EFSA)****1.3.2. Organic shops – food centres.****UNIT 2: Fresh and Dry Plant products****(15 Hours)****2.1. Fresh plant products: Food – health drink – juice - herbs herbal drink- salad)****2.2. Cut flowers usage (garland, Bonsai & Bouquet)****2.3. Nursery (cultivating and sale of ornamental plants, medicinal plants)****2.4. Dried plant products: (spices, leaf plates –leaf fan - plant articles –woodwork)****2.5. Food supplements (health mix)****2.6. Beverages (tea/coffee)****2.7. Raw drugs****2.8. Natural dyes****2.9. Cosmetic products****2.10. Awareness on narcotic plants.****Unit 3: Nursery Business****(15 Hours)****3.1. Fundamentals of nursery site selection****3.2. Design &development of ornamental and medicinal plants****3.3. Bonsai techniques****3.4. Propagation methods of Cactus****Unit 4: Farm Supplements****(15 Hours)****4.1. Bio-fertilizer types****4.1.1. Microbial biofertilizer production (*Azospirillum*)****4.1.2. Green manuring****4.2. Mass cultivation of *Azolla*, *BGA*****4.3. Composting processes (vermi, backyard compost)**

UNIT 5: Mushroom Technology**(15 Hours)**

- 5.1. Identification and characterization of edible mushroom
- 5.2. Collection of edible mushroom
- 5.3. Nutritional, medicinal and economic values of mushroom
- 5.4. Substrates, spawning and pure culture techniques
- 5.5. Protocols for cultivation (Paddystraw and Oyster mushroom cultivation)
- 5.6. Harvest and Post-harvest technology
- 5.7. Marketing strategies
- 5.8. Mushroom recipes.

UNIT 6: Practical**(15 Hours)**

- 6.1. Extraction of natural dyes from plants
- 6.2. Herbal tea preparation
- 6.3. Healthy juice preparation
- 6.4. Cultivation of Cactus
- 6.5. *Azolla* production
- 6.6. Vermicomposting preparation
- 6.7. Mushroom cultivation
- 6.8. Mushroom soup preparation

Topics for Self-Study:

Sl No.	Topics- self-study	References
1.	Government scheme for start-ups	https://www.startupindia.gov.in/content/sih/en/government-schemes.html
2.	Global market	https://www.moneycontrol.com/markets/global-indices/
3.	Toxic mushrooms	https://www.britannica.com/list/7-of-the-worlds-most-poisonous-mushrooms

TEXT BOOKS

1. Bahl, N. 2000. *Hand book on mushroom cultivation*. 4th Ed. Oxford & IBH Publishing Co. New Delhi. ISBN: 8120413997

2. SubbaRao, N. S., 1995. *Soil microorganisms and Plant Growth*. Oxford & IBH Publishing Co., New Delhi. ISBN: 1886106185.
3. Niir Board, 2017. *Handbook on herbs cultivation and processing*, 2004, Asia Pacific Business Press Inc. ISBN:9788178330747

REFERENCE BOOKS

1. Chang, T.S. and Hayes, W.A. 1978. *The biology and cultivation of edible mushrooms*. Academic Press, New York. ISBN: 9781483271149
2. Nair, M.C., Gokulapalan, C. and L. Das, 1997. *Topics on mushroom cultivation*. Scientific Publishers, Jodhpur, India.
3. Abu Mathur, 2017. *Fundamentals of Entrepreneurship*, The tax and corporate laws of India publication. ISBN: 9789386882479.

Web Links:

<https://www.startupindia.gov.in/content/sih/en/reources/l-d-listing.html>

<https://www.udemy.com/courses/business/entrepreneurship/>

SPECIFIC LEARNING OUTCOME (SLO):

Unit	CONTENT	LEARNING OUTCOME	Highest Bloom taxonomic level of transaction
I	Plant trade		
1.1	Trade opportunities – Becoming an Entrepreneur	<ul style="list-style-type: none"> • Tell the definition of entrepreneur 	K1
1.2	Guidance from MSME and SME.	<ul style="list-style-type: none"> • Explain the government schemes 	K2
1.2.1	Finance from banks	<ul style="list-style-type: none"> • Explain the schemes 	K2
1.2.2	SME –MSMED act - plan and proposal	<ul style="list-style-type: none"> • Define the schemes related tp MSME and SME 	K1

1.2.3	Training in the concerned field	<ul style="list-style-type: none"> • Get idea about the training in the field 	K1
1.2.4	Trade license and registration marks	<ul style="list-style-type: none"> • Define the procedures related to trading 	K1
1.2.5	Marketing strategies	<ul style="list-style-type: none"> • Explain the possibilities of marketing 	K2
1.3	Food safety	<ul style="list-style-type: none"> • Explain the possibilities of food adulteration 	K2
1.3.1	Food certification (FAO, EFSA)	<ul style="list-style-type: none"> • Define food certification 	K1
1.3.2	Organic shops – food centres	<ul style="list-style-type: none"> • Tell the organic food shops 	K1
Fresh and Dry Plant products			
2.1	Fresh plant products: Food – health drink – juice - herbs herbal drink- salad)	<ul style="list-style-type: none"> • Explain the process of making various fresh plant products 	K2
2.2	Cut flowers usage (garland, Bonsai & Bouquet)	<ul style="list-style-type: none"> • Define the steps for flower decorations. 	K1
2.3	Nursery (cultivating and sale of ornamental plants, medicinal plants)	<ul style="list-style-type: none"> • Define the stages for nursery maintenance 	K1
2.4	Dried plant products: (spices, leaf plates –leaf fan - plant articles –woodwork)	<ul style="list-style-type: none"> • Explain the possibilities of plant products. 	K2
2.5	Food supplements (health mix)	<ul style="list-style-type: none"> • Define the use of alternate food supplements 	K1
2.6	Beverages (tea/coffee)	<ul style="list-style-type: none"> • Explain the process of making quality beverages 	K2
2.7	Raw drugs	<ul style="list-style-type: none"> • Define the raw drugs form nature 	K1
2.8	Natural dyes	<ul style="list-style-type: none"> • Apply the plant parts for making natural dyes 	K3
2.9	Cosmetic products	<ul style="list-style-type: none"> • Aware of the natural cosmetics 	K2
2.10	Awareness on narcotic plants	<ul style="list-style-type: none"> • Define the toxic plants 	K1
III	Nursery Business		
3.1	Fundamentals of nursery site selection	<ul style="list-style-type: none"> • Explain the basics of site selection 	K2

3.2	Design & development of ornamental and medicinal plants	<ul style="list-style-type: none"> Choose the apt plant for plant business 	K2
3.3	Bonsai techniques	<ul style="list-style-type: none"> Analyze the use techniques for making Bonsai 	K4
3.4	Propagation methods of Cactus	<ul style="list-style-type: none"> Compare the methods of cultivation of various cactus. 	K5
IV	Farm Supplements		
4.1	Bio-fertilizer types	<ul style="list-style-type: none"> Define types of fertilizers 	K1
4.2	Microbial biofertilizer production (<i>Azospirillum</i>)	<ul style="list-style-type: none"> Explain microbial fertilizers 	K2
4.3	Green manuring	<ul style="list-style-type: none"> Explain the process of making green manures 	K5
4.4	Mass cultivation of <i>Azolla</i> , <i>BGA</i>	<ul style="list-style-type: none"> Analyze the use of <i>Azolla</i> as green manure 	K4
4.5	Composting processes (vermi, backyard compost)	<ul style="list-style-type: none"> Compare the vermicompost methods 	K5
V	Mushroom Technology		
5.1	Identification and characterization of edible mushroom	<ul style="list-style-type: none"> Identify the edible mushrooms 	K3
5.2	Collection of edible mushroom	<ul style="list-style-type: none"> Define the possibility of mushroom cultivation 	K1
5.3	Nutritional, medicinal and economic values of mushroom	<ul style="list-style-type: none"> Explain the values of edible mushrooms 	K2
5.4	Substrates, spawning and pure culture techniques	<ul style="list-style-type: none"> Compare the substrates and techniques of mushroom cultivation 	K4
5.5	Protocols for cultivation (Paddystraw and Oyster mushroom cultivation)	<ul style="list-style-type: none"> Define the protocols of mushroom cultivation 	K1
5.6	Harvest and Post-harvest technology	<ul style="list-style-type: none"> Define the process of harvesting of mushrooms 	K5
5.7	Marketing strategies	<ul style="list-style-type: none"> Explain the marketing strategy of mushrooms 	K5
5.8	Mushroom recipes	<ul style="list-style-type: none"> Define recipes of mushroom curries. 	K1
VI	Practical		

6.1	Extraction of natural dyes from plants	<ul style="list-style-type: none"> Apply the use of natural dyes 	K3
6.2	Herbal tea preparation	<ul style="list-style-type: none"> Make use of natural tea preparation 	K3
6.3	Healthy juice preparation	<ul style="list-style-type: none"> Analyse the healthy natural juice production 	K4
6.4	Cultivation of Cactus	<ul style="list-style-type: none"> Explain the cacti techniques 	K5
6.5	<i>Azolla</i> production	<ul style="list-style-type: none"> Explain <i>azolla</i> cultivation procedure 	K5
6.6	Vermicomposting preparation	<ul style="list-style-type: none"> Tell the vermicompost preparation 	K1
6.7	Mushroom cultivation	<ul style="list-style-type: none"> Define the techniques of mushroom cultivation 	K2
6.8	Mushroom soup preparation	<ul style="list-style-type: none"> Explain the process of soup preparation 	K5

Mapping Scheme for the Course Code: P21BY1:B

P21BY1: B	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	H	M	-	M	-	-	-	M	-	H	M
CO2	M	L	L	-	-	H	L	-	L	H	M	H	-
CO3	M	M	-	-	M	-	-	-	M	H	L	H	L
CO4	L	M	M	M	-	L	-	M	M	-		H	-
CO5	M	L	L	L	-	-	M	H	M	-	H	M	-
CO6	M	L	L	L	-	-	M	H	M	-	H	H	M

L-Low (1) M-Medium (2) H-High (3)

Course Assessment Methods:

Direct

- 1. Continuous Assessment in** Class test, Group Discussion and Quiz.
- Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
- 3. End Semester Examination**

Indirect

1. Course-end survey

Elective I - Biofertilizers and Bioinoculum

Semester : I

Course Code : P22BY1:C

Credits : 4

Hours/Week : 6

Course Outcomes:

On completion of the course students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Evaluate and compare the significance, classification, and processes of biofertilizers.	K5	I
CO 2	Design the isolation, mass multiplication, and crop response to bacterial and fungal biofertilizer to carry out the experiments.	K6	II
CO 3	Apply the basic principles of algal and fern biofertilizers' characteristics, isolation, multiplication, and field application process.	K3	III
CO 4	Create the practises involved in maintaining soil fertility and plant productivity and plan a proper pest management strategy for various crops.	K6	IV- VI
CO 5	Summarize the different methods of application and regulation by the government for biofertilizers and bioinoculum.	K2	V
CO 6	Integrate the skills to become an entrepreneur.	K4	II- VI

SYLLABUS:

Unit – I Significance of Biofertilizer (15 Hours)

1.1 Biofertilizers- Introduction, Scope and importance of biofertilizer, Biopesticides and Bioagents in agriculture and organic farming system

1.2 History of biofertilizers production

1.3 Classification of biofertilizers microorganisms used in biofertilizers production.

1.4 Growth characteristics of various microbes used in biofertilizers production.

1.5 Nitrogen cycle in Nature.

1.6 Process of nodule formation, Role of Nif and Nod gene in Biological Nitrogen fixation, Enzyme nitrogenase and its component,

1.7 Biochemistry of nitrogen fixation

Unit –II Bacterial and Fungal Biofertilizers (15 Hours)

2.1 Isolation, Mass multiplication, field application and crop response of *Rhizobium*, *Azotobacter* and Phosphobacteria (Plant Growth Promoting Rhizobacteria- PGPR)

2.2 Isolation, Inoculum production, mass production, field application and crop response of Mycorrhizae, Structure, types and its significance and AM fungi, Mechanisms of translocation of nutrients.

Unit – III -Algal and Fern Biofertilizer (15 Hours)

3.1 Distribution, study characteristic, isolation, mass production, field application and crop response of Cyanobacteria - *Nostoc*, *Anabaena* and *Scytonema*.

3.2 Characteristics, isolation, mass production, field application of *Azolla*.

Unit –IV - Biocontrol and Bioagents (15 Hours)

4.1 Importance of *Trichoderma* spp., *Pseudomonas* spp. and *Bacillus* spp. as a biocontrol agents.

4.2 Mechanism of disease control by these organisms bioagents .

4.3 Types of diseases controlled bioagents formulations, Effectiveness of bioagents against seed borne and soil borne plant pathogens, Mass multiplication and packing, Strategies of marking, and Registration with CIB and organic farming institute

4.4 Importance of *Trichogramma*, *Cryptolaemus*, *Chrysoperla*, NPV and entomofungal pathogens.

4.5 Establishing insectary for host insects and natural enemies, Mass production of *Verticillium*, *Metarhizium*, *Trichoderma*, / *Pseudomonas*/*Bacillus*/Potash Mobilizers/Sulphur oxidizers /organic matter decomposers.

Unit – V Inoculum Preparation (15 Hours)

5.1 Quality standard for biofertilizers different methods of application of biofertilizers,

5.2 role of microorganisms in decomposition of organic farm wastes, methods of quality control assessment in respect of biofertilizers,

5.3 Strategies of Mass multiplication and packing Registration of biofertilizers.

5.4 Strategies of marking and Registration with CIB (Central Insecticides Board) of bioagents and biopesticides

5.5 Mass Multiplication, mode of packaging and storage methods.

5.6 Role of Government in quality control and subsidiaries making potential of biofertilizers.

Unit – VI Practials (15 Hours)

Medium Preparation for bacteria and fungi

Isolation of microorganisms from soil, air and water

Isolation and mass production of bacterial and fungal culture.

Maintenance of pure culture.

Carrier preparation

Azolla cultivation

Topics for Self Study:

S. no	Self Study	References
1	Bioinoculants procedure for agricultural application	https://nbri.res.in/media/Bioinoculant-Producer-for-Agricultural-Application.pdf
2	Role of biofertilizer	https://impellobio.com/blogs/inoculants/role-of-biofertilizer-in-organic-farming#:~:text=Biofertilizers%20utilize%20microorganisms%20and%20materials,the%20biological%20processes%20through%20microorganisms.
3	Nutrient recycling in organic farming	https://eorganic.org/node/787
4	Soil fertility and agriculture	https://agriinfo.in/role-of-biofertilizers-in-soil-fertility-and-agriculture-170/
5	Precision farming	https://www.tab-beim-bundestag.de/en/pdf/publications/summarys/TAB-Arbeitsbericht-ab106_Z.pdf
6	Soil erosion and conservation	https://www.nature.com/articles/s41467-017-02142-7
7	ICAR	https://icar.org.in/
8	Agriculture in space	https://www.agriculture.com/technology/crop-management/farming-in-space

TEXT BOOKS:

1. Somani L.L., 20007. Hand book of Biofertilizers, Agrotech publication academy, Udaipur.
2. Jaiwal A.P and Gupta N. C., 2013. Biofertilizers technology, Enkay Publishing house New Delhi.
3. Varma, A., and Hock, B., 1995. Mycorrhiza, Springer, Verleg Berlin
4. Subha Rao N.S., 1998. Biofertilizers in Agriculture and Forestry, India Book House Ltd. New Delhi.
5. Borkar,S.G. 2015.Beneficial Microbes as Biofertilizers and its Production Technology Woodhead Publisher, India,New Delhi.

REFERENCE BOOKS

1. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and Usage- A Source Book-cum-glossary. FDCO, New Delhi.

2. Biofertilizer Technology, Marketing and usage- A source Book -cum-glossary 1995. Motsara, I. M.R., P. Bhattacharyya and Beena Srivastava, FDCO, New Delhi.
3. Krishnendu Acharya, Surjit Sen and Manjula Rai, 2019. Biofertilizers and Biopesticides, Techno World, Kolkata.
4. John Havlin, James Beaten, Samuel Tisdale, Werner Nelson, 2005. Soil Fertility and Fertilizers - An Introduction to Nutrient Management. 7th Edition, Prentice, Hall. Upper Saddle River, NJ.
5. Brady, N.C., 2002 The Nature and Properties of Soils (13th Edition) McMillan Co., New York. Indian Publisher – Eurasia Publishing House (P) Ltd., Ramnagar, New Delhi.

Web links:

<https://www.shobhituniversity.ac.in/pdf/econtent/Potential-of-Biofertilizers-in-Indian-Agriculture-Prof-Amar-P-Garg.pdf>

<https://agrimoon.com/wp-content/uploads/Manures-Fertilizers-Agrochemicals.pdf>

SPECIFIC LEARNING OUTCOMES (SLO):

UNIT/ SECTI ON	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMI C LEVEL OF TRANSACTI ON
1	Significance of Biofertilizers		
1.1	Biofertilizers- Introduction, Scope and importance of biofertilizer, Biopesticides and Bioagents in agriculture and organic farming system	<ul style="list-style-type: none"> • Define biofertilizers. • Explain the Scope and importance of biofertilizer 	K2
1.2	History of biofertilizers production	<ul style="list-style-type: none"> • illustrate the history of biofertilizers production 	K2

1.3	Classification of biofertilizers microorganisms used in biofertilizers production.	<ul style="list-style-type: none"> • Which microorganisms are used in the production of biofertilizers name them? • Classify the microorganisms used in biofertilizer production. 	K1 K4
1.4	Growth characteristics of various microbes used in biofertilizers production.	<ul style="list-style-type: none"> • What are the characteristics of biofertilizers? • Identification of the role of microorganisms as biofertilizers 	K1 K3
1.5	Nitrogen cycle in Nature.	<ul style="list-style-type: none"> • Explain Nitrogen cycle and their types. 	K5
1.6	Process of nodule formation, Role of Nif and Nod gene in Biological Nitrogen fixation, Enzyme nitrogenase and its component,	<ul style="list-style-type: none"> • Examine the process of nodule formation. • Compare and contrast between Nif and Nod gene • Discuss the enzyme involved in nitrogen fixation 	K4 K6
	Biochemistry of nitrogen fixation	<ul style="list-style-type: none"> • Illustrate the biochemistry of nitrogen fixation. 	K2
II	Bacterial and Fungal Biofertilizers		
2.1	Isolation, Mass multiplication, field application and crop response of <i>Rhizobium</i> , <i>Azotobacter</i> and Phosphobacteria (Plant Growth Promoting Rhizobacteria- PGPR)	<ul style="list-style-type: none"> • Compare field application and crop response of <i>Rhizobium</i>, <i>Azotobacter</i> and Phosphobacteria. • Discuss the isolation and mass multiplication of Bacterial biofertilizers. 	K5 K6
2.2	Isolation, Inoculum production, mass production, field application and crop response of Mycorrhizae, Structure, types and its significance and AM fungi,	<ul style="list-style-type: none"> • Compare field application and crop response of <i>Mycorrhizae</i> and AM fungi.. • Discuss the isolation and mass multiplication of fungal biofertilizers. 	K4 K6

	Mechanisms of translocation of nutrients.	<ul style="list-style-type: none"> Explain the mechanisms of translocation of nutrients 	
III	Algal and Fern Biofertilizer		
3.1	Distribution, study characteristic, isolation, mass production, field application and crop response of Cyanobacteria - <i>Nostoc</i> , <i>Anabaena</i> and <i>Scytonema</i> .	<ul style="list-style-type: none"> Compare the different types of algal biofertilizer production. List out the industrial application of Cyanobacteria. Evaluate the action mechanisms of plant growth promoting BGA 	K4 K5
3.2	Characteristics, isolation, mass production, field application of <i>Azolla</i> .	<ul style="list-style-type: none"> What are the characteristics of <i>Azolla</i> Explain the uses, roles, importance in rice production of <i>Azolla</i>. Discuss the isolation and mass production <i>Azolla</i>. 	K4 K3 K6
IV	Biocontrol and Bioagents		
4.1	Importance of <i>Trichoderma</i> spp., <i>Pseudomonas</i> spp. and <i>Bacillus</i> spp. as a biocontrol agents.	<ul style="list-style-type: none"> List out the importance of biocontrol agents Compare the different types of bacterial biocontrol agents. 	K4
4.2	Mechanism of disease control by these organisms bioagents.	<ul style="list-style-type: none"> Develop disease-control mechanisms using these microorganism bioagents. 	K6
4.3	Types of diseases controlled bioagents formulations, Effectiveness of bioagents against seed borne and soil borne plant pathogens, Mass multiplication and packing , Strategies of marking, and	<ul style="list-style-type: none"> Explain the types diseases controlled by bioagents formulations. Evaluate the impact of biopesticides to the environment and farmers. Summarize the development, regulation and use of biopesticides. 	K2 K5 K2

	Registration with CIB and organic farming institute		
4.4	Importance of <i>Trichogramma</i> , <i>Cryptolaemus</i> , <i>Chrysoperla</i> , NPV and entomofungal pathogens.	<ul style="list-style-type: none"> List out the application of <i>Trichogramma</i>, <i>Cryptolaemus</i>, <i>Chrysoperla</i> Compare the usage of <i>Trichogramma</i>, <i>Cryptolaemus</i>, <i>Chrysoperla</i>, NPV and entomofungal pathogens. 	K4 K5
4.5	Establishing insectary for host insects and natural enemies, Mass production of <i>Verticillium</i> , <i>Metarhizium</i> , <i>Trichoderma</i> , / <i>Pseudomonas</i> / <i>Bacillus</i> /Potash Mobilizers/Sulphur oxidizers /organic matter decomposers.	<ul style="list-style-type: none"> What is the term of natural enemies of insect pests? Classify the approaches to biological control of insect pests. Compare and contrast between Natural enemies and biological control. Elaborate in detail about beneficial insect- predators, parasitoids and Pollinators. 	K1 K4 K5 K6
V	Inoculum Preparation		
5.1	Quality standard for biofertilizers different methods of application of biofertilizers,	<ul style="list-style-type: none"> Discuss the procedure for quality control of biofertilizers. Explain the methods of applying biofertilizers. 	K6 K5

5.2	role of microorganisms in decomposition of organic farm wastes, methods of quality control assessment in respect of biofertilizers,	<ul style="list-style-type: none"> • Explain the role of microorganisms in waste management. • Summarize the role of microbes in decomposing of organic farm wastes 	K5 K2
5.3	Strategies of Mass multiplication and packing Registration of biofertilizers.	<ul style="list-style-type: none"> • Discuss the biofertilizers production and marketing. 	K6
5.4	Strategies of marking and Registration with CIB (Central Insecticides Board) of bioagents and biopesticides	<ul style="list-style-type: none"> • List out the organisation directorate's guidelines and data requirements for registration of bio pesticides in our country. 	K4
5.5	Mass Multiplication, mode of packaging and storage methods.	<ul style="list-style-type: none"> • Evaluates the multiplication, packaging and storage methods of biofertilizer and bioinoculum. 	K5
5.6	Role of Government in quality control and subsidiaries making potential of biofertilizers.	<ul style="list-style-type: none"> • Summarise the role of the government in quality control and the potential for biofertilizers. 	K2
VI	Practical		

6.1	<ul style="list-style-type: none"> • Medium Preparation for bacteria and fungi • Isolation of microorganisms from soil, air and water • Isolation and mass production of bacterial and fungal culture. • Maintenance of pure culture. • Carrier preparation • <i>Azolla</i> cultivation 	<ul style="list-style-type: none"> • Explain and demonstrate different types of methods that involve isolation, purification, and characterization of microorganisms. 	K5
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Mapping Scheme for the Course Code: P22BY1:C

P22BY 1:C	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	H	-	M	-	-	-	-	-	-	L	-	-
CO2	M	-	L	M	M	H	M	L	-	M	L	L
CO3	L	-	L	M	L	H	M	L	-	-	L	M
CO4	H	M	H	-	-	-	L	L	-	M	M	M
CO5	M	M	M	-	-	M	-	-	-	-	-	-
CO6	M	-	H	-	-	M	M	M	-	M	L	M

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

CORE PAPER IV - PLANT TAXONOMY AND SYSTEMATICS

Semester: II

Course Code : P21BY204

Credit: 5

Hours/Week : 6

Course Outcomes:

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Classify the plants systematically using modern taxonomic principles	K4	I
CO 2	Assess various flora, Monographs and publications for the proper identification of Plant	K5	II
CO 3	Examine the morpho-genetic and anatomical variation as taxonomic evidence for the identification of closely related plant species	K4	III
CO 4	Organize the Taxonomic hierarchy of plant species	K3	III
CO 5	Distinguish the plant families with their specific diagnostic features	K4	IV, V
CO 6	Assess the economically important families for the utilization and commercialization	K5	IV, V

SYLLABUS:

Unit 1: Introduction, Classification systems and Techniques. (15 Hours)

- 1.0 Introduction – Scope and objectives.
- 1.1 History of classification
- 1.2 A detailed study of classification –(a) Sexual system - Carolus Linnaeus (b) Natural System -Bentham and Hooker(c) Modern System - Engler and Prantl, Hutchinson, Takhtajan, APG system- IV.
- 1.3 Taxonomic key
- 1.4 Specimen preparation and herbarium management.
- 1.5 Modern trends in Taxonomy – chemotaxonomy and numerical taxonomy/ Phenetics
- 1.6 Digital taxonomy – need, application and data base structure.
- 1.7 OTU, weighting and cluster analysis

Unit-2: Botanical Nomenclature and Taxonomic Principles (15 Hours)

- 2.1 International Code of Botanical Nomenclature - Salient features– Principles, Rules, Recommendations, Provisions and Appendices.
- 2.2 Typification, Principles of priority and their limitations.
- 2.3 Effective and valid publications - Author citation, retention, choice and rejection of names.
- 2.4 Familiarity with botanical literature - Monographs, periodicals and floras.
- 2.4 A brief account of B.S.I. and its role in taxonomic studies.

Unit 3: Characters as taxonomic evidence (15 Hours)

- 3.0 Concept of characters and following characters as taxonomic evidence in solving taxonomic problems. (a) Morphology, (b) comparative plant anatomy (c) karyology (d) embryology, (e) palynology, (f) paleobotany, (g) ecology and Plant genome as source of taxonomic evidence
- 3.1 Taxonomic hierarchy - categories and ranks.
- 3.2 Relevance of taxonomy to conservation.

Unit 4: Understanding Angiosperm families (15 Hours)

- 4.1 Detailed study of the following families covering diagnostic features, distribution and description:
(a) Menispermaceae, (b) Nymphaeaceae, (c) Capparaceae, (d) Caryophyllaceae, (e) Meliaceae, (f) Aizoaceae, (g) Rubiaceae, (h) Asteraceae, (i) Convolvulaceae, (j) Solanaceae,
- 4.2 Economic importance of the above mentioned families.

Unit 5: Understanding Angiosperm families (Contd.,) (15 Hours)

- 5.1 Detailed study of the following families covering diagnostic features, distribution and description:
(a) Scrophulariaceae, (b) Acanthaceae, (c) Verbenaceae (d) Lamiaceae, (e) Loranthaceae, (f) Euphorbiaceae, (g) Hydrocharitaceae, (h) Commelinaceae, (i) Araceae (j) Cyperaceae.
- 5.2 Economic importance of the above mentioned families.

Topics for Self Study:

S. no	Self-Study	References
1	Nomenclature types	https://www.floridamuseum.ufl.edu/herbarium/types/abouttypes.htm
2	Role of Herbarium	López, A., & Sassone, A. B. (2019). <i>The Uses of Herbaria in Botanical Research. A Review Based on Evidence From Argentina. Frontiers in Plant Science, 10.</i> doi:10.3389/fpls.2019.01363

3	Publications in Journals	https://www.ifis.org/publishing-guide/why-publish-in-journals
4	IUCN – Conservation of plants	https://www.iucn.org/regions/mediterranean/projects/completed-projects/conserving-wild-plants-and-habitats-people-across-mediterranean
5	Microscopic specimen preparation	https://conductscience.com/optical-microscopy-specimen-preparation-staining-and-quantitative-analysis/
6	Field identification characters of families	https://www.jstor.org/stable/42600141?seq=1

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1. Burkill, I.H. 1965. *Chapters of the history of Botany in India*, Government of India Press, The Manager of Publications, Nasik.
2. Young, D.A. and Seiyler, D.S. 1981. *Phytochemical and Angiosperm Phylogeny*. Prager Publications. New York.
3. Davis, P.H. and Heywood, V.H. 1967. *Principles of Angiosperm Taxonomy*. Oliver and Boyd, London.
4. Heywood, V.H. 1967. *Plant Taxonomy*. English Language Book Society, London.
5. Jeffrey, C. 1982. *Introduction of Plant Taxonomy*, Cambridge University Press, Cambridge.
6. Tiagi, Y.D. and Kshetrapal, S. 1988. *An Introduction to the Taxonomy of Angiosperms*. Ramesh Book Depot, Jaipur, India.
7. Takhtajan, A.L. 1997. *Diversity and Classification of Flowering Plants*. Columbia, University Press, New York.
8. Singh, G. 2005. *Plant Systematics: Theory and Practices* (2nd Ed.). Oxford and IBH Publishing Co., Pvt. Ltd. New Delhi.

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1. Gamble, J.S. 1933. *Flora of the Presidency of Madras*. Botanical Survey of India, Calcutta.
2. Nordenstam, B., ElGazaly, G. and Kassar, M. 2000. *Plant systematics for 21st Century*. Portland Press Ltd. London.

3. Burkill, I.H., 1965, *Chapters of the history of Botany in India*, Government of India Press, Nasik, The Manager of Publications.
4. Hillis, DM., Moritz, C & Mable, BK (eds) 1996, *Molecular Systematics*, Sinauer Associates, Sunderland, USA.
5. Naik, V.N. 2006. *Taxonomy of Angiosperms*. Tata McGraw Hill Education, Pvt. Ltd., New Delhi.

Web Links:

https://onlinecourses-archive.nptel.ac.in/noc18_bt22

<https://nptel.ac.in/content/storage2/courses/122103039/pdf/mod1.pdf>

SPECIFIC LEARNING OUTCOMES (SLO):

UNIT/ Section	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
I	Classification systems and Techniques		
1.1	Introduction – Scope and objectives. -History of classification	<ul style="list-style-type: none"> • Recall the various important events in the history of plant taxonomy • Utilize opportunities in the field of plant taxonomy 	K1 K3
1.2	A detailed study of classification – (a) Sexual system - Carolus Linnaeus (b) Natural System - Bentham and Hooker (c) Modern System - Engler and Prantl, Hutchinson, Takhtajan, APG system.	<ul style="list-style-type: none"> • Explain the basics of all plant classification systems • Classify the plants systematically according to any classification system 	K2 K4
1.3 1.4	Taxonomic key Specimen preparation and herbarium management.	<ul style="list-style-type: none"> • Examine a taxonomic key for the identification plant species • Organize herbarium specimens in specific guidelines. 	K4 K3

1.5	Modern trends in Taxonomy – chemotaxonomy and numerical taxonomy / Phenetics	<ul style="list-style-type: none"> Utilize modern techniques in plants classification. Analyze database on the locally available plant species 	K3
1.6	- Digital taxonomy – need, application and data base structure.		K4
1.7	- OTU, weighting and cluster analysis		
II	Botanical Nomenclature and Taxonomic Principles		
2.1	International Code of Botanical Nomenclature - Salient features– Principles, Rules, Recommendations, Provisions and Appendices.	<ul style="list-style-type: none"> Outline the role ICBN in validating the scientific nomenclature of plants. Apply the rules and principles in writing the scientific nomenclatures 	K2
2.2	Typification, Principles of priority and their limitations.		K3
2.3	Effective and valid publications - Author citation, retention, choice and rejection of names.	K5	
2.4	Familiarity with botanical literature - Monographs, periodicals and floras	<ul style="list-style-type: none"> Utilize botanical literature in the field of Plant systematics 	K3
2.5	A brief account of BSI and its role in taxonomic studies.	<ul style="list-style-type: none"> Summarize the role of BSI Utilize the opportunities available in the BSI 	K2
			K3
III	Characters as taxonomic evidence		
3.0	Concept of characters: following characters as taxonomic evidence in solving taxonomic problems. (a) Morphology, (b) comparative plant anatomy (c) karyology (d) embryology, (e) palynology, (f) paleobotany, (g) ecology and Plant genome	<ul style="list-style-type: none"> Identify the proper taxonomic evidence in solving taxonomic problems prevailing Compare the characters of plants for their identification and classification 	K3
3.1	Taxonomic hierarchy - categories and ranks.		K4
3.2	Relevance of taxonomy to conservation.	<ul style="list-style-type: none"> Utilize taxonomy in plant conservation 	
IV	Understanding Angiosperm families		

4.1	Detailed study of the following families covering diagnostic features, distribution and description: (a) Menispermaceae, (b) Nymphaeaceae, (c) Capparaceae, (d) Caryophyllaceae, (e) Meliaceae, (f) Aizoaceae, (g) Rubiaceae, (h) Asteraceae, (i) Convolvulaceae and (j) Solanaceae	<ul style="list-style-type: none"> • Illustrate the characters of different families with diagnostic features. • Inspect the relationships prevails among the closely related plant families 	K2 K4
4.2	Economic importance of the above-mentioned families:	<ul style="list-style-type: none"> • Utilize economic importance in plants 	K3
V	Understanding Angiosperm families		
5.1	Detailed study of the following families covering diagnostic features, distribution and description: (a) Scrophulariaceae (b) Acanthaceae (c) Verbenaceae (d) Lamiaceae, (e) Loranthaceae, (f) Euphorbiaceae, (g) Hydrocharitaceae, (h) Commelinaceae, (i) Araceae and (j)Cyperaceae	<ul style="list-style-type: none"> • Identify the plant families by analyzing the distinguishing characters • Explain the taxonomic characters in relation with the evolution of Plant families 	K3 K5
5.2	Economic importance of the above-mentioned families:	<ul style="list-style-type: none"> • outline the various economic important different plant families 	K2

Mapping Scheme for the Course Code: P21BY204

P21BY 204	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	H	-	M	L	-	-	-	H	H	M	-	-
CO2	-	H	-	H	-	-	M	-	H	H	-	-	-
CO3	M	H	L	H	-	-	H	-	H	H	H	M	M
CO4	-	H	-	-	-	-	-	-	L	M	M	-	-
CO5	L	H	-	L	L	-	L	-	M	H	H	-	L
CO6	-	M	-	-	L	-	-	M	H	H	L	L	-

L-Low M-Medium H-High

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

CORE PAPER - V

CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY

Semester: II

Course Code: P21BY205

Credits: 5

Hours/Week:6

Course Outcomes:

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO1	Analyze the history of cell, Prokaryotic and Eukaryotic cell structure, Explain the cell organelles.	K5	I
CO 2	Apply the basic principles of inheritance in plants, allelic and non allelic gene, linked gene and recombination gene	K3	II
CO 3	Construct and modify personal and family pedigree charts and discuss the inheritance of X and Y linked inheritance gene	K6	III
CO4	Evaluate the RNA, DNA and Protein synthesized	K5	IV , V
CO5	Analyze the molecular processes	K4	II, IV, V
CO6	Classify the latest concepts of hormonal signaling, senescence, abscission and Apoptosis	K4	IV

Unit 1 : Introduction to cell biology

(18 Hours)

1.1 Cell Biology – (a) Definition, (b) History (c) Theory

1.2 Cell – Prokaryotic and Eukaryotic

1.3 Plasma membrane – (a) Chemical composition, (b) Structure (Fluid mosaic model of membrane) (c) Functions

- 1.4 Cell wall – (a) Chemical compositions (b) Structure (Primary, Secondary, Tertiary), Functions, Growth
- 1.5 Cytoskeleton (a) Microtubules and microfilaments, (b) Motor and flagella movements.
- 1.6 Chloroplast and mitochondria: Ultra-structure and function.
- 1.7 Plant vacuole - Structure and function.
- 1.8 Other Cellular organelles: Structure and functions of (a) Micro-bodies (b) Golgi apparatus (c) Ribosomes (d) Lysosomes(e) Endoplasmic Reticulum.
- 1.9 Nucleus (a) Structure (b) Nuclear pores (c) Nucleosome organization (d) nucleolous,
- 1.10 Chromatin organization (a) Chromosome structure and packaging of DNA, (b) Molecular organization of centromere and telomere(c) Euchromatin and Heterochromatin.
- 1.11 Specialized types of chromosomes (a) polytene (b) lampbrush and sex chromosomes (c) molecular basis of chromosome pairing.
- 1.12 Cell cycle (a) Mitosis and Meiosis - cytokinesis and cell plate formation.

Unit II Genetics:

(18 Hours)

- 2.1 Genetics – Definition, Scope and importance of Genetics
- 2.2 Mendelian Principles
- i) Phenomenon of Dominance – Law of segregation and Law of Independent Assortment ii) Mono hybrid Cross, Dihybrid Cross, Back cross and Test cross
- iii) Variation in Dominance- (a) Incomplete dominance (b) Co-dominance
- 2.3. Gene interaction**
- 2.3.1 Gene interaction – Definition
- 2.3.2 Kinds of Gene interaction
- (a) Non-allelic / Inter allelic genetic interaction
- (b) Epistasis – Definition and types i) Dominant and Recessive Epistasis
- ii) Duplicate genes
- 2.4 Lethal Genes – Definition
- 2.5. Multiple alleles**
- 2.5.1 Multiple alleles – Definition and Characteristics
- 2.5.2 i) ABO Blood group in Human beings ii) Rh factor
- 2.6. Mechanisms of Sex Determination**
- 2.6.1 Sex Determination – Definition, Common Mechanisms – A) Genetically Controlled Sex determining mechanisms B) Metabolically Controlled C) Hormonally Controlled
- 2.6.2 Environmentally Controlled; Genetically Controlled Mechanisms – A) Heterogametes

B) Genic Balance Mechanism C) Male Haploidy D) Single Gene Effects

2.7 Intergenic and Intragenic Complementation and Recombination

2.8 Extra nuclear Inheritance

2.7.1 Extranuclear Inheritance – Definition and Characteristics

2.7.2 A) Maternal Inheritance – Ex: Shell coiling in *Limnaea* B) Cellular Organelles – Ex: Chloroplast Inheritance in *Mirabilis jalapa* and mitochondrial Inheritance – Male Sterility in Maize C) Endosymbionts – Ex: Kappa Particles in *Paramecium aurelia*

2.8. Polygenic inheritance

(a) Kernal Colour in Wheat

(b) Skin colour in Man

Unit III: Genetic Mapping and Human Genetics

(18 Hours)

3.1 Gene Mapping Methods

3.1.1 Linkage – Definition, Kinds – i) Complete Linkage ii) Incomplete Linkage

3.1.2 Linkage Map construction -

i) Determination of Linkage Groups

ii) Determination of Map Distance- Two point Test Cross, Three Point Test Cross iii) Determination of Gene Order iv) Combining Map Segments

3.2 Tetrad Analysis: *Neurospora* Analysis

3.3 Mapping with Molecular Markers

3.3.1 Molecular Marker – Definition, Characteristics

3.3.2 Example – i) RFLP – Procedure, Advantages ii) RAPD – Procedure, Advantages

3.4 Mapping by using Somatic Cell Hybrids

3.4.1 Somatic Cell Hybrids – Definition, Characteristics

3.4.2 Procedure – Mapping of Somatic Cell Hybrids

3.5 Development of Mapping Population in Plants

3.6 Mapping genes by Interrupted mating

3.7 Human Genetics

3.7.1 Pedigree Analysis

3.7.2 Lod Score for Linkage Testing

3.7.3 Karyotypes – definition, Procedure

3.7.4 Genetic Disorders

3.7.5 Eugenics – Definition and types – i) Positive Eugenics ii) Negative Eugenics

Unit IV -Molecular Biology

(18 Hours)

- 4.1 Nucleic Acids – (a) DNA (b) RNA
- 4.2 Deoxyribonucleic acid: (a) Chemical composition (b) Molecular structure
 - 4.2.1 Watson and crick’s double helical model– Biological Significance
 - 4.2.2 Different forms of DNA – A, B, C, D and Z
 - 4.2.3 Denaturation – Renaturation
- 4.3 DNA Replication:
 - 4.3.1 Molecular Mechanism of Prokaryotic and Eukaryotic
 - 4.3.2 Enzymology of DNA Replication – (a) DNA polymerase enzymes (b) Polynucleotide ligase (c) Exonuclease
- 4.4 Ribonucleic Acid: The genetic, Non - genetic and other types of RNAs
 - 4.4.1 Genetic RNA
 - 4.4.2 Non genetic RNA – mRNA, rRNA, tRNA
 - 4.4.3 Other types of RNAs – snRNAs, hnRNAs
- 4.5 Genetic code: (a) Triplet code (b) Nature and characteristic features

Unit-V- Protein synthesis

(18 Hours)

- 5.1 Central dogma and central dogma reverse.
 - 5.1.1 Raw material for protein synthesis
 - 5.1.2 Mechanism of Protein synthesis - Transcription (a) Mechanism of RNA Transcription in Prokaryotes (b) Molecular Mechanism of Transcription in Eukaryotic cells (c) Post Transcriptional modification of RNA (d) Mechanism of RNA splicing
 - 5.1.3 Mechanism of Protein synthesis – Translation (a) Translation in prokaryotes (b) Translation in Eukaryotes(c) Post translational modifications.

Topics for Self- Study

Sl	Self- study topic	Refernces
1	<i>genetical disorders, causes of mutation,</i>	https://medlineplus.gov/geneticdisorders.html
2	<i>Fluorescent and photoactive proteins,</i>	https://www.sciencedirect.com/science/article/pii/S0968000416301736
3	<i>Protamines, Nucleosome concept,</i>	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC384709/
4	<i>Junk DNA,</i>	https://www.scientificamerican.com/article/what-is-junk-dna-and-what/

TEXT BOOKS:

1. Benjamin, L. 2014. *Genes IX*, New York: Oxford University.
2. Bruce Alberts, 2008. *Essentials of Cell Biology*. New York: Garland Science.
3. Chhazllani V. K.. 2011. *Plant Cell Biology*. Delhi: Mangalam.
4. David P. Clark, 2005 *Molecular Biology*. New York: Elsevier.
5. De Robertis, E.D.P, and De Robertis. E.M.F, 2007. *Cell and Molecular Biology*, (6th ed.) Philadelphia: W.B.Saunders College.
6. Freifelder, D.1987. *Molecular Biology*. (2nded.). Boston: Jones and Barlett.
7. Geoffrey, M.Cooper and Robert, E.Hausman, 2007. *The Cell*. (4th ed.), USA :ASM.
8. Karp.G, 2007. *Cell and Molecular Biology*.New York: John Wiley.
9. Morris M. D, 2016. *Molecular Biotechnology* CBS New Delhi.
10. Polard.F.D.,W.C.Earnshaw and J.L.Schwartz.2008. *Cell Biology*. Philadelphia: Saunders.
11. Preeti Mehta, 2016 *Understanding Molecular Biology* Narosa.
12. Wolfe, S.L. 1999. *Molecular and Cellular Biology*. USA: Wadsworth.

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1. Daniel L Harti., 2014. *Essential Genetics*. Jones and Bartlett, Unites States of America.
2. Mann Rosanna, 2017. *Human Genetics and Genomics*, Callisto Reference.
3. Verma, P.S., V.K. Agarwal, 2014. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*, S. Chand, New Delhi.

WEB LINK:

<https://courses.lumenlearning.com/suny-wmopen-biology1/chapter/dna-mutations/>

<https://www.edx.org/learn/molecular-biology>

<https://www.coursera.org/courses?query=molecular%20biology>

SPECIFIC LEARNING OUTCOME (SLO):

UNIT	CONTENT	LEARNING OUTCOME	Highest Bloom
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			taxonomic level of transaction
Introduction to cell biology			
1.1	Cell Biology – (a) Definition, (b) History,(c) Theory	<ul style="list-style-type: none"> Relate the Definition, History, Theories of cell biology 	K2
1.2	Cell – Prokaryotic and Eukaryotic	<ul style="list-style-type: none"> Compare the Prokaryotic and Eukaryotic cells 	K4
1.3	Plasma membrane – (a) Chemical composition, (b) Structure (Fluid mosaic model of membrane) (c) Functions	<ul style="list-style-type: none"> Assume the Plasma membrane – (a) Chemical composition, (b) Structure (Fluid mosaic model of membrane) (c) Functions 	K4
1.4	Cell wall – (a) Chemical compositions (b) Structure (Primary, Secondary, Tertiary), Functions, Growth	<ul style="list-style-type: none"> Analyze the cell wall – (a) Chemical compositions (b) Structure (Primary, Secondary, Tertiary), Functions, Growth 	K4
1.5	Cytoskeleton (a) Microtubules and microfilaments, (b) Motor and flagella movements.	<ul style="list-style-type: none"> Explain the Cytoskeleton, Microtubules and microfilaments, Motor and flagella movements. 	K5
1.6	Chloroplast and mitochondria: Structure and function.	<ul style="list-style-type: none"> Recall the Chloroplast and mitochondria: Structure and function. 	K1
1.7	Plant vacuole - Structure and function.	<ul style="list-style-type: none"> Infer the plant vacuole - Structure and function. 	K2
1.8	Other Cellular organelles: Structure and functions of (a) Micro-bodies (b) Golgi apparatus (c) Ribosomes (d) Lysosomes(e) Endoplasmic Reticulum.	<ul style="list-style-type: none"> Discuss the Structure and functions of (a) Micro-bodies (b) Golgi apparatus (c) Ribosomes (d) Lysosomes(e) Endoplasmic Reticulum. 	K2
1.9	Nucleus	<ul style="list-style-type: none"> Explain the (a) Structure (b) Nuclear pores (c) Nucleosome organization(d) 	K5

	(a) Structure (b) Nuclear pores (c) Nucleosome organization(d) nucleolous,	nucleolous,	
1.10	Chromatin organization (a) Chromosome structure and packaging of DNA, (b) Molecular organization of centromere and telomere(c) Euchromatin and Heterochromatin.	<ul style="list-style-type: none"> Determine the Chromosome structure and packaging of DNA 	K5
1.11	Karyotype (a) Karyotype analysis (b) Banding patterns(c) karyotype evolution.	<ul style="list-style-type: none"> Deduct the Karyotype analysis, Banding patterns, karyotype evolution. 	K5
1.12	Specialized types of chromosomes (a) polytene (b) lampbrush and sex chromosomes (c) molecular basis of chromosome pairing.	<ul style="list-style-type: none"> Assess the specialized types of chromosomes polytene (b) lampbrush and sex chromosomes (c) molecular basis of chromosome pairing. 	K5
1.13	Cell cycle (a) Mitosis and Meiosis - cytokinesis and cell plate formation.	<ul style="list-style-type: none"> Elaborate the Cell cycle Compare the Mitosis and Meiosis - cytokinesis and cell plate formation. 	K5 K5
MENDELISM AND GENIC INTERACTION			
2.1	Definition of Genetics, Scope and importance of genetics	<ul style="list-style-type: none"> Recall the concepts of genetics Classify the scope and importance genetics 	K4
2.2	Mendel's Laws of inheritance.- Law of segregation, Law of dominance and Law of independent assortment	<ul style="list-style-type: none"> Explain the Mendel's Law. Distinguish between law of dominance and Law of independent assortment 	K4

2.3	Monohybrid cross, dihybrid cross, Back cross and Test cross	<ul style="list-style-type: none"> Analyze monohybrid and dihybrid cross. Make up the back cross and test cross 	K4
2.4	Variation in Dominance- Incomplete dominance, Co-dominance, Lethal factor in plants	<ul style="list-style-type: none"> Apply the incomplete and codominance Explain lethal factor 	K3
2.5	Gene Interaction- Complementary gene 9:7, Supplementary genes, Duplicate genes.	<ul style="list-style-type: none"> Make use of the gene interaction with a allelic and non allelic gene interaction. 	K3
2.6	Epistasis-Definition and types- Dominant Epistasis (12:3:1), Recessive Epistasis (9:3:4)	<ul style="list-style-type: none"> Define Epistasis Interpret dominant and recessive epistasis and its significance 	K4
2.7	Multiple alleles- Polygenic inheritance- Definition, Kernel Colour in wheat, Skin colour in human	<ul style="list-style-type: none"> Recall the multiple allele. Apply kernel colour in wheat and skin colour in human 	K3
2.8	Blood Group in human and Rh factor.	<ul style="list-style-type: none"> List out the types of blood groups Illustrate the blood groups in human and Rh factor 	K2
LINKAGE AND CROSSING OVER			
3.1	Linkage - Definition and types- complete and incomplete linkage and its Significance of linkage	<ul style="list-style-type: none"> Define Linkage Explain the characteristic of linkage. Importance of complete and incomplete linkage 	K5
3.2	Crossing over - Definition, Types –Single, double and	<ul style="list-style-type: none"> What is crossing over Explain they types of crossing over and its significance 	K5

	Multiple crossing over and its significance		
3.3	Crossing over - Theories about the mechanisms of crossing over- Stern's experiment, Tetrad analysis and Creighton and McClintocks experiment	<ul style="list-style-type: none"> • Prove crossing over theories and its mechanisms 	K6
3.4	Linkage Mapping	<ul style="list-style-type: none"> • Construct the Linkage mapping. • Solve the sum of gene mapping 	K3 K6
3.5	Cytoplasmic inheritance– Kappa particle (<i>Paramecium</i>) and Plastid inheritance in <i>Mirabilis</i> .	<ul style="list-style-type: none"> • Define Plasmagene. • Support the kappa particle and plastid inheritance in <i>Mirabilis</i>. 	K5
3.6	Sex linkage – Definition and <i>Drosophila</i> (Bar eye) and human (colour blindness)	<ul style="list-style-type: none"> • Make use of sex linkage in <i>Drosophila</i> and human, • Solve the colour blindness and haemophilia through sex linkage 	K3 K6
3.7	Sex determination -Definition and <i>Drosophila</i> and human	<ul style="list-style-type: none"> • Classify the sex determination and <i>Drosophila</i> and Human. 	K4
3.8	<i>Neurospora</i> Genetics	<ul style="list-style-type: none"> • Explain <i>Neurospora</i> in genetics 	K4
MOLECULAR BIOLOGY			
4.1	Nucleic Acids – (a) DNA (b) RNA	<ul style="list-style-type: none"> • Recall that the types nucleic acids and its function • Distinguish between DNA and RNA 	K1 K4
4.2	Deoxyribonucleic acid: (a) Chemical compositions (b) Molecular structure-	<ul style="list-style-type: none"> • Sketch the structure of DNA • Explain the main feature of Watson and 	K3 K5

	Watson and crick's double helical model– Biological Significance, Different forms of DNA – A, B, C, D and Z, Denaturation – Renaturation	<p>Crick's DNA</p> <ul style="list-style-type: none"> • What are the chemical components of DNA • Prove the chemical and molecular structure of DNA • Importance of denaturation of protein • Differentiate between denaturation and Renaturation of protein 	<p>K1</p> <p>K5</p> <p>K5</p> <p>K4</p>
4.3	<p>DNA Replication- Molecular Mechanism of Prokaryotic and Eukaryotic,</p> <p>Enzymology of DNA Replication – (a) DNA polymerase enzymes (b) Polynucleotide ligase (c) Exonuclease</p>	<ul style="list-style-type: none"> • Why is DNA replication important? • Importance molecular mechanism of prokaryotic and eukaryotic replication. • Explain the enzyme of DNA replication and their function 	<p>K1</p> <p>K5</p>
4.4	<p>Ribonucleic Acid: The genetic, Non - genetic and other types of RNAs</p> <p>a) Genetic RNA</p> <p>b) Non genetic RNA – mRNA, rRNA, tRNA</p> <p>c) Other types of RNAs – snRNAs, hnRNAs</p>	<ul style="list-style-type: none"> • What are the types of RNA and their functions? • Model of t-RNA structure. • Explain genetic, non genetic RNA and other types. • Evaluate the roles of RNA in protein synthesis 	<p>K1</p> <p>K3</p> <p>K5</p> <p>K5</p>
4.5	<p>Genetic code: (a) Triplet code (b) Nature and characteristic features</p>	<ul style="list-style-type: none"> • Explain the genetic code and how does it work? • Prove that is genetic code universal. 	<p>K5</p>
Protein synthesis			
5.1	<p>Central dogma and central dogma reverse.</p>	<ul style="list-style-type: none"> • Define Central dogma. • Classify the central dogma and central dogma reverse 	<p>K1</p> <p>K4</p>
5.2	<p>Raw material for protein synthesis</p>	<ul style="list-style-type: none"> • Explain the raw material for protein 	<p>K5</p>

		synthesis	
5.3	Mechanism of Protein synthesis - Transcription (a) Mechanism of RNA Transcription in Prokaryotes (b) Molecular Mechanism of Transcription in Eukaryotic cells(c) Post Transcriptional modification of RNA(d) Mechanism of RNA splicing	<ul style="list-style-type: none"> • Determine the mechanism of transcription. • Interpret how transcription work in prokaryotes and eukaryotes • Analyze the steps of transcription • Classify the mechanisms of RNA splicing. • Distinguish post transcriptional modification of RNA 	K5 K4 K5
5.4	Mechanism of Protein synthesis – Translation (a) Translation in prokaryotes (b) Translation in Eukaryotes(c) Post translational processing of Proteins	<ul style="list-style-type: none"> • Explain the steps and process of translation. • Compare mechanisms of translation in prokaryotes and eukaryotes. • Elaborate the post translational processing of protein modification • Examine the post translational modification 	K5 K2 K5
5.1	Central dogma and central dogma reverse.	<ul style="list-style-type: none"> • Define Central dogma. • Classify the central dogma and central dogma reverse 	K1 K4
5.2	Raw material for protein synthesis	<ul style="list-style-type: none"> • Explain the raw material for protein synthesis 	K5

Mapping Scheme for the Course Code: P21BY205

P21BY205	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
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CO1	-	-	H	M	-	M	-	-	-	M	-	H	M
CO2	H	M	L	-	-	H	L	-	L	H	M	H	-
CO3	H	M	-	-	M	-	-	-	M	H	L	H	L
CO4	L	M	H	H	-	H	-	M	M	-		H	-
CO5	M	M	H	H	-	H	M	H	M	-	H	M	-
CO6	M	L	H	H	-	H	M	H	M	-	H	H	M

L – Low (1) M-Medium (2) H-High (3)

Course Assessment Methods:

Direct
<ol style="list-style-type: none"> 1. Continuous Assessment in Class test, Group Discussion and Quiz. 2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams. 3. End Semester Examination
Indirect
<ol style="list-style-type: none"> 1. Course-end survey

Core VI - MICROBIOLOGY AND PLANT PATHOLOGY

Semester : II

Course Code : P21BY206

Credits : 4

Hours/Week: 6

Course Outcomes:

On completion of this course, the students will be able to:

No.	COURSE OUTCOMES (CO)	Level	Unit
CO1	Understand and application of microbiology concepts as a diverse area such as Agriculture, environment, medical, food and industries.	K3	I - IV
CO2	Take students to higher level of learning about microbial association with plants	K2	I, II
CO3	Develop basic skills such as culturing, maintaining microbes and safety issues related to handling of microbes	K6	I - IV
CO4	Explain the causal agent of microbes, evidence of management, host resistance of diseases.	K5	V
CO5	Elaborate the various staining procedure of microorganisms	K6	II
CO6	Equip students with skills and techniques related microbiology and pathology, so that can design their own experiment	K6	V, VI

Syllabus:

Unit 1: Introductory Microbiology (18 Hours)

- 1.0. Fundamental concepts and scope of microbiology
- 1.1. Types of microorganism in nature
- 1.2. Outline classification of Bergey's Manual of 9th Edition.
- 1.3. Study of microbes Bacteria, Viruses, Mycoplasma, Ricketts and chlamydia under these aspects structure, physiology and reproduction.

Unit 2 : Methods of studying bacteria and Viruses (18 Hours)

- 2.0. Staining techniques – simple, differential, (Gram Staining and acid-fast staining), negative and endospore staining.
- 2.1 Culture media – Natural and synthetic medium selective medium
Nutritional medium classification of bacteria
- 2.3 Sterilization methods- Physical and chemical.
- 2.3. Culture and growth of bacteria

- 2.4. Culture of viruses - in embryonated egg and in plants.
- 2.5 Isolation of microorganism- Serial dilution, pure culture techniques

Unit 3: Microbes in the environment

(18 Hours)

- 3.0. Microbial flora of soil
- 3.1. Factors affecting the microbial community in soil
- 3.2. Microbiology of water and air
- 3.3. Water borne diseases - diphtheria, chicken pox.
- 3.4. Air borne diseases – SARS and COVID infections.

Unit 4 - Microbial applications

(18 Hours)

- 4.0. Role of microbes in decomposition and recycling processes- Solid and liquid waste (Domestic)
- 4.1. Biofertilizers – Definition and types
 - 4.1.1. Methods of mass multiplication and applications.
- 4.2. Food preservation – Definition, types – physical and chemical methods
- 4.3. Food poisoning - Definition and Types - Food intoxication (Botulism, Staphylococcal food poisoning)
- 4.4. Preservation methods of milk – Pasteurization and ultra-pasteurization, Sterilization and dehydration

Unit 5: Plant diseases and defense mechanisms

(18 Hours)

- 5.0. Causal organism, symptoms, disease cycle and control measures of
 - i) Fungal disease –*Puccinia* ii) Bacterial disease –*Xanthomonas* iii) Viral disease – Cauliflower mosaic. iv) Mycoplasma – Little leaf and Nematode disease – Root rot.
- 5.1 Mode of infection and dissemination.
- 5.2 Molecular basis of infection and disease resistance, defense – morphological and structural defense mechanisms.
- 5.3 Phytoalexins.

Topics for Self-Study

Sl No	Topics for self-study	References
1	<i>Fluorescent staining, metabolomics, Environmental reclamation.</i>	https://www.coursera.org/lecture/experimental-methods/lecture-1-fluorescence-microscopy-dKo26 https://ext.ualberta.ca/enroll/land-reclamation
2	<i>Microbial proteins, Phycoalexin integrated pest management</i>	https://coursesandconferences.wellcomeconnectingscience.org/event/bacterial-genomes-from-dna-to-protein-function-using-bioinformatics-20201012/ https://nptel.ac.in/courses/126/104/126104003/ http://www.agmoocs.in/course/ipm2020

TEXT BOOKS:

1. Mehrotra R.S., and Askok Agarwall. 2008. *Plant pathology*, Tata McGraw Hill Education Pvt., Ltd., New Delhi, India.
2. Kathleen P.Talaro and Berry Chess 2012. *Foundations in Microbiology*. Tata McGraw Hill Education Pvt., Ltd., New Delhi, India.
3. Parry, J. Thelma, P. and Rosa, K. 1984. *Principles of Microbiology*. Hutchinson London
4. Panda S.C., 2011. *Principles and Practices of Water Management*. Agrobios.
5. Power, C. B. and Dagainawala, H. F. 2010. *General Microbiology*, Himalaya Publishing House, New Delhi.
6. Dubey, R. C and D. K. Maheswar, 2010. *A Text book of Microbiology*, S. Chand Publication, New Delhi.
7. Mehrotra, R. S and Ashok Aggarwal, 2002. *Plant Pathology*, Mc Graw Hill, New Delhi.
8. Rangasamy G. 1998. *Diseases of crop plants in India*. Prentice- Hall of India, New Delhi

REFERENCE BOOKS

1. Hogg, S. 2010. *Essentials Microbiology*, John Wiley. Joanne M Willey, England.
2. Pelczar, J. Michael, (Jr.), D. Reid, Roger, Chan E. C. S. and Kreig. 1993. *Microbiology*. Tata McGraw – Hill, New Delhi, India
3. Prescott, L.M., John, P.H. and Klein D.A. 2005. *Microbiology*. W.M. Brown, USA.
4. Sharma P.D., 2001, *Microbiology and Plant Physiology*. Rastogi publications, Meerut.

SPECIFIC LEARNING OUTCOME (SLO)

UNIT	CONTENT	LEARNING OUTCOME	Highest Bloom taxonomic level of transaction
Introductory Microbiology			
1.1	Fundamental concepts and scope of microbiology	<ul style="list-style-type: none"> Analyze the Fundamental concepts of microbes Apply the scopes of microorganisms Understanding of recent developments in the area of Microbiology 	K1 K3 K2
1.2	Types of microorganism in nature	<ul style="list-style-type: none"> Classify the types of microorganisms in nature 	K2
1.3	Classification (Bergey's Manual of 9th Edition, 1993 and 2000)	<ul style="list-style-type: none"> Classify different types and forms of Bacteria 	K2
1.4	Microbial studies under these aspects structure, physiology and reproduction. (Bacteria, Viruses, Mycoplasma, Ricketts and chlamidiae)	<ul style="list-style-type: none"> Discuss the microbial life cycle Compare the structure, physiology and reproduction Distinguish between the microbes 	K6 K4 K4
Methods of studying bacteria			
2.1	Staining techniques simple, differential	<ul style="list-style-type: none"> Apply the Staining techniques 	K3

	Gram Staining Acid-fast staining Negative straining Endospore staining.	<ul style="list-style-type: none"> • Explain the simple, differential Staining techniques 	K2
2.2	Culture and growth of bacteria	<ul style="list-style-type: none"> • Demonstrate the Bacterial culture and growth 	K2
2.3	Culture of viruses - in embryonated egg and in plants	<ul style="list-style-type: none"> • Define embryonated egg. • Interpret the culture medium of viruses. • Explain cultivation of virus 	K1 K5
Microbes in the environment			
3.1	Microbial flora of soil	<ul style="list-style-type: none"> • What is the role of microorganisms in soil fertility? • Compare the anatomical features of various fossil forms • Explain soil microflora of soil. 	K3 K5
3.2	Factors affecting the microbial community in soil	<ul style="list-style-type: none"> • Analyse the factors affecting the microbial community in soil • Explain physical features of soil that influence microbial populations 	K6 K5
3.3	Microbiology of water and air	<ul style="list-style-type: none"> • Outline of microbes in water and air • How can you prevent bacteria from growing in water? 	K2 K3
3.4	Water borne diseases - diphtheria, chicken pox.	<ul style="list-style-type: none"> • Explain the water borne diseases • Compare the disease life cycle • Discuss the diphtheria and chicken pox differ 	K2 K4 K6

		from other bacterial disease	
3.5	Air borne diseases - Swine flu and Nosocomial infections.	<ul style="list-style-type: none"> • Explain the Air borne diseases • Identify the Air borne diseases • Discuss the Swine flu disease life cycle • Examine the Nosocomial infections 	K2 K3 K6 K4
Microbial applications			
4.1	Microbes in decomposition and recycling processes- Solid and liquid waste (Domestic	<ul style="list-style-type: none"> • Define biodegradable waste • Which type of waste can be broken down by microbial activities of fungi and bacteria? • Explain microbes in waste management. • Discuss microbes as vital for solid waste management. 	K2 K5 K6
4.2	Biofertilizer – Definition and types	<ul style="list-style-type: none"> • What is biofertilizer? • Importance of biofertilizer in plant growth and soil health • Discuss the types biofertilizer 	K1 K5
4.3	Methods of mass multiplication and applications.	<ul style="list-style-type: none"> • Classify the production of Biofertilizers • Discuss various methods for applications of Biofertilizers. • Compare synthetic and biofertilizer. 	K4 K6 K5
4.4	Food preservation – Definition, types – physical, chemical methods and radiation	<ul style="list-style-type: none"> • Define food preservation • Demonstrate methods of food preservation. • Importance of food preservation • Interpret mechanisms and commercial aspects of food preservation 	K1 K2 K5
4.5	Food poisoning - Definition and Types - Food intoxication	<ul style="list-style-type: none"> • How do you know if its food poisoning? 	K1

	(Botulism, Staphylococcal food poisoning)	<ul style="list-style-type: none"> • Classify food intoxication. • Evaluate possible causes of food poisoning • How do you solve the food poisoning 	K4 K5
4.6	Milk preservation methods – Pasteurization, Sterilization and dehydration.	<ul style="list-style-type: none"> • How is milk preserved? • Explain preserve fresh milk for a long time. • Demonstrate methods of preservation of milk 	K1 K5 K2
Plant diseases and defence mechanisms			
5.1	Causal organism, symptoms, disease cycle and control measures of i) Fungal disease – <i>Puccinia</i> ii) Bacterial disease – <i>Xanthomonas</i> iii) Viral disease – Cauliflower mosaic. iv) Mycoplasma – Little leaf and Nematode disease – Root rot	<ul style="list-style-type: none"> • Demonstrate crop protection • Identify the common disease of crops and their symptoms • Interpret the causal organisms, symptoms and control measure of various diseases. 	K2 K3 K5
5.2	Mode of infection and dissemination.	<ul style="list-style-type: none"> • Define dissemination. • Illustrate the basic modes transmission of infection • Relationship between infection and dissemination 	K1 K2 K4
5.3	Molecular basis of infection and disease resistance / defense.	<ul style="list-style-type: none"> • Explain disease resistance mechanisms in plants. • Discuss the molecular basis of plant resistance to pathogen. • Justify plant response to pathogen attack 	K5 K6 K5
5.4	Physiology of parasitism.	<ul style="list-style-type: none"> • Define parasitism. • Classify the studies in the physiology of parasitism. • Explain host parasite relation. 	K1 K4 K5

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Mapping Scheme for the Course Code: P21BY206.

P21BY206	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	H	L	M	H	L	L	M	M	L	H	-
CO2	H	M	L	-	-	L	L	-	L	H	M	H	-
CO3	H	L	-	M	L	-	M	-	M	H	L	H	H
CO4	H	L	L	-	M	-	-	-	M	M	-	H	H
CO5	M	L	-	M	-	L	M	L	-	M	H	-	L
CO6	M	-	-	L	L	M	L	L	M	-	-	L	-

L-Low (1) M-Medium (2) H-High (3)

Course Assessment Methods:

Direct
1. Continuous Assessment in Class test, Group Discussion and Quiz.
Indirect
1. Course-end survey

CORE PRACTICAL- III

PLANT TAXONOMY AND SYSTEMATICS

Semester : II

Course Code : P21BY2P3

Credits : 3

Hours/Week : 3

Course Outcomes:

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Identify the plant families and species by describing their morphological characters and by using taxonomic keys	K3	I
CO 2	Create taxonomic keys for the locally available plant species	K6	I
CO 3	Develop herbarium of plants based on their morphology	K6	I
CO 4	Analyse the adaptations of plants	K4	I
CO 5	Examine the importance of floral adaptations	K5	I
CO 6	Apply the scientific knowledge for plant identification	K3	I

SYLLABUS:

Unit 1: Plant Systematics

(45 Hours)

1. Identification and their description of a specimen from representative, locally available families.
2. Binomial identification using Gamble flora.
3. Phytophraphy (describing plants with technical terms).
4. Location of key characters and use of keys at family level
5. Description of various species of a genus, location of key characters and preparation of keys at generic level.
6. Study of the following families with reference to their Tamil Nadu representatives and minimum of one member each to be taxonomically described dissected and sketched
(a) Menispermaceae, (b) Nymphaeaceae, (c) Capparidaceae, (d) Caryophyllaceae, (e) Meliaceae, (f) Aizoaceae, (g) Rubiaceae, (h) Asteraceae, (i) Convolvulaceae, (j) Solanaceae, (k) Scrophulariaceae, (l) Acanthaceae, (m) Verbenaceae (n) Lamiaceae, (o) Loranthaceae, (p) Euphorbiaceae, (q) Hydrocharitaceae, (r) Commelinaceae, (s) Araceae and (t) Cyperaceae.
7. Analysis of plant characters of Polypetalae and Gamopetalae monochlamydeae
8. Training in using floras and herbarium for identification of specimens described in class.

9. Submission of herbarium sheets and digital description of any five plant species
10. Exercise in the important article of the code
11. Computer databases in plant identification
12. Field trips/Excursion, compilation of field notes and preparation of herbarium specimens (20) of wild plants.

TOPICS FOR SELF-STUDY:

S. No	Self- Study	References
1	APG System	http://www.mobot.org/MOBOT/research/APweb/
2	Gamble	https://training.carmelcollegemala.edu.in/course/info.php?id=10

REFERENCE BOOKS:

1. Jintu Sarma and Dipankar Borah, 2021. *Plant Systematics theory and practicals*. IBH publication, New Delhi
2. Singh and Gurcharan, 2012. *Plant Systematics theory and practical*, Oxford and IBH publication, New Delhi.
3. Heywood, V. K & Moore, D.M., 1984, *Current Concepts in Plant Taxonomy*, AP, London.

WEB LINKS:

<http://2020.botanyconference.org/engine/search/index.php?func=detail&aid=444>

SPECIFIC LEARNING OUTCOME (SLO):

UNIT	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
I	Plant Systematics		
1.1.	Identification and their description of a specimen from representative, locally available families.	<ul style="list-style-type: none"> • Describe the plant specimens in the locally available families • Illustrate the key characters of plant families 	K2
1.2	Location of key characters and use of keys at family level		K2
1.3.	Description of various species of a genus, location of key characters and preparation of keys at generic level	<ul style="list-style-type: none"> • Create key for any given plant families for easy identification at generic level 	K6

1.4.	Training in using floras and herbarium for identification of specimens described in class	<ul style="list-style-type: none"> Utilize the various floras and herbarium for the identification of plant specimens 	K3
1.5.	Field trips/Excursion, compilation of field notes and preparation of herbarium specimens of wild plants	<ul style="list-style-type: none"> Take part in the field collection of plant specimens and preparation of herbarium specimens of wild plants 	K4

Mapping Scheme for the Course Code: P21BY2P3

P21BY2P3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	H	-	-	-	-	L	-	-	H	H	-	M
CO2	L	H	-	-	-	-	-	-	-	H	H	-	L
CO3	-	-	H	-	-	-	-	-	-	-	-	H	-
CO4	-	-	L	H	-	-	-	-	-	-	-	H	-
CO5	-	-	L	H	-	-	-	-	-	-	-	H	-
CO6	-	-	-	L	M	H	-	M	M	H	L	L	M

L-Low M-Medium H-High

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment in Practical works, dissecting, record submission.
2. Practical tests, Records etc.
3. End Semester Examination

Indirect

1. Course-end survey

CORE PRACTICAL- IV

CELL BIOLOGY, GENETICS, MICROBIOLOGY AND PLANT PATHOLOGY

Semester : II

Course Code : P21BY2P4

Credits : 3

Hours/Week : 3

Course Outcomes:

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Make use of the cytological knowledge to solve the genetic questions.	K3	I
CO 2	Analyze the cell divisions	K4	I
CO 3	Apply the different genetics problems on sex linked inheritance, Linkage mapping and chromosome mapping	K3	II
CO 4	Evaluate genetic materials such DNA and RNA by using modern technologies.	K5	III
CO 5	Analyze the importance of microbes	K4	IV
CO 6	Explain different plant breeding methods for commercial plantation of crops	K5	V

SYLLABUS:

Unit 1: Cell biology (6 hours)

1. Cell organelles structure and their functions
2. Mitosis and Meiosis

Unit 2: Genetics (9 Hours)

1. Genetics problems – Interaction of factors, sex linked inheritance.
2. Linkage mapping
3. Chromosome mapping

Unit 3: Molecular Biology (12 Hours)

1. Elution of enzymes
2. Isolation of DNA (CTAB method)
4. Isolation of plasmid from bacterium, Restriction, digestion, ligation and PCR amplification.

Unit 4: Microbiology (15 Hours)

1. Preparation of media - Fungal (PDA medium) and Bacterial (Nutrient Agar medium)
2. Micrometry, hemocytometry and Colony counter.
3. Isolation of microorganisms from compost and sewage.
4. Methylene Blue Reductase test
5. Bacterial Staining – Differential
6. TC, FC, FS and MPN techniques.

Unit 5 : Plant pathology

(3 hours)

1. Little leaf of Brinjal
2. Red rot of sugar cane
3. Citrus canker
4. Tobacco mosaic virus
5. Fungicides and Pesticides

Topics for self-study:

S. no	Plasmid transduction	https://www.zymoresearch.com/blogs/blog/what-are-transformant-transfection-transduction
1	genetical disorders	https://www.medicinenet.com/genetic_disease/article.htm
2	Vavilov Contribution	http://www.surendranathcollege.org/new/upload/JAYANTA_SIRChapter%2012020-03-26Economic%20Botany%20Chapter%201.pdf
3	Fluorescent and photoactive proteins	https://www.sciencedirect.com/science/article/abs/pii/S0968000401736
4	Nucleosome concept	https://microbenotes.com/nucleosome-model-of-chromosome/
5	Junk DNA	https://www.scientificamerican.com/article/what-is-junk-dna-and-what/

PRACTICAL MANUALS:

1. Dubey, R.C and Maheshwari, D. K. 2010. *Practical Microbiology*, S. Chand and Company Pvt. Ltd., New Delhi,
2. Huma Naz, Hadi Husain Kahn, Chandan Kumar Singh, Asma Naz, Samiya Maqsood, Brima, F.I. A. and Ayesha. 2015. *Practical Lab Manual for Microbiology and Plant Pathology*, Akinik Publication, New Delhi.
3. Kathleen P.Talaro and Berry Chess 2012. *Foundations in Microbiology*. Tata McGraw Hill Education Pvt., Ltd., New Delhi, India.
4. Kannan, N. 1996. Laboratory manual in general microbiology. Palani paramount Publications, Palani
5. De Robertis, E. D. P., Francisco A. Salny and De Robertis, E. M. F. 1995. *Cell Biology*. W. B. Saunders company, London (International Edition).
6. Gardner / Simmons / Smustad. 1984. Principles of Genetics. John Wiley and Sons, Inc, New York.

WEB LINKS:

- <https://www.acsedu.com/courses/cell-biology-877.aspx>
<https://www.coursera.org/courses?query=molecular%20biology>
<https://www.plantbreeding.org/content/online-resources-for-plant-breeding-education>

SPECIFIC LEARNING OUTCOMES (SLO):

UNIT	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
I	Cell Biology		
1	Cell organelles structure and their functions	<ul style="list-style-type: none"> Describe and illustrate various regions in cell organelles Describe the structure of cell organelles 	K4 K2
2	Mitosis and Meiosis	<ul style="list-style-type: none"> Analyse the importance of cell division 	K4
II	Genetics		
2.1.	Genetics problems – Interaction of factors, sex linked inheritance	<ul style="list-style-type: none"> Solve the problems based on interaction of genetic factors and sex-linked inheritance 	K3
2.2 2.3	Linkage mapping Chromosome mapping	<ul style="list-style-type: none"> Explain the distance of genes by using linkage and chromosome mapping 	K2
III	Molecular Biology		
3.1.	Elution of enzymes	<ul style="list-style-type: none"> Elucidate the enzymes from different sources 	K3
3.2 3.3 3.4	Isolation of DNA Isolation of RNA Isolation of plasmid from bacterium, Restriction, digestion, ligation enzymes and PCR amplification.	<ul style="list-style-type: none"> Separate Plastids, DNA and RNA by different isolation procedure and by using Biotechnological tools. Examine different enzymes and application of its properties in molecular studies 	K3 K5
IV	Microbiology		
1	Types of microorganism in nature	<ul style="list-style-type: none"> Classify the types of microorganisms in nature 	K2
2	Different medium	<ul style="list-style-type: none"> Examine the medium on which various microbes grow 	K4
V	Plant Breeding		
5.1	Emasculation	<ul style="list-style-type: none"> Explain new plant hybrids by crossing different plant varieties through hand pollination methods 	K5
5.2 5.3	Mass Selection Pure Line Selection	<ul style="list-style-type: none"> Choose proper selection methods for crop plant breeding 	K3

5.4	Back Cross Selection		
5.5	Mutagens	<ul style="list-style-type: none"> Develop new plant varieties by applying different mutagens 	K3
5.6.	Centres and origin for cultivated plants	<ul style="list-style-type: none"> Illustrate the centres and origin of cultivated plants 	K2

Mapping Scheme for Course Code: P21BY2P4

P21BY2P4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	H	L	M	H	L	L	M	M	L	H	-
CO2	H	M	L	-	-	L	L	-	L	H	M	H	-
CO3	H	L	-	M	L	-	M	-	M	H	L	H	H
CO4	H	L	L	-	M	-	-	-	M	M	-	H	H
CO5	M	L	-	M	-	L	M	L	-	M	H	-	L
CO6	M	-	-	L	L	M	L	L	M	-	-	L	-

ELECTIVE PAPER: II – TIDAL FORESTRY

Semester : II
Credits : 4

Course Code : P21BY2:A
Hours/ Week: 4

Course Outcomes:

On completion of this course, the students will be able to:

No	Course Outcomes (CO)	Level	Unit
CO 1	Assess the species diversity and its status in wet land	K4	I
CO 2	Compare the past and present status of Mangrove vegetation	K5	II
CO 3	Examine the factors affecting mangrove vegetation and reclamation process to be taken	K5	III
CO 4	Estimate the values of Nutrient enrichment and energy fluxes in Mangroves	K5	IV
CO 5	Evaluate water quality parameters and its influence in Mangrove vegetation	K5	V
CO 6	Elaborate the anthropogenic pressure and pollutants in Mangroves	K6	VI

Syllabus:

Unit 1: Principles of wetland ecology

(12 Hours)

- 1.1. Sand dunes with emphasis on vegetation and ecological importance
- 1.2. Mangrove biodiversity
- 1.3. Inter-relationships between ecosystems

- 1.4. Methods of assessing biodiversity
- 1.5. Importance of assessing species diversity and status
- 1.6. IUCN conservation species status - Status book.

Unit 2: Distribution and Biology of mangroves (8 Hours)

- 2.1. Global distribution, Extent of mangroves in various countries
- 2.2. Past and present extent of distribution, damage and reclamation caused in the recent past.
- 2.3. Temporal and regional variations
- 2.4. Morphology and anatomy of mangrove plants
- 2.5. Physiology and biochemistry of mangrove plants
- 2.6. Factors affecting various growth parameters of mangrove plants
- 2.7. Role of mangrove forest

Unit 3: Flora and fauna of mangroves and associated environments (12 Hours)

- 3.1. Bacteria, fungi and actinomycetes, microalgae, sea-grasses, salt-marsh and other flora
- 3.2. Collection, preservation and identification techniques
- 3.3. Factors affecting biodiversity
- 3.4. Comparison of flora of mangroves and associated environments
- 3.5. General account of mangrove fauna.

Unit 4: Ecological roles of mangroves (8 Hours)

- 4.1. Litter production and decomposition and nutrient enrichment
- 4.2. Biomass, food web and energy fluxes
- 4.3. Interaction of mangroves with other halophytes and agro-ecosystems
- 4.4. Importance - Damages caused - Need for conservation.

Unit 5: Threat and conservation factors in mangrove systems (8 Hours)

- 5.1. Water quality parameters
- 5.2. Anthropogenic pressure
- 5.3. Types of pollutants causing damage to mangroves
- 5.4. Sewage, industrial, and other organic and inorganic man-made pollutants
- 5.5. Conservation strategies: Species selection, propagation and plantation techniques

Unit 6: Practical (12 Hours)

- 6.1. Study of zonation pattern in mangroves.
- 6.2. Study of sand dune plants
- 6.3. Study of mangrove associates plants
- 6.4. Type study of mangroves from Rhizophoraceae, Myrsinaceae and Acanthaceae
- 6.5. Study of vivipary in mangroves
- 6.6. Study of salt glands, trichomes, sclerides in mangroves
- 6.7. Study of phenological events in different mangrove species

Field visit: Pichavaram, Killai, Cuddalore District

Topics for self-study:

S.No	Topics	Reference
1	Adaptations of Mangroves	https://study.com/academy/lesson/mangrove-adaptations-lesson-for-kids.html
2	Climate of India	https://data-flair.training/blogs/climate-of-india/

TEXT BOOKS:

1. Chapman, V.J. and Chapman, D. J. 1975. *The Algae*. 2nd edition. MacMillan Publications Inc., New York.
2. Lembi, C.A. and Waaland, J. R. 1988. *Algae and Human Affairs*. Press Syndicate of the University of Cambridge.
3. Lobban, C.S., Harrison, P. J. and Duncan, M. J. 1985. *The Physiological Ecology of Seaweeds*. Cambridge University Press, New York.
4. Roy, P.M. and Helfferich, C. 1997. *Seagrass Ecosystems*. Maxel Dekker II, New York.
5. Borse, D.G. and Bhat, D. J. 2012. *Marine Fungi of India*. BBC Publishers.
6. Abhijit Mitra, 2019. *Mangrove Forest In India: Exploring Ecosystem services*, Springer Publication, New York.
7. Singh, V. P and K. Odaki, 2004. *Mangrove Ecosystem: Structure and Function*, Scientific publishers, Chennai.
6. Websites of NIO and Mangrove Society of India.

REFERENCE BOOKS:

1. Barry Tomlinson P. 2016. *The Botany of Mangroves*, Cambridge University Press, United Kingdom
2. Patricia Hutchings, Peter Saenger. 1987. *Ecology of Mangroves*, University of Queensland Press, Australia
3. Aroloye O Numbere, 2018. *Mangrove Species Distribution and composition, Adaptive strategies and Ecosystem service in the Niger River Delta*. Open access Journal.

WEB LINKS:

<https://www.unep.org/explore-topics/education-environment/what-we-do/massive-open-online-courses>

<https://www.amnh.org/explore/videos/biodiversity/mangroves-the-roots-of-the-sea/why-mangroves-matter>

SPECIFIC LEARNING OUTCOMES (SLO):

Unit	CONTENT	LEARNING OUTCOME	Highest Bloom taxonomic level of transaction
I	Principles of wetland ecology		
1.1	Sand dunes with emphasis on vegetation and ecological importance	<ul style="list-style-type: none"> • Demonstrate the vegetation development in Sand dunes • Summarize the Ecological Importance of Vegetation 	K2 K2
1.2	Mangrove biodiversity	<ul style="list-style-type: none"> • Summarize the biodiversity richness of Mangrove Forests 	K2
1.3	Inter-relationships between ecosystems	<ul style="list-style-type: none"> • Analyze the relationship between the Ecosystems near Mangroves 	K4
1.4	Methods of assessing biodiversity	<ul style="list-style-type: none"> • Apply modern methods to assess the biodiversity of Mangroves 	K3
1.5	Importance of assessing species diversity and status	<ul style="list-style-type: none"> • Discuss the importance of assessing species diversity and status 	K2
1.6	IUCN conservation species status - Status book.	<ul style="list-style-type: none"> • Explain the conservation status of species in mangrove ecosystem. • Assess the species threat status in Mangrove forest 	K2 K4
II	Distribution and Biology of mangroves		
2.1	Global distribution, Extent of mangroves in various countries	<ul style="list-style-type: none"> • Outline the Global distribution of Mangrove vegetations. 	K2 K3

2.2	Past and present extent of distribution, damage and reclamation caused in the recent past.	<ul style="list-style-type: none"> • Compare the past and present distribution of Mangrove forests. • Develop a reclamation plan for the damaged Mangrove ecosystem 	K2 K3
2.3	Temporal and regional variations	<ul style="list-style-type: none"> • Compare the variation in different mangrove vegetation in relation to the regional distribution. 	K5
2.4	Morphology and anatomy of mangrove plants	<ul style="list-style-type: none"> • Explain the morphological and anatomical modifications of mangrove plants for its survival 	K2
2.5	Physiology and biochemistry of mangrove plants	<ul style="list-style-type: none"> • Examine the various physiological process of Mangrove plants 	K4
2.6	Factors affecting various growth parameters of mangrove plants	<ul style="list-style-type: none"> • list out the factors affecting growth parameters of mangrove plants • Explain the factors that affecting the Mangrove vegetation 	K4 K2
2.7	Role of mangrove forest	Explain the importance of Mangrove Forest	K2
III	Flora and fauna of mangroves and associated environments		
3.1	Bacteria, fungi and actinomycetes, microalgae, sea-grasses, salt-marsh and other flora	<ul style="list-style-type: none"> • Classify the species diversity of Mangroves and associated environment. • Explain the species distribution in mangroves and associated environment 	K2 K5
3.2	Collection, preservation and identification techniques	<ul style="list-style-type: none"> • Apply various techniques for collection, preservation and identification of Mangrove flora and fauna. 	K3
3.3	Factors affecting biodiversity	<ul style="list-style-type: none"> • Identify the factors affecting mangrove biodiversity 	K3

3.4	Comparison of flora of mangroves and associated environments	<ul style="list-style-type: none"> • Compare the species distribution of mangroves and associated environments 	K4
3.5	General account of mangrove fauna.	<ul style="list-style-type: none"> • Summarize the list of fauna of mangroves 	K2
IV	Ecological roles of mangroves		
4.1	Litter production and decomposition and nutrient enrichment	<ul style="list-style-type: none"> • Analyze the efficiency of Mangroves in nutrient enrichment of their environment 	K4
4.2	Biomass, food web and energy fluxes	<ul style="list-style-type: none"> • Examine the ecological interdependence of species in the Mangrove environment 	K3
4.3.	Interaction of mangroves with other halophytes and agro-ecosystems	<ul style="list-style-type: none"> • Illustrate the interaction of Halophytes and adjoining agro-ecosystems 	K2
4.4.	Importance - Damages caused - Need for conservation.	<ul style="list-style-type: none"> • Explain the importance and need for the conservation of Marshland vegetation. • Develop action plan for the conservation of Mangroves 	K2 K3
V	Threat and conservation factors in mangrove systems		
5.1	Water quality parameters	<ul style="list-style-type: none"> • Determine different quality parameters of Water in Mangrove systems 	K5
5.2	Anthropogenic pressure	<ul style="list-style-type: none"> • Summarize the pressure exerted on mangroves by human activities 	K2
5.3	Types of pollutants causing damage to mangroves	<ul style="list-style-type: none"> • list the pollutants that are damage the mangrove ecosystems. 	K4
5.4	Sewage, industrial, and other organic and inorganic man-made pollutants	<ul style="list-style-type: none"> • Interpret the various source of pollutants and its effects in mangroves ecosystem 	K4

5.5	Conservation strategies: Species selection, propagation and plantation techniques	<ul style="list-style-type: none"> Discuss the action plan for the conservation of mangrove vegetations 	K5
VI	Practical		
6.1	Study of zonation pattern in mangroves.	<ul style="list-style-type: none"> outline the zonation pattern in mangroves 	K2
6.2	Study of sand dune plants	<ul style="list-style-type: none"> Identify the plants species in sand dune vegetations and to interpret the stage of development 	K3
6.3	Study of mangrove associated plants	<ul style="list-style-type: none"> Assess the species interaction and distribution of plants in mangroves and its associated environments 	K5
6.4	Type study of mangroves from Rhizophoraceae, Myrsinaceae and Acanthaceae	<ul style="list-style-type: none"> Illustrate the characters of different families prevails in mangrove forest with diagnostic features. Inspect the relationships prevails among the closely related plant families. 	K2 K4
6.5	Study of vivipary in mangroves	<ul style="list-style-type: none"> Explain the strategy of mangrove plants to sustain in marshy land 	K2
6.6	Study of salt glands, trichomes, sclerides in mangroves	<ul style="list-style-type: none"> Examine the internal structure of mangroves species 	K3
6.7	Study of phenological events in different mangrove species	<ul style="list-style-type: none"> Infer the phenological events and influence of climatic changes in mangrove species 	K2

Mapping Scheme for the Course Code: P21BY2:A

P21BY2:A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	M	-	H	-	M	L	L	H	H	L	-
CO2	M	H	M	-	H	M	L	H	L	H	M	L	L
CO3	M	-	L	-	M	-	H	L	M	M	L	-	-
CO4	-	H	H	M	L	-	L	-	H	H	M	-	-
CO5	-	-	M	H	L	-	H	-	L	H	-	-	L

CO6	H	-	-	H	-	-	M	H	-	H	M	L	L
CO7	L	-	-	-	-	M	-	L	H	M	-	-	M

L-Low (1) M-Medium (2) H-High (3)

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

ELECTIVE PAPER: II – MICROBIAL FOOD PROCESSING

Semester : II

Course Code : P21BY2:B

Credits : 4

Hours/ Week : 4

COURSE OUTCOMES:

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

No.	COURSE OUTCOMES (CO)	LEVEL	UNIT
CO 1	Explain the interaction between microorganisms and the food environment and factors influencing their growth and Survival	K5	I , III
CO 2	Distinguish the, characters, significance and activities of microorganisms in food	K4	I, II
CO 3	Evaluate the characteristics, food borne, water borne and spoilage microorganisms and methods for their isolation, detection and identification.	K5	III
CO 4	Utilize the microbial quality control programme are necessary in food production and Dairy products	K3	IV, V, VI
CO 5	Explain the effects of fermentation in food production and how it influences the microbial quality and status of the food production	K2	III, V, VI
CO 6	Discuss the rational for the use of standard method and procedure for the microbial analysis of food.	K6	I- VI

Syllabus:

Unit 1: Sensory Characters of Food (12 hours)

- 1.1. Definition of food
- 1.2. Sensory or organoleptic factors appearance factors (size, shape, colour, gloss, consistency, wholeness, patterns)
- 1.3. Textural factors and Texture changes
- 1.4. Flavour factors (smell, taste, mouthfeel, temperature) and Taste interactions

Unit 2: Food as a Substrate for Microorganisms (12 hours)

- 2.1. Factors affecting microbial growth in food
- 2.2. Intrinsic factors – hydrogen ion concentration – moisture or water activity – oxidation-reduction potential – nutrient content – inhibitory substances and biological structure – combined effect of various factors
- 2.3. Extrinsic factors : Temperature of storage – Relative humidity – Concentration of gases

Unit 3: General Principles Underlying Spoilage of Food (12 hours)

- 3.1. Fitness or unfitness of food for consumption causes of spoilage
- 3.2. Classification of foods by ease of spoilage
- 3.3. Factors affecting kinds, numbers and growth of microorganisms in food and chemical changes caused by microorganisms

Unit 4: Production of Cultures for Food Fermentations (12 hours)

- 4.1. Selection of cultures and Maintenance of activity and purity of culture
- 4.2. Preparation of culture
- 4.3. Microbial cultures in food fermentation
- 4.4. Bacterial : Lactic acid culture – Propionic culture – Acetic acid bacteria
- 4.5. Yeast : Bakers' yeast – Wine yeasts – Distillers' yeast –Brewers' yeast

Unit 5: Food, dairy and beverage industries: (12 hours)

- 5.1. Production of single cell proteins (SCP) from bacteria, fungi, and algae
- 5.2. Lactic acid production
- 5.3. Yogurt and cheese production
- 5.4. Alcoholic beverages: Beer and wine fermentation.

Unit 6: Practical (15 hours)

- 6.1. Production of wine from grapes
- 6.2. Baking of cake/bread/cookies
- 6.3. Preparation of sauerkraut
- 6.4. Preparation of butter/yogurt

6.5. Determination of spoilage by Microbiological methods for dairy, fruits, vegetables and cereals by Standard Plate Count, indicator bacteria and pathogens, Methylene blue reductase test

Topics for Self - study:

S. No.	Self Study	References
1	Microbial protein	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/microbial-proteins
2	Microbial toxin	https://www.sciencedirect.com/topics/immunology-and-microbiology/microbial-toxins
3	Antibiosis	https://www.sciencedirect.com/topics/immunology-and-microbiology/antibiosis
4	Government Regulatory food practices and policies	https://www.fda.gov/food/guidance-regulation-food-and-dietary-supplements https://www.rentokil-pestcontrolindia.com/food-safety/regulations-standards/
5	GM food crops	https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/
6	Probiotics	https://my.clevelandclinic.org/health/articles/14598-probiotics
7	Bifidobacterium	https://www.sciencedirect.com/topics/immunology-and-microbiology/bifidobacterium
8	Coliphages	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/coliphages#:~:text=Coliphages%20are%20viruses%20that%20are,feecal%20indicator%2C%20fecal%20coliform%20bacteria.

TEXT BOOKS:

1. Joshi V.K. and Pandey A, 1999. *Biotechnology: Food Fermentation Vol. 1 & 2*, Education Publisher and Distributer, New Delhi.
2. Marwaha S.S. and Arora, J.K, 2000. *Food Processing: Biotechnological applications*, Asia tech Publishers Inc., New Delhi.
3. Frazier W. C. and Westhoff D.C.1995. *Food Microbiology*. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi

4. Adams M.R. and M.O. MOSS 2005. *Food Microbiology*.1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi.
5. Vijaya Ramesh, K. 2007. *Food Microbiology*, MJP Publishers, Chennai.
6. Swaminathan, N. 1987. *Food Science and experimental foods*. Ganesh Publications, Madras.
7. James M Jay.2004. *Modern Food Microbiology.4th Edition*, CBS Publishers and Distributors, New Delhi.
8. Joy. J.M. 1970. *Modern Food Microbiology*, New York: Van Nostrand Reinhold Co.
9. Norman N. Potter, 1987. *Food Science* (3rded), New Delhi: CBS Publ. and Distributors.

REFERENCE BOOKS:

1. Read G. and Nogodwanithana, 1991. *Yeast Technology*, 2ndEdition, AVI Book, Van Nostrant, Reinhold, New York.
2. Lee B.H. 1996. *Fundamental of Food Biotechnology*, VCH Publishers.
3. Goldberg I. and Williams R. 1991. *Biotechnology and Food Ingredients*, Van Nostrant., Reinhold, New York.
4. Hui Y.H. 1995. *Food Biotechnology: Micro-organism*, VCH Publisher.
5. Doyle M.P, 1997. *Food Microbiology: Fundamentals and Frontiers*, ASM Press Washington.

WEB LINKS:

- <http://nuristianah.lecture.ub.ac.id/files/2014/09/fundamental-food-microbiology.pdf>
- <http://agrimoon.com/wp-content/uploads/FOOD-AND-INDUSTRIAL-MICROBIOLOGY.pdf>

SPECIFIC LEARNING OUTCOMES (SLO):

Unit/Sections	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM' S TAXONOMI C LEVEL OF TRANSACTION
I	Sensory Characters of Food		
1.1	Definition of food	<ul style="list-style-type: none"> • Define food. • Recall the history of microorganism on food. • List out the types of foods. 	K1

1.2	Sensory or organoleptic factors appearance factors (size, shape, colour, gloss, consistency, wholeness, patterns)	<ul style="list-style-type: none"> • What is the appearance in sensory evaluation? • List out the role and characteristic of sensory evaluation 	K1
1.3	Textural factors and Texture changes	<ul style="list-style-type: none"> • Explain the quality factor in food • Illustrate the factor that affect microbial growth. 	K4
1.4	Flavour factors (smell, taste, mouthfeel, temperature) and Taste interactions	<ul style="list-style-type: none"> • Compare and contrast of flavour influencing food. 	K4
II	Food as a Substrate for Microorganisms		
2.1	Factors affecting microbial growth in food	<ul style="list-style-type: none"> • Discuss the factors affecting the growth of micro organisms in food 	K6
2.2	Intrinsic factors – hydrogen ion concentration – moisture or water activity – oxidation- reduction potential – nutrient content – inhibitory substances and biological structure – combined effect of various factors	<ul style="list-style-type: none"> • Identify the intrinsic factors in food • Examine the factors affecting biological structure of foods 	K3
2.3	Extrinsic factors : Temperature of storage – Relative humidity – Concentration of gases	<ul style="list-style-type: none"> • Compare and contrast of intrinsic and extrinsic factors • Solve the intrinsic and extrinsic factors of food • Define relative humidity 	K5 K6
III	General Principles Underlying Spoilage of Food		
3.1	Fitness or unfitness of food for consumption causes of spoilage	<ul style="list-style-type: none"> • Recall the principle of food spoilage • List out cause of food spoilage and render it unfit for human consumption 	K4
3.2	Classification of foods by ease of spoilage	<ul style="list-style-type: none"> • Classify the food on the basis of perishability. 	K5

		<ul style="list-style-type: none"> • Compare the types of food spoilage 	
3.3	Factors affecting kinds, numbers and growth of microorganisms in food and chemical changes caused by microorganisms	<ul style="list-style-type: none"> • Identify the factor affecting the growth of microorganism in food. • Discuss the intrinsic factors that affect the grow of microorganisms in food. 	K6
IV	Production of Cultures for Food Fermentations		
4.1	Selection of cultures and Maintenance of activity and purity of culture	<ul style="list-style-type: none"> • Practice the methods for microbial examination for food. • Identify the importance and properties of indication organisms. 	K3
4.2	Preparation of culture	<ul style="list-style-type: none"> • Explain the basic principle of the preparation of culture media. • Elaborate the preparation of culture media for bacteria. 	K6
4.3	Microbial cultures in food fermentation	<ul style="list-style-type: none"> • Discuss the microorganism involved in fermenting food. 	K6
4.4	Bacterial : Lactic acid culture – Propionic culture – Acetic acid bacteria	<ul style="list-style-type: none"> • Interpret the role of propionic acid bacteria. • Why are Lactic acid bacteria beneficial? 	K2
4.5	Yeast : Bakers’ yeast – Wine yeasts – Distillers’ yeast –Brewers’ yeast	<ul style="list-style-type: none"> • Recall the industrial uses of bakers and brewing yeast. • Compare and contrast between baker yeast and brewer yeast 	K4
V	Food, dairy and beverage industries:		
5.1	Production of single cell proteins (SCP) from bacteria, fungi, and algae	<ul style="list-style-type: none"> • List out the microbes used inSCP.’ • Discuss the role of microbes in the production of SCP 	K6
5.2	Lactic acid production	<ul style="list-style-type: none"> • Illustrate the Lactic acid production and production 	K2
5.3	Yogurt and cheese production	<ul style="list-style-type: none"> • Identify the process creates chees and Yogurt. • Compare the difference between Yogurt and cheese production 	K5
5.4	Alcoholic beverages: Beer and wine fermentation	<ul style="list-style-type: none"> • Distinguish between beer and wine fermentation. • Explain the two alcoholic beverages made in fermentation 	K5

VI	Practicals		
	Production of wine from grapes. Baking of cake/bread/cookies Preparation of sauerkraut Preparation of butter/yogurt Determination of spoilage by Microbiological methods for dairy, fruits, vegetables and cereals by Standard Plate Count, indicator bacteria and pathogens, Methylene blue reductase test	<ul style="list-style-type: none"> Experiment the techniques in production of wine from grapes Evaluate the production baking of cake and bread. Discuss microbial spoilage of food 	K6 K5 K5

Mapping Scheme for the Course Code: P21BY2:B

P21BY2:B	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	H	L	M	M	L	H	M	M	L	H	-
CO2	H	M	L	-	-	L	L	-	L	H	M	H	-
CO3	H	L	-	M	L	-	M	H	M	H	L	H	L
CO4	H	L	L	-	M	-	-	-	M	M	-	H	L
CO5	M	L	-	M	-	L	M	H	-	M	H	-	L
CO6	M	-	L	L	L	M	L	L	M	-	H	L	-

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

Elective II - Plant Genetic Resources

Semester : II
Credits : 4

Course Code : P22BY1:C
Hours/Week : 6

Course Outcomes:

On completion of the course students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Knowledge on the conservation biology like insitu and exsitu conservation techniques and understand various organisation involved in conservation and other polices.	K2	I
CO 2	Classify various germplasm strategies and methods	K4	II
CO 3	Understand the idea of the importance and applicability of conservation of plant genetic resources.	K2	III
CO 4	Inculcate knowledge about various principles, objectives, regulations, and the relevance of plant quarantine.	K6	IV
CO 5	Evaluate germplasm characterization, evaluation, maintenance, and regeneration.	K5	V
CO 6	Knowledge of statistical methods, research ethics, topic selection, application, and entrepreneurship is required.	K6	I- V

SYLLABUS:

Unit I: Biodiversity and Plant Genetic Resources (15 hours)

- 1.1. Biosphere and biodiversity; plant species richness and endemism; concept and importance of plant genetic resources and its increasing erosion.
- 1.2. Centres of origin and diversity of crop plants, domestication, evaluation, bioprospecting.
- 1.3. National and International organizations associated with PGR.
- 1.4. Convention on Biological Diversity (CBD).
- 1.5. Recent issues related to access and ownership of Plant genetic Resources (PGR), Intellectual Property Rights (IPR), Plant Breeders Rights (PBRs), farmers rights, sui-generis system etc.

Unit II: Germplasm Augmentation (15 hours)

- 2.1. History and importance of germplasm collection.
- 2.2. Ecogeographical distribution of diversity, logistics of exploration and collection, use of flora and herbaria.
- 2.3. Random and selective sampling, gene pool sampling in self and cross pollinated species.

2.4. Concept, importance and Ecogeographical considerations of introduction and exchange of plant germplasm.

2.5. Prerequisites conventions and achievements of PGR exchange.

Unit III: Germplasm Conservation (15 hours)

3.1. Principles and methods of conservation, in situ and ex situ methods, on – farm conservation and Gene banks.

3.2. Short medium and long term conservation strategies.

3.3. Seed physiology and seed technology in conservation.

3.4. Seed storage behaviour (orthodox, recalcitrant), field genebanks, clonal repositories.

3.5. Gene bank management, gene bank standard for various crops, International Seed Testing Association (ISTA), Association of Official Seed Analysis (AOSA), International Plant Genetic Resources Institute (IPGRI) guidelines, documentation of information in gene bank.

Unit IV: Biotechnology in PGR and Plant Quarantine (15 hours)

4.1. Plant conservation biotechnology, biotechnology in plant germplasm acquisition.

4.2. Plant tissue culture in disease elimination, in vitro conservation and exchange.

4.3. Cryopreservation, transgenic – exchange and biosafety issues.

4.4. Biochemical and molecular approaches to assessing plant diversity.

4.5. Principles, objectives and relevance of plant quarantine.

4.6. Regulations and plant quarantine set up in India.

4.7. Economic significance of seed borne pests, pathogens and weeds.

4.8. Detection and post entry quarantine operations, salvaging of infested/infected germplasm, domestic quarantine.

Unit V: Germplasm characterization, evaluation, maintenance and regeneration (15 hours)

5.1. Principles and strategies of PGR evaluation, approaches in germplasm characterization and diversity analysis.

5.2. Concept of core collection, descriptors and descriptor states for data scoring.

5.3. Maintenance of working and active collections of self-cross-pollinated and vegetatively propagated crops, perennials and wild relatives.

- 5.4. Principles and practices of regeneration in relation to mode of reproduction.
- 5.5. Concept of genetic integrity, genetic shift, genetic drift and optimum environment.
- 5.6. Post-harvest handling of germplasm; PGR data base management.

Topics for Self Study:

S. no	Self Study	References
1	ITPGRFA	https://en.wikipedia.org/wiki/International_Treaty_on_Plant_Genetic_Resources_for_Food_and_Agriculture
2	PGRFA	file:///C:/Users/Bhc/Downloads/GPP_4_1-2_13-21.pdf
3	Cryopreservation	https://en.wikipedia.org/wiki/Cryopreservation
4	Chemical kinetics	https://en.wikipedia.org/wiki/Chemical_kinetics
5	Trade secret	https://en.wikipedia.org/wiki/Trade_secret
6	Patent	https://en.wikipedia.org/wiki/Patent
7	Copy rights	https://blog.ipleaders.in/copyright-intellectual-property-rights/
8	Conservation	http://www.businessandbiodiversity.org/the_issues_conserve.html

TEXT BOOKS

1. Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS
2. Singh P. 2002. Objective Genetics and Plant Breeding. Kalyani.
3. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
4. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
5. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
6. Frankel OH & Bennett E. 1970. Genetic Resources in Plants – their Exploration and Conservation. Blackwell.

REFERENCES

1. Dhillon BS, Varaprasad KS, Kalyani S, Singh M, Archak S, Srivastava U & Sharma GD. 2001. Germplasm Conservation A Compendium of Achievements. NBPGR, New Delhi.
2. Paroda RS & Arora RK. 1991. Plant Genetic Resources Conservation and Management Concepts and Approaches. IPGRI Regional office for South and South Asia, New Delhi.
3. Briggs D. 1997. Plant Variation and Evolution. Science Publ.
4. Painting KA, Perry MC, Denning RA & Ayad WG. 1993. Guide Book for Genetic Resources Documentation. IPGRI, Rome, Italy.

5. Gautam PL, Dass BS, Srivastava U & Duhoon SS. 1998. Plant Germplasm Collecting: Principles and Procedures. NBPGR, New Delhi.
6. Singh RJ & Jauhar PP. 2005. Genetic Resources, Chromosomal Engineering and Crop Improvement. Vol. I. Grain Legumes, Vol. II. Cereals. CRC Press, Taylor & Francis Group, USA.

WEBLINKS

https://agritech.tnau.ac.in/crop_improvement/crop_imprv_plantgeni.html

<file:///C:/Users/Bhc/Downloads/Book-min-183-202.pdf>

<file:///C:/Users/Bhc/Downloads/PGRFAforsustainabledevelopment-Nnadozie.pdf>

SPECIFIC LEARNING OUTCOMES (SLO):

UNIT/ SECTI ON	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMI C LEVEL OF TRANSACTI ON
1	Biodiversity and Plant Genetic Resources		
1.1	Biosphere and biodiversity; plant species richness and endemism; concept and importance of plant genetic resources and its increasing erosion.	<ul style="list-style-type: none"> • Explain the importance of biodiversity and plant genetic resources. 	K5
1.2	Centres of origin and diversity of crop plants, domestication, evaluation, bioprospecting.	<ul style="list-style-type: none"> • Relationship between centres of origin and diversity of crop plants • Importance of bioprospecting and domestication. 	K4 K5
1.3	National and International organizations associated with PGR.	<ul style="list-style-type: none"> • List out the national and international organizations associated with PGR. 	K4

1.4	Convention on Biological Diversity (CBD).	<ul style="list-style-type: none"> Discuss the role Convention on Biological Diversity. 	K6
1.5	Recent issues related to access and ownership of Plant genetic Resources (PGR), Intellectual Property Rights (IPR), Plant Breeders Rights (PBRs), farmers rights, sui-generis system etc.	<ul style="list-style-type: none"> List out the issues related to access and ownership of PGR, IPR, PBRs, farmers rights, sui-generis system etc. 	K4
II	Germplasm Augmentation		
2.1	History and importance of germplasm collection.	<ul style="list-style-type: none"> Importance of germplasm collection and its history. 	K5
2.2	Ecogeographical distribution of diversity, logistics of exploration and collection, use of flora and herbaria.	<ul style="list-style-type: none"> Justify the role of herbaria, flora for diversity distribution, exploration and collection. 	K5
2.3	Random and selective sampling, gene pool sampling in self and cross pollinated species.	<ul style="list-style-type: none"> Importance of sampling methods used for self and cross pollinated species. 	K5
2.4	Concept, importance and Ecogeographical considerations of introduction and exchange of plant germplasm.	<ul style="list-style-type: none"> Explain the concept and importance introduction and exchange of plant germplasm. 	K2
2.5	Prerequisites conventions and achievements of PGR exchange.	<ul style="list-style-type: none"> Discuss the prerequisites conventions and achievements of PGR exchange. 	K6
III			
3.1	Principles and methods of conservation, in situ and ex situ methods, on – farm conservation and Gene banks.	<ul style="list-style-type: none"> Compare the In-situ and Ex- situ conservation methods. 	K4

3.2	Short medium and long term conservation strategies.	<ul style="list-style-type: none"> Elaborate the short-medium and long- term conservation strategies. 	K6
3.3	Seed physiology and seed technology in conservation.	<ul style="list-style-type: none"> Evaluate the role of seed physiology and seed technology in conservation. 	K5
3.4	Seed storage behaviour (orthodox, recalcitrant), field genebanks, clonal repositories.	<ul style="list-style-type: none"> Importance of seed storage behavior, field genebanks, and clonal repositories. 	K5
3.5	Gene bank management, gene bank standard for various crops, International Seed Testing Association(ISTA), Association of Official Seed Analysis(AOSA), International Plant Genetic Resources Institute (IPGRI) guidelines, documentation of information in gene bank	<ul style="list-style-type: none"> Evaluate the international seed testing agency guidelines for gene bank management and its standard for various crops. 	K5
IV	Biotechnology in PGR and Plant Quarantine		
4.1	Plant conservation biotechnology, biotechnology in plant germplasm acquisition.	<ul style="list-style-type: none"> Discuss the plant conservation biotechnology and its in the plant germplasm acquisition. 	K6
4.2	Plant tissue culture in disease elimination, in vitro conservation and exchange.	<ul style="list-style-type: none"> Elaborate the role of plant tissue culture in disease elimination, in-vitro conservation and exchange.. 	K6
4.3	Cryopreservation, transgenic – exchange and biosafety issues.	<ul style="list-style-type: none"> Discuss the cryopreservation technique, transgenic exchange and biosafety issues. 	K6
4.4	Biochemical and molecular approaches to assessing plant diversity.	<ul style="list-style-type: none"> Evaluate the biochemical and molecular approaches to assessing plant diversity. 	K5

4.5	Principles, objectives and relevance of plant quarantine.	<ul style="list-style-type: none"> • Explain the principles, objectives and relevance of plant quarantine 	K2
4.6	Regulations and plant quarantine set up in India.	<ul style="list-style-type: none"> • Discuss the quarantine regulations and plant quarantine set up in India. 	K6
4.7	Economic significance of seed borne pests, pathogens and weeds.	<ul style="list-style-type: none"> • Importance of seed borne pests, pathogens and weeds. 	K5
4.8	Detection and post entry quarantine operations, salvaging of infested/infected germplasm, domestic quarantine.	<ul style="list-style-type: none"> • Elaborate the quarantine operations, salvaging of infested germplasm and domestic quarantine. 	K6
V	Germplasm characterization, evaluation, maintenance and regeneration		
5.1	Principles and strategies of PGR evaluation, approaches in germplasm characterization and diversity analysis.	<ul style="list-style-type: none"> • Explain principles and strategies of PGR evaluation, approaches in germplasm characterization and diversity analysis. 	K2
5.2	Concept of core collection, descriptors and descriptor states for data scoring.	<ul style="list-style-type: none"> • List the descriptor states for data scoring. • Important concept of core collection 	K4 K5
5.3	Maintenance of working and active collections of self-cross-pollinated and vegetatively propagated crops, perennials and wild relatives.	<ul style="list-style-type: none"> • Compare the active and working collections of self-cross-pollinated and vegetatively propagated crops perennials and wild relatives. 	K4
5.4	Principles and practices of regeneration in relation to mode of reproduction.	<ul style="list-style-type: none"> • Explain the principles and practices of regeneration in relation to mode of reproduction. 	K2
5.5	Concept of genetic integrity, genetic shift, genetic drift and optimum environment.	<ul style="list-style-type: none"> • Compare the genetic concepts between genetic integrity, genetic shift and genetic drift. 	K4

5.6	Post-harvest handling of germplasm; PGR data base management.	<ul style="list-style-type: none"> Elaborate the post-harvest handling of germplasm and PGR data base management. 	K6
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Mapping Scheme for the Course Code: P22BY2:C

P22BY 1:C	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	M	-	-	-	-	-	-	L	-	-	-
CO2	M	-	L	M	M	H	M	L	-	M	L	L	M
CO3	L	-	L	M	L	H	M	L	-	-	L	M	-
CO4	H	M	H	-	-	-	L	L	-	M	M	M	-
CO5	M	M	M	-	-	M	-	-	-	-	-	-	-
CO6	M	-	H	-	-	M	M	M	-	M	L	M	M

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

CORE PAPER VII- PLANT PHYSIOLOGY

Semester : III

Credits : 5

Course Code : P21BY307

Hours/Week: 6

Course Outcomes:

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Explain the physiological processes of growth and development and the changes occurred during that processes	K5	I
CO 2	Evaluate the Plant -water relations in water absorption and transpiration.	K5	II
CO 3	Appraise the carbon Metabolic pathways involved in Photosynthesis.	K5	III
CO 4	Relate the integration of Metabolic pathways through Krebs cycle in Respiration.	K2	III
CO 5	Analyse the mechanism of mineral absorption and nitrogen metabolism	K4	IV
CO 6	Examine the physiological processes in Agriculture crop	K5	V

SYLLABUS:**Unit 1 : WATER PHYSIOLOGY****(18 Hours)****1.1 Nature of Protoplasm**

1.1.1 Properties of Protoplasm, Polyphasic Colloidal System

1.2 Permeability

1.2.1 Theories of Cell Permeability – a) Fluid Mosaic Theory b) Colloidal Theory c) Sieve or Ultrafiltration Theory

1.3 Properties of Water, Water relations

1.3.1 Elixir of Life, Physico-chemical Properties

1.3.2 Diffusion, Osmosis, Imbibition, DPD, Turgor Pressure, Wall Pressure, Suction Pressure and Water Potential.

1.4 Absorption of Water

1.4.1 Soil Water, Movement of water into the root cells

1.4.2 Mechanism – a) Active – i) Osmotic Theory ii) Non-Osmotic Theory b) Passive

1.5 Ascent of Sap

1.5.1 Definition, Mechanism – i) Vital Theories ii) Root Pressure Theory iii) Physical Theory

1.6 Transpiration

- 1.6.1 Definition and types- Cuticular, Stomatal and Lenticular.
- 1.6.2 Mechanism of Stomatal opening and closing- Theories – i) Photosynthetic Production in the guard cells ii) The starch-sugar hypothesis iii) Glycolate theory iv) Active K⁺ Transport Mechanism
- 1.6.3 Factors regulating Transpiration and its significance
- 1.6.4 Guttation

Unit 2 : CARBON METABOLISM & INTEGRATION OF METABOLIC CYCLES (18 Hours)

2.1 Photosynthesis

- 2.1.1 Definition, Significance and Photosynthetic apparatus – i) Photosynthetic Pigments - Chl a,b,c,d and e ii) Light Harvesting Complexes – Reaction Centres- PSI, PSII.
- 2.1.2 The role of light – Radiant energy
- 2.1.3 Photophysiological reaction – i) Cyclic Photophosphorylation ii) Non-cyclic Photophosphorylation.

2.2 Carbon Fixation

- 2.2.1 Pathways and Carbon Productivity of the following Cycles- C₃, C₄, CAM, HMP and C₂ cycle.

2.3 Translocation of Solutes

- 2.3.1 Path of translocation- i) Downward ii) Upward
- 2.3.2 Mechanism of Phloem conduction – Theories i) Diffusion Hypothesis ii) Activated Diffusion iii) Electro-osmotic Theory iv) Interfacial flow Hypothesis v) Munch Mass Flow Hypothesis

2.4 Respiration

- 2.4.1 Definition, Types- i) Aerobic ii) Anaerobic Respiration
- 2.4.2 Mechanism of Aerobic Respiration –Glycolysis, Krebs' Cycle, Oxidative Phosphorylation
- 2.4.3 Energy Transfer – ATP Synthesis
- 2.4.4 Pasteur's Effect, Bioluminescence – Definition, Significance, Role of Luciferase
- 2.4.5 Integration of Metabolic Pathways through Krebs cycle, Distribution of Metabolites
- 2.4.6 Factors regulating Respiration

Unit 3 : MINERAL NUTRITION AND NITROGEN METABOLISM (18 Hours)

3.1 Mineral Nutrition

- 3.1.1 Physiological role and deficiency symptoms of essential elements in Plants – a) Macro Nutrients- C,H,O₂, N,S, P, Cl, K, Mg, Silicon.
b) Micronutrients (I, Mn, Bo, Cu, Zn, Mo, Na)
- 3.1.2 Sand Culture, Hydroponics – definition, Nutrient Film Technique, Significance
- 3.1.3 Chemical Fertilizers – N, P, K. Manures, Foliar application of nutrients
- 3.1.4 Mineral Absorption – availability of nutrients in soil and air
- 3.1.5 Mechanism of mineral absorption – i) Passive – Mass flow, diffusion, Ion Exchange Donnan Equilibrium ii) Active - The Carrier concept, Lundegardh's cytochrome Pump Theory, Bennet-Clark's Protein-Lecithin Theory
- 3.1.6 Source and sink relations – Phloem Loading and Unloading
- 3.1.7 Heterotrophic Plants – i) Parasites ii) Saprobies iii) Symbionts
- 3.2 Nitrogen Metabolism**
- 3.2.1 Sources of Nitrogen
- 3.2.2 Nitrogen Fixation
i) Physical – Photochemical reactions, Lightning ii) Biological – a) Non-symbiotic b) Symbiotic Nitrogen Fixation – *Rhizobium*, Process of Nitrogen Fixation
- 3.2.3 Nitrogen Cycle – Nitrogen fixation, Ammonification and Denitrification
- 3.2.4 Synthesis of Amino Acids – Reductive Amination, Transamination, Conversion of Ammonium into Amino Acids, Types of Amino Acids, Breakdown of Amino Acids, Nucleic Acids-DNA, mRNA, tRNA and rRNA.

Unit 4 : PHYSIOLOGY OF GROWTH AND MOVEMENTS

(18 Hours)

4.1 Viability - Definition

4.1.1 Factors affecting viability of seed

(a) Time (b)Temperature and Moisture(c) Nature (d) Storage Conditions(e) Pollination 1.1.2

Seed Viability Test – Tetrazolium Test

4.2 Dormancy- Definition

4.2.1 Factors responsible for dormancy - (a) Hard seed coat (b) Immature Embryo (c) Period after ripening (d) Germination Inhibitors

4.2.2 Mechanism and Factors regulating dormancy

4.2.3 Hormonal Control of Dormancy in seeds

4.2.4 Dormancy controlled by Temperature and restricted oxygen uptake.

4.2.5 Methods of breaking Dormancy – (a) Scarification (b) Mechanical (c) Low Temperature (d) Alternating Temperature (e) Light (f) Pressure.

4.3 Vernalization

4.3.1 Definition, Vernalization and Flowering, Vernalization and Gibberellins

4.3.2 Mechanism of Vernalization– (a) Phasic Development Theory (b) Hormonal Theories

4.3.3 Devernalization, Practical utility.

4.4 Germination

4.4.1 Structure of Dicot Seed, Physiological Changes

4.4.2 Conditions essential for germination – Water, Oxygen, Temperature and Light.

4.5 Flowering Physiology

4.5.1 Synthesis of Flowering Hormone

4.5.2 Gibberellins and flowering response

4.5.3 Photoperiodism and the C/N ratio

4.6 Photobiology

4.6.1 Phytochrome –Photochemical and Biochemical properties, Pr and Pfr forms, Characteristics of Phytochrome induced responses, Structure and function of Phytochrome proteins.

4.6.2 Cryptochromes –Regulation in Plant Development, Photo receptor interaction in the inhibition of stem elongation.

4.6.3 Critical Day length and Photoperiodic Induction – Definition – Photoperiodism, Classification based on photoperiodic responses- (a) SDPs (b) LDPs (c) LSDPs (d) SLDPs (e) DNPs, Photoperiodic induction- Clock Hypothesis.

4.7 Phytohormone

1.7.1 Biosynthesis and Physiological role of the following Phytohormones a) Auxin b) Gibberellins c) Cytokinins d) ABA e) Ethylene

4.8 Fruiting Physiology

4.8.1 Fruit Initiation – Resource for fruit growth & Synthesis of starch

4.8.2 Fruit Maturation – Sugar storage & Starch storage

4.8.3 Fruit Ripening – Changes (a) Carbohydrate Composition (b) colour (c) Flesh Softening & textural change (d) Aroma Volatiles (e) Accumulation of organic acids

4.9 Physiology of Senescence and Abscission

4.9.1 **Senescence** – Definition, Types- (a) Organ (b) Whole Plant (c) Shoot (d) Sequential (e) Synchronous

4.9.2 Mechanism – (a) Theory of Hormonal induction of senescence (b) Hormonal root Pruning theory (c) Senescence due to hormones

4.9.3 Programmed cell death

4.9.4 **Abscission-** Definition, Mechanism – Auxin gradient Hypothesis

4.10 Movement in Plants

4.10.1 Classification of Plant Movements – a) Movement of Locomotion b) Movement of Curvature

4.10.2 Biological Clock – Evidences

4.10.3 Circadian Rhythms – a) Diurnal Variations (b) Seasonal Variations

Unit 5 : APPLIED PHYSIOLOGY

(18 Hours)

5.1 Stress Physiology

5.1.1 Physiological changes during the following stresses – i) Temperature ii) Pathogens iii) Water iv) Salt v) Pesticide and Xenobiotics vi) Heavy Metal vi) Radiation vii) Noise

5.1.2 Mechanism of stress tolerance and resistance

5.2 Agricultural Physiology

5.2.1 Water regulation and Anti transpiration

5.2.2 Seed Technology – Seed Storage, Physical Methods, Cold Storage, Seed Viability and dormancy regulation

5.3 Applied Photosynthesis

5.3.1 Hydrogen Products for Combustion

5.3.2 NanoPhotocells

Topics for Self- Study:

Biosynthesis of Chlorophyll	https://link.springer.com/chapter/10.1007/978-94-007-1579-0_3
Light regulated Enzymes	https://www.annualreviews.org/doi/abs/10.1146/annurev.pp.31.060180.002013?journalCode=arplant.1
Photosynthetic cells	https://www.ncbi.nlm.nih.gov/books/NBK26819/
Products of Symbiotic Nitrogen Fixation	https://link.springer.com/chapter/10.1007/978-1-4613-0835-5_3

Ecophysiology and Drought Physiology	https://www.scielo.br/scielo.php?script=sci_arttext&pid=S1677-04202012000300008&lng=en&nrm=iso&tlng=en
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TEXT BOOKS:

1. Jain., V.K., 2009. *Fundamental of Plant Physiology*, S. Chand Publication, Ram Nagar, New Delhi.
2. Verma, S.K. and Mohit Verma, 2007. *A Text Book of Plant Physiology, Biochemistry and Biotechnology*, S. Chand Publication, New Delhi.
3. Salisbury, C.B and Ross C.W. 2006. *Plant Physiology*. CBS Publication and Distributions. New Delhi, India.
4. Devlin, R.M. and Witham F.H. 1986. *Plant Physiology*. CBS Publication and Distributions. New Delhi, India.

REFERENCE BOOKS:

1. Verma, V. 2016. *Plant Physiology* (II Ed). Athena Academic. London.
2. William, G. Hopkins. 1995. *Introduction to Plant Physiology* (II Ed). John Wiley and Sons Inc., New York.
3. Lincoln Taiz and Eduardo Zeiger. 2010. *Plant Physiology* (5thEdition). Sunderland, Massachusetts. USA.
4. Frank B. Salisbury & Cleon W. Ross, 1992, *Plant Physiology*. 4thEdition, Wadsworth Publishing Co.,Belmont.

Web Links:

https://onlinecourses.swayam2.ac.in/cec19_bt09/preview

<https://www.classcentral.com/course/swayam-plant-physiology-and-metabolism-17732>

SPECIFIC LEARNING OUTCOME (SLO):

UNIT	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
I	WATER PHYSIOLOGY		
1.1	<p>Protoplasm</p> <p>Nature of Protoplasm</p> <p>Properties of Protoplasm, Polyphasic Colloidal System</p>	<ul style="list-style-type: none"> List the nature and properties of Protoplasm. 	K4

1.2	<p>Permeability</p> <p>Theories of Cell Permeability – a) Fluid Mosaic Theory b) Colloidal Theory c) Sieve or Ultrafiltration theory</p>	<ul style="list-style-type: none"> • Infer the theories related with Cell permeability. 	K2
1.3	<p>Elixir of Life, Physico-chemical Properties - Properties of Water, Water relations, Physico-chemical properties, Diffusion, Osmosis, Imbibition, DPD, Turgor Pressure, Wall Pressure, Suction Pressure and water potential</p>	<ul style="list-style-type: none"> • Summarize the Physico-chemical properties of water. 	K5
1.4	<p>Absorption of Water- Soil water, Movement of water into the root cells, Mechanism – a) Active – i) Osmotic ii) Non-osmotic b) Passive</p>	<ul style="list-style-type: none"> • Compare the Active Osmotic and Non-Osmotic absorption of water. • Distinguish active and passive absorption of water. 	K4 K4
1.5	<p>Ascent of Sap Definition, Mechanism – i) Vital Theories ii) Root Pressure Theory iii) Physical Theory</p>	<ul style="list-style-type: none"> • Explain the mechanism of ascent of sap and its related theory. 	K5
1.6	<p>Transpiration Mechanism of stomatal opening and closing – Theories – i) Photosynthetic Production in the guard cells ii) The starch-sugar hypothesis iii) Glycolate theory iv) Active K⁺ Transport Mechanism, Factors regulating Transpiration and its significance.</p>	<ul style="list-style-type: none"> • Explain the theories involved in the mechanism of stomatal movements. 	K5

II	CARBON METABOLISM & INTEGRATION OF METABOLIC CYCLES		
2.1	<p>Photosynthesis</p> <p>Definition, significance and Photosynthetic apparatus – i) Photosynthetic Pigments – Chl a, b, c, d & e ii) Light harvesting Complexes - Reaction Centres -PSI, PS II.</p> <p>The role of light -Radiant energy,</p> <p>Photo-physiological reaction – i) Cyclic Photophosphorylation ii) Non-Cyclic Photophosphorylation</p>	<ul style="list-style-type: none"> • Recall the photosynthetic apparatus and pigments. • Compare the Cyclic and Non-cyclic Photophosphorylation 	<p>K1</p> <p>K5</p>
2.2	<p>Carbon Fixation</p> <p>Pathways and Carbon productivity of the following Cycles – C3, C4, CAM, HMP and C2 cycle.</p>	<ul style="list-style-type: none"> • Outline the carbon fixative pathways of C3, C4, CAM, HMP and C2 cycle. • Distinguish C3 and C4 Pathway. 	<p>K2</p> <p>K4</p>
2.3	<p>Translocation of Solutes</p> <p>Path of Translocation – i) Downward ii) Upward</p> <p>Mechanism of Phloem conduction – Theories i) Diffusion Hypothesis ii) Activated Diffusion iii) Electro-osmotic theory iv) Interfacial flow Hypothesis v) Munch flow Hypothesis</p>	<ul style="list-style-type: none"> • Justify the Mechanism of translocation of organic solutes by phloem. 	<p>K5</p>
2.4	<p>Respiration</p> <p>Definition, Types i) Aerobic ii) Anaerobic Respiration</p> <p>Mechanism of Aerobic Respiration – Glycolysis, Krebs Cycle, Oxidative</p>	<ul style="list-style-type: none"> • Classify the types of respiration • Explain the Mechanism of Aerobic Respiration. • Relate the pathways which are in connection with Krebs's cycle. 	<p>K2</p> <p>K5</p>

	Phosphorylation, Energy Transfer – ATP Synthesis, Integration of Metabolic Pathways through Krebs's cycle, Factors regulating Respiration.		K2
III	MINERAL NUTRITION AND NITROGEN METABOLISM		
3.1	<p>Mineral Nutrition</p> <p>Physiological role & deficiency symptoms of essential elements in Plants</p> <p>a) Macro Nutrients – C,H,O₂, N, S,P, Cl, K, Mg, Silicon,</p> <p>b) Micro Nutrients – (I, Mn, Bo, Cu, Zn, Mo, Na),</p> <p>Sand culture, Hydroponics, Aeroponics -definition, Significance,</p> <p>Chemical Fertilizers -N,P,K, Manures, Foliar application of nutrients,</p> <p>Mineral Absorption,</p> <p>Mechanism of Mineral Absorption – i) Passive ii) Active,</p> <p>Source & sink relations – Phloem loading and unloading.</p> <p>Heterotrophic Plants – i) Parasites ii) Saprobes iii) Symbionts</p>	<ul style="list-style-type: none"> • List the physiological role and deficiency symptoms of Macro and Micro nutrients • Explain the soilless culture and its significance. • Categorize the mechanism of mineral absorption. • Analyse the processes of phloem loading and unloading. 	<p>K4</p> <p>K2</p> <p>K4</p> <p>K4</p>
3.2.	<p>Nitrogen Metabolism</p> <p>Nitrogen Fixation -i) Physical ii) Biological – a) Non-Symbiotic b) Symbiotic -</p>	<ul style="list-style-type: none"> • Interpret the processes of nitrogen metabolism. 	K4

	<p><i>Rhizobium</i>, iii) Industrial-Proteolysis(Amino acid biosynthesis), Ammonification, Nitrate reduction, Denitrification.</p> <p>Synthesis of AminoAcids – Reductive Amination, Transamination, Conversion of Ammonium into AminoAcids, Types of AminoAcids, Breakdown of AminoAcids, Nucleic AcidsDNA, mRNA, tRNA and rRNA</p>	<ul style="list-style-type: none"> • Explain the biological nitrogen fixation Process. 	K2
VI	STRESS PHYSIOLOGY		
4.1	<p>Physiological changes during the following stresses – i) Temperature ii) Pathogens iii) Water iv) Salt v) Pesticide and Xenobiotics vi) Heavy metal vi) Radiation vii) Noise,</p> <p>Mechanism of Stress tolerance and resistance</p>	<ul style="list-style-type: none"> • Criticize various Biotic and abiotic stresses and the Physiological changes occurred during that processes. 	K5
4.2	<p>Dormancy</p> <p>Dormancy -Definition, Factors responsible for dormancy – (a) Hard Seed coat (b) Immature Embryo (c) Period after ripening (d) Germination Inhibitors</p> <p>Mechanism and Factors regulating dormancy,</p> <p>Hormonal control of Dormancy in seeds,</p> <p>Dormancy controlled by Temperature and restricted oxygen uptake.</p>	<ul style="list-style-type: none"> • Explain the Mechanism and factors regulating dormancy 	K5

	<p>Methods of breaking dormancy – (a) Scarification (b) Mechanical (c) Low Temperature (d) Alternating Temperature (e) Light (f) Pressure</p>		
4.3	<p>Vernalization Definition, vernalization and flowering, vernalization and Gibberellins, Mechanism of Vernalization – (a) Phasic developmental theory (b) Hormonal theories, Devernalization, Practical Utility</p>	<ul style="list-style-type: none"> Justify the Mechanism of Vernalization and its practical utility 	K6
4.4	<p>Germination Structure of Dicot seed, Physiological changes, Conditions essential for germination – water, oxygen, temperature & light</p>	<ul style="list-style-type: none"> Explain the Physiological changes occurred during germination process 	K2
4.5	<p>Flowering Physiology Synthesis of Flowering Hormone Gibberellins and flowering response, Photoperiodism and the C/N ratio</p>	<ul style="list-style-type: none"> Summarize the synthesis of Flowering Hormone and the role of Gibberellins 	K2
4.6	<p>Photobiology Phytochrome -Photochemical and Biochemical properties, Pr and Pfr forms, Characteristics of Phytochrome induced responses; structure and function of Phytochrome proteins. Cryptochromes – Regulation in Plant Development, Photo</p>	<ul style="list-style-type: none"> Evaluate the role of Phytochrome and Cryptochrome in the Plant developmental processes 	K5

	receptor interaction in the inhibition of stem elongation.		
4.7	Phytohormones Biosynthesis and Physiological role of the following Phytohormones (a) Auxin (b) Gibberellins (c) Cytokinins (d) ABA I Ethylene	<ul style="list-style-type: none"> Outline the biosynthetic pathways of the plant growth regulators and its physiological role 	K2
4.8	Fruiting Physiology Fruit Initiation- Resource for fruit growth & synthesis of starch, Fruit Maturation-Sugar storage & Starch storage, Fruit Ripening – Changes (a) Carbohydrate composition (b) Colour (c) Flesh softening & textural change (d) Aroma Volatiles (e) Accumulation of Organic acids	<ul style="list-style-type: none"> Explain the physiological changes occurred during the fruit ripening Process 	K5
4.9	Physiology of Senescence and Abscission Senescence -Definition, Mechanism – (a) Theory of Hormonal Induction of Senescence (b) Hormonal root pruning theory (d) Senescence due to hormones, Programmed cell death, Abscission – Definition, Mechanism -Auxin gradient Hypothesis.	<ul style="list-style-type: none"> Examine the mechanism involved in the physiology of Senescence and abscission. 	K4
4.10	Movement in Plants Classification of Plant Movements – a) Movement of Locomotion b) Movement of Curvature, Biological clock – Evidences, Circadian Rhythms – a) Diurnal variations b) Seasonal variations	<ul style="list-style-type: none"> Classify the plant movement and its type with suitable illustration. 	K2
V	APPLIED PHYSIOLOGY		
5.1	Physiological changes during the following stresses – i)	<ul style="list-style-type: none"> Criticize various Biotic and abiotic stresses and the Physiological 	K5

	Temperature ii) Pathogens iii) Water iv) Salt v) Pesticide and Xenobiotics vi) Heavy metal vi) Radiation vii) Noise, Mechanism of Stress tolerance and resistance	changes occurred during that processes.	
5.2	Agricultural Physiology Water regulation and Anti transpiration, Seed Technology – Seed storage, Physical Methods, Cold storage, Seed viability and dormancy regulation	<ul style="list-style-type: none"> Prove the role of water regulation and anti-transpirants in agriculture. 	K5
5.3	Applied Photosynthesis Hydrogen Products of Combustion, Nano Photocells	<ul style="list-style-type: none"> Examine the application of nano photocells. 	K4

Mapping Scheme for the Course Code: P21BY307

P21BY 307	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	-	M	-	M	-	-	L	H	H	-	H	H
CO2	H	L	M	-	H	-	-	-	L	H	-	H	H
CO3	H	L	M	-	M	-	-	-	L	H	-	H	M
CO4	M	-	L	-	L	L	-	-	L	L	-	M	H
CO5	M	L	M	-	M	M	-	-	L	M	-	M	H
CO6	H	L	H	L	M	H	L	L	H	L	-	L	L

L – Low (1) M-Medium (2) H-High (3)

COURSE ASSESSMENT METHODS

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination

Indirect

1. Course-end survey

CORE PAPER -VIII – BIOPHYSICS,BIOCHEMISTRY AND PHARMACOGNOSY

Semester : III

Course Code : P21BY308

Credits : 4

Hours/week : 6

Course Outcomes:

On completion of this course, the students will be able to:

No	Course Outcomes	Level	Unit
CO 1	Explain the basic physical principles and nature of chemical atoms in relation of biological molecules	K2	I
CO 2	Demonstrate the biopolymers formation and structural configuration	K2	II
CO 3	Classify the Biomolecules based on their nature and function	K4	II
CO 4	Make use of different instruments for scientific researches	K3	III
CO 5	Develop methodology for the utilization and identification of drugs from plants	K6	IV
CO 6	Determine the nature, quality and biological effects of different phytochemical drugs	K5	V

SYLLABUS:

Unit 1: BIOPHYSICS

(18 Hours)

- 1:1 Atom- Definition and Structure of atom,
- 1:2 Schrodinger's theory – Principle and application
- 1:3 Quantum numbers- definition and types
- 1:4 Pauli's exclusion principle,
- 1:5 Hunds rule.
- 1:6 Bonds – definition and types -Ionic, covalent, Hydrogen, Electrostatic, Disulphide and peptide bonds,

- 1:7 Vander waals forces- Principle and procedure
- 1:8 Isomerism- definition and types- Structural isomerism, geometrical isomerism, optical isomerism and optical activity.
- 1:9 Bioenergetics – definition, Radiant energy and light absorption,
- 1:10 Energy and Heat transfer with in plants and environment and plants,
- 1:11 Laws of thermodynamic- Concept of free energy, Energy rich compounds, Entropy, free energy and enthalpy
- 1:12 Redox potential
- 1:13 Oxidation – Reduction reaction.

Unit 2: BIOMOLECULES

(18 Hours)

- 2:1 Biopolymers- definition, type and application
- 2:2 Carbohydrates-definition, Classification - Monosaccharides, Oligosaccharides, polysaccharides and glycosides, Chemistry of monosaccharide- Isomerism and Ring structure and its significance, Biosynthesis and metabolism –Gluconeogenesis.
- 2:3 Amino acids- definition and Classification – Aliphatic, aromatic and heterocyclic and its significance
- 2:4 Protein- definition and classification – Simple, Conjugate and Derived protein, Structure-Primary, Secondary, Tertiary and Quaternary and its significance and Ramachandran's curve.
- 2:5 Lipids- Definition and classification- Simple- Saturated, Unsaturated, branched chain and Cyclic fatty acids, Compound and Derived –Steroids:- Stigmasterol, Ecdysone, Lophenol and Cycloaudenol and its significance, Biosynthesis and metabolism --oxidation.
- 2:6 Enzymes: Definition- Nature, Properties, Classification, Isoenzymes, Michaelis Constant, Model for explaining enzyme action- Lock and key model and Induced fit model, Enzyme action- Exergonic, Reversible and Endergonic reaction, Enzyme , Enzyme Inhibition-Competitive, Non competitive, Uncompetitive and Allosteric inhibition and factors affecting enzyme activity.
- 2:7 Secondary metabolites – definition and type, chemical and role- Alkaloids, Steroids, Terpenes, Phenols, and Glycosides.
- 2:8 Vitamins – Definition and types, Fat soluble- Vitamin A, D, E and K water soluble vitamins- B, C, H O- occurrence, Structure and properties.

Unit 3 : BIOINSTRUMENTATION

(18 Hours)

- 3:1 pH- Meter– Principle, structure and application.
- 3:2 Electrolytes – definition –pH - Glass, Calomel and combination, Ion Selective and oxygen electrode
- 3:3 Acid and base- Definition, differences and Acid and base reactions-
- 3:5 Buffers- definition, characteristics, and types-Phosphate and Tris buffer.
- 3:6 Chromatography: definition and types- Adsorption and Partition chromatography
- 3:7 Principle, structure and applications- PC, TLC CC, GC, HPLC, GC-MS, LC-MS, Colorimetry, Spectrophotometry- UV-Vis, Electrophoresis, Ultracentrifugation.

Unit 4: PHARMACOGNOSY**(18 Hours)**

- 4:1 Traditional and alternative systems of medicine- Ayurveda, siddha, Unani, Naturopathy and Yoga.
- 4:2 Classification of crude drugs- Aliphatic, Taxonomical, Morphological, Pharmacological, chemical and chemotaxonomical classification.
- 4:3 Scheme for pharmacognostic studies of a crude drug- Official title, synonyms, biological origin, geographical source, Cultivation, collection and protection of plant, preparation of crude drugs for market, macroscopic and microscopic characters, chemical constituents, chemical test, therapeutic and pharmacological uses, Commercial varieties, substitutes and adulterants and storage.
- 4:4 Collection, processing and preparation of crude drugs.

Unit 5 : DRUG THERAPY**(18 Hours)**

- 5:1 Analytical pharmacognosy –Definition
- 5:2 Drug adulteration, methods of drug evaluation – Replacement by exhausted drugs, substitution with superficially similar but inferior drugs, substitution of artificially manufactured substitutes, presence of organic matter obtained from the same plant and chemical constituent of the drugs.
- 5:3 Drug Evaluation – Confirmation of drug identity, determination of quality and purity, Organic, Microscopic, Physical, Chemical and biological evaluation, Biological testing of herbal drugs- Toxic, Symptomatic and tissue method- Hepatoprotective, Hypoglycaemic and antifertility activities
- 5:4 Phytochemical investigations
- 5:5 Phytopharmaceuticals – Retrospects and prospect
- 5:6 Ayurvedic Pharmacy- Definition, Rasa, guna, virya, vipaka and Prabhava
- 5:7 AYUSH- Definition and their programme and Quality standard for drug

Topics for Self Study:

S. no	Topics for Self Study	References
1	Chemical bonds	https://www.britannica.com/science/chemical-bonding
2	Biomolecules synthesis and metabolism	http://hyperphysics.phy-astr.gsu.edu/hbase/Chemical/bond.html
3	Pharmacognostic studies	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3985058/
4	Traditional medicine in pandemic and Medicinal plants	https://www.longdom.org/special-issue/covid19-outbreak-the-use-of-medicinal-plants-as-herbal-ingredients-in-the-formulations-for-medicine-1026.html

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1. Rastogi, S.C. 2008. *Biochemistry*. Tata McGraw Hill publishing Company Limited, New Delhi.
2. Jain. J. L., Sunjay Jain and Nitin Jain, 2012. *Fundamental of Biochemistry*. S. Chand and Company Pvt. Ltd., New Delhi.
3. Sathyanarayana, U. and Chakrapani, U.2009. *Biochemistry* (3rd Edt.). Arunabha Sen Books and Allied Pvt.Ltd. Kolkata, India.
4. Veerakumari, L. 2006. *Bioinstrumentation*. MJP Publisher, Chennai. Tamil Nadu.
5. Gurumani, N. 2014. *Research Methodology for biological sciences*. MJP Publisher, Chennai. Tamil Nadu.
6. Verma, S.K. and Mohit Verma, A. 2016. *Text book of Plant physiology, Biochemistry and Biotechnology*. S.Chand and Company Pvt. Ltd., New Delhi, India
7. Harborne, J.B. 1998. *Phytochemical methods a guide to modern techniques for plant analysis* (3rdEdt.). Chapman and Hill, London,.
8. Shah, C.S. and Quadry, J. S. 2008. *A Text book of Pharmacognosy* (13th Edt.). B.S.Shah Prakashan, Ahmedbad, India.
9. Kokate, C.K, 2019, Pharmacognosy, Nirali Prakashan Publishers, Pune, Mahrastra.

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1. Murray, R. K., Granner, D. K., Mayes, P. A. and Rod Well, V. W. 1993. *Harper's Biochemistry*. Prentice – Hall of International limited, London.
2. Voet, D. and Voet, J. G. 2011. *Biochemistry*. Fourth Edition. John Wiley and sons, Inc, New York.
3. Stryer Lubert, 2005, *Biochemistry*, W.H. Freeman & Co., NY
4. David L Nelson and Michael M Cox, 2021. *Lehninger, Principals of Biochemistry*, W.H. Freeman, New York

Web Links:

- <https://www.acsedu.co.uk/Courses/Science/BIOCHEMISTRY-I-PLANTS-BSC102-256.aspx>
https://onlinecourses.swayam2.ac.in/cec20_bt13/preview
https://onlinecourses.swayam2.ac.in/cec19_bt09/preview

SPECIFIC LEARNING OUTCOMES (SLO):

UNI T/ Secti on	CONTENT	LEARNING OUTCOME	HIGHE S T BLOOM TAXON OMIC LEVEL OF TRANSA CTION
I	Biophysics		
1.1	- Atom- Definition and Structure of atom. - Schrodinger's theory – Principle and application - Quantum numbers- definition and types - Pauli's exclusion principle, - Hunds rule	<ul style="list-style-type: none"> • Explain the basics about atom and its structure • Relate various theories and principles involved in Atom function and structure 	K2 K2
1.2	Bonds – definition and types -Ionic, covalent, Hydrogen, Electrostatic, Disulphide and peptide bonds, Vander waals forces- Principle and procedure	<ul style="list-style-type: none"> • Explain the different types of bonds involved in the molecular interactions 	K2
1.3	Isomerism- definition and types- Structural isomerism, geometrical isomerism, optical isomerism and optical activity	<ul style="list-style-type: none"> • Explain the isomerism prevails in the biomolecules 	K2
1.4	- Bioenergetics – definition, Radiant energy and light absorption, -Energy and Heat transfer with in plants and environment and plants, - Laws of thermodynamic- Concept of free energy, Energy rich compounds, Entropy, free energy and enthalpy	<ul style="list-style-type: none"> • Tell thermodynamic laws in the general metabolic process. • Explain the heat and energy transfer in the environment 	K1 K2
1.5	Redox potential Oxidation – Reduction reaction	<ul style="list-style-type: none"> • Summarize the Redox reaction process 	K2
II	BIOMOLECULES		
2.1	Biopolymers- definition, type and application	<ul style="list-style-type: none"> • Recall Biopolymers structure and its types 	K1

2.2	Carbohydrates -definition, Classification - Monosaccharides, Oligosaccharides, polysaccharides and glycosides, Chemistry of monosaccharide - Isomerism and Ring structure and its significance, Biosynthesis and metabolism – Gluconeogenesis	<ul style="list-style-type: none"> Classify the carbohydrates molecules based on their complexity. Construct the structure of different carbohydrate molecules Demonstrate the biosynthesis of carbohydrate 	K2 K3 K4
2.3	Amino acids- definition and Classification – Aliphatic, aromatic and heterocyclic and its significance	<ul style="list-style-type: none"> Categorize the amino acids based on the function in cell 	K4
2.4	Protein- definition and classification – Simple, Conjugate and Derived protein, Structure- Primary, Secondary, Tertiary and Quaternary and its significance and Ramachandran’s curve.	<ul style="list-style-type: none"> Summarize the protein types based on their structural significance. Apply the functional forms of proteins 	K2 K3
2.5	Lipids- Definition and classification- Simple- Saturated, Unsaturated, branched chain and Cyclic fatty acids, Compound and Derived – Steroids:- Stigmasterol, Ecdysone, Lophenol and Cycloaudenol and its significance, Biosynthesis and metabolism - oxidation.	<ul style="list-style-type: none"> Explain the function and metabolism of Lipids Model the biosynthesis of Lipids 	K2 K3
2.6	Enzymes: Definition- Nature, Properties, Classification, Isoenzymes, Michalis Constant, Model for explaining enzyme action- Lock and key model and Induced fit model, Enzyme action- Exergonic, Reversible and Endergonic reaction, Enzyme , Enzyme Inhibition- Competitive, Non competitive, Uncompetitive and Allosteric inhibition and factors affecting enzyme activity.	<ul style="list-style-type: none"> Interpret mode of catalytic activity of different enzymes. Analyze the enzyme action with different models 	K4 K4

2.7	Secondary metabolites – definition and type, chemical and role- Alkaloids, Steroids, Terpenes, Phenols, and Glycosides.	<ul style="list-style-type: none"> • Illustrate the role of secondary metabolites in Plant metabolism and defense mechanism 	K2
2.7	Vitamins – Definition and types, Fat soluble- Vitamin A, D, E and K water soluble vitamins- B, C, H O- occurrence, Structure and properties.	<ul style="list-style-type: none"> • Explain the importance of vitamins their occurrence and properties 	K2
III	BIOINSTRUMENTATION		
3.1	-pH- Meter– Principle, structure and application. Electrolytes – definition –pH - Glass, Calomel and combination, Ion Selective and oxygen Electrode	<ul style="list-style-type: none"> • Choose appropriate electrode for experiments • Explain the working principal of different Electrodes 	K3 K2
3.2	Acid and base- Definition, differences and Acid and base reactions- - Buffers- definition, characteristics, and types-Phosphate and Tris buffer	<ul style="list-style-type: none"> • Experiment with acid and base solutions and utilization of Buffers in research methods 	K3
3.3	Chromatography: definition and types- Adsorption and Partition chromatography	<ul style="list-style-type: none"> • Explain the principle of chromatography applications 	K2
	Principle, structure and applications- PC, TLC CC, GC, HPLC, GC-MS, LC-MS, Colorimetry, Spectrophotometry- UV-Vis, Electrophoresis, Ultracentrifugation.	<ul style="list-style-type: none"> • Apply the principle of chromatography in separation and identification of phytochemicals 	K3
IV	PHARMACOGNOSY		
4.1	Traditional and alternative systems of medicine- Ayurveda, siddha, Unani, Naturopathy and Yoga	<ul style="list-style-type: none"> • Utilize the different traditional system of medicine • Develop new methods of plant extraction 	K3 K6
4.2	Classification of crude drugs- Aliphatic, Taxonomical, Morphological, Pharmacological, chemical and chemotaxonomical classification	<ul style="list-style-type: none"> • Classify the crude drugs and phytochemical evaluation 	K4

4.3	Scheme for pharmacognostic studies of a crude drug- Official title, synonyms, biological origin, geographical source, Cultivation, collection and protection of plant, preparation of crude drugs for market, macroscopic and microscopic characters, chemical constituents, chemical test, therapeutic and pharmacological uses, Commercial varieties, substitutes and adulterants and its storage.	<ul style="list-style-type: none"> Analyze the properties, therapeutic and pharmacological uses of plant drugs. Assess plant crude drugs as alternative source of medicine 	K4 K5
4.4	Collection, processing and preparation of crude drugs.	<ul style="list-style-type: none"> Utilize the resource of plant derived crude drugs 	K3
V	DRUG THERAPY		
5.1	Analytical pharmacognosy –Definition	<ul style="list-style-type: none"> Recall analytical pharmacognosy uses and application 	K2
5.2	Drug adulteration, methods of drug evaluation – Replacement by exhausted drugs, substitution with superficially similar but inferior drugs, substitution of artificially manufactured substitutes, presence of organic matter obtained from the same plant and chemical constituent of the drugs	<ul style="list-style-type: none"> Deduct adulteration of crude drugs Explain alternative drug sources 	K5 K5
5.3	Drug Evaluation – Confirmation of drug identity, determination of quality and purity, Organic, Microscopic, Physical, Chemical and biological evaluation, Biological testing of herbal drugs- Toxic, Symptomatic and tissue method- Hepatoprotective, Hypoglycaemic and antifertility activities Phytochemical investigations Phytopharmaceuticals – Retrospects and prospect	<ul style="list-style-type: none"> Identify the chemical components of plant derived drugs. Determine the purity and physicochemical nature of drugs 	K3 K5

5.6	Ayurvedic Pharmacy- Definition, Rasa, guna, virya, vipaka and Prabhava 5:7 AYUSH- Definition and their programme and Quality standard for drug	<ul style="list-style-type: none"> Make use of traditional medicinal practice 	K3
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Mapping Scheme for the Course Code: P21BY308

P21BY 308	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	M	-	-	-	L	M	H
CO2	-	-	M	-	-	-	L	-	M	-	M	M	H
CO3	-	-	L	-	-	-	M	-	-	-	H	H	M
CO4	-	-	-	L	-	-	M	-	L	-	M	M	-
CO5	-	L	-	M	L	H	H	-	H	M	H	-	L
CO6	-	-	-	M	-	H	H	-	H	M	H	-	M

L-Low M-Medium H-High

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

CORE IX- PLANT BIOTECHNOLOGY

Semester : III

Course Code : P21BY309

Credits : 4

Hours/Week : 6

Course Outcomes:

On completion of this course, the students will be able to:

NO	COURSE OUTCOMES (C)O)	Level	Unit
CO 1	Interpret the concepts of genome organization in plants	K2	I
CO 2	Explain the concepts of molecular markers connecting to diversity analysis, phylogenetic relationship and create tools for marker-assisted selection in plant breeding	K5	I
CO 3	Appraise the knowledge about the various aspects of tissue culture and their applications	K5	II

CO 4	Develop suitable techniques/protocol for <i>In vitro</i> culture	K6	II
CO 5	Determine biotechnological techniques and genetic engineering involved in breeding plants	K5	III
CO 6	Explain the concepts of transgenic plants and Application of Biotechnology in Plant improvement, Bioprospecting plants	K5	IV&V

SYLLABUS:

Unit – 1: Genome organization in Plants (18 Hours)

- 1.1 Nuclear – Nucleus and chromatin organisation
- 1.2 Chloroplast – Chemistry and function
- 1.3 Mitochondrial genome – Structure and functions
- 1.4 Molecular Marker-aided Breeding
 - (a) RFLP maps (b) linkage analysis (c) RAPD markers (d) STS (e) Microsatellites (f) SCAR (Sequence Characterized Amplified Regions), (g) SSCP (Single Strand Conformational Polymorphism), (h) AFLP, (i) SSR,(j) ISSR, (k) QTL, map based cloning, molecular marker assisted selection.

Unit 2: Plant Tissue Culture (18 Hours)

- 2.2.1 Tissue culture media (composition and preparation)
- 2.2.2 Callus and suspension culture
- 2.2.3 Somaclonal variation
- 2.2.4 Micropropagation
- 2.2.5 Organogenesis
- 2.2.6 Somatic embryogenesis
- 2.2.7 Hardening.
- 2.3 Embryo culture and embryo rescue.
- 2.4 Synthetic seeds.
- 2.5 Protoplast isolation and fusion
- 2.6 Somatic hybridization
- 2.7 Cybrids
- 2.8 Anther, pollen and ovary culture for production of haploid plants.
- 2.9 Cryopreservation
- 2.10 Germplasm conservation.

Unit 3: Plant Genetic Transformation methods (18 Hours)

- 3.1 Features of Ti and Ri plasmids and its use as vectors,
 - 3.1.2 Binary vectors,
 - 3.1.3 Viral vectors,
 - 3.1.4 35S and other promoters,
 - 3.1.5 Use of reporter genes and marker genes,
- 3.2 Gene transfer methods in plants:
 - 3.2.1 Direct and indirect DNA transfer.

- 3.2.2 Chloroplast transformation and its advantages.
- 3.2.3 Transgene stability and gene silencing.

Unit 4 : Application of Biotechnology in Plant improvement (18 Hours)

- 4.1 Improvement of photosynthetic efficiency of plants;
- 4.2 Concepts of transgenic plants
- 4.3 Developing disease resistant Varieties- bacterial and fungal
- 4.4 Improvement of quality of seed storage Proteins
- 4.5 Genetic engineering for extended shelf-life of fruits,
- 4.6 Development of stress tolerant plants
- 4.7 Regulation of gene expression under stress condition
- 4.8 Role of monoclonal antibodies in agriculture
- 4.9 Antisense technology.

Unit 5 :BIOPROSPECTING PLANTS (18 Hours)

- 5.1 Molecular farming- benefits and risks,
- 5.2 Plantibodies
- 5.3 Edible vaccines
- 5.4 Edible interferon's
- 5.5 Production of secondary metabolites.
- 5.6 Procedures involved in commercialization of transgenic crops.
- 5.7 Policy and technological options to deal with India's food surpluses and shortages.
- 5.8 Ethical issues related to G.M. crop.
- 5.9 Biotechnology and intellectual property rights (IPR)
- 5.10 Plant genetic resources GATT & TRIPS
- 5.11 Patent for higher plant genes.

Topics for Self-study:

S. no	Topics for Self-study	References
1	Totipotency	https://www.frontiersin.org/articles/10.3389/fpls.2019.00536/full
2	Morphogenesis	https://www.archdaily.com/office/morphogenesis
3	Embryo Rescue	https://www.slideshare.net/abhijedi123/embryo-rescue-somaclonal-variation-cryopreservation
4	Haploid plants	https://link.springer.com/chapter/10.1007/978-1-4613-9365-8_3
5	GM Plants	https://extension.colostate.edu/topic-areas/agriculture/genetically-modified-gm-crops-techniques-and-applications-0-710/
6	GURT	https://www.slideshare.net/siddarudh/gurt-genetic-use

7	Terminator seeds- Impacts	https://yinnepal.wordpress.com/portfolio/the-suicide-seeds-genetic-use-restriction-technology/
8	PPV and FRA	https://www.researchgate.net/publication/334899127_PPV_and_FRA_2001

TEXT BOOKS:

1. Dubey, R.C. 2005. *A textbook of Biotechnology*, S. Chand Publishers, New Delhi, India.
2. Ramawat, K.G., and Shaily Goyal 2009. *Comprehensive Biotechnology*. S. Chand Publishers, New Delhi. India.
3. Mantel, Mathews and Mickee. 1985. *An introduction to genetic engineering in plants*. Blackwell Scientific Publishers. London.
4. Grierson, D. and Convey S.V. 1984. *Plant Molecular Biology*. Blackie and Son Limited. New York .
5. Mantell, S.H and Smith, H. 1983. *Plant Biotechnology*. Cambridge University press, UK
6. Chrispeels, M. J. and Sadava, D.F. 2000. *Plants, genes and agriculture*. The American Scientific Publishers, USA.
7. Hammond, J., Mc Garvey, P. and Yusibov, V. 2000. *Plant Biotechnology* Springer, Verlag, UK

REFERENCE BOOKS:

1. J.Hammond, P. Mc Garvey and V. Yusibov 2000. *Plant Biotechnology* Springer Verlag, UK.
2. Kirsi-Marja Oksman - Caldentey and Wolfgang H. Barz. Marcel Dekker, 2002. *Plant Biotechnology and Transgenic Plants*, New York.

Web link:

<https://www.classcentral.com/course/swayam-principles-of-biotechnology-17738>

https://onlinecourses.nptel.ac.in/noc19_bt20/preview

https://onlinecourses.swayam2.ac.in/cec20_bt07/preview

SPECIFIC LEARNING OUTCOME (SLO) :

Unit	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
I	Genome organization in Plants		
1.1	Nuclear – Nucleus and chromatin organisation	<ul style="list-style-type: none"> • Explain the internal structure and genome organisation 	K2

1.2	Chloroplast – Chemistry and function	<ul style="list-style-type: none"> Explain the molecular organization of chloroplast 	K2
1.3	Mitochondrial genome – Structure and functions	<ul style="list-style-type: none"> Explain the molecular organization of Mitochondria 	K2
1.4	Molecular Marker-aided Breeding (a) RFLP maps (b) linkage analysis (c) RAPD markers (d) STS (e) Microsatellites (f) SCAR (Sequence Characterized Amplified Regions), (g) SSCP (Single Strand Conformational Polymorphism), (h) AFLP, (i) SSR, (j) ISSR, (k) QTL, map based cloning, molecular marker assisted selection.	<ul style="list-style-type: none"> Tell the importance of molecular markers in relation to diversity analysis, phylogenetic relationship Interpret suitable tools for marker-assisted selection in plant breeding 	K1 K5
II	Plant Tissue Culture		
2.1	Tissue culture media (composition and preparation)	<ul style="list-style-type: none"> Identify suitable medium for <i>In vitro</i> Propagation 	K3
2.2	Callus, suspension culture Somaclonal variation, Micropropagation, Organogenesis- Types Somatic embryogenesis and Embryo culture	<ul style="list-style-type: none"> Explain the protocol for micropropagation Discuss Micropropagation experiments 	K5 K6
2.3	Synthetic seeds	<ul style="list-style-type: none"> Explain the need of production artificial seed 	K2
2.4	Protoplast isolation and fusion	<ul style="list-style-type: none"> Examine the suitable techniques for isolation of cell 	K4
2.5	Somatic hybridization and cybrids		
2.6	Anther, pollen and ovary culture for production of haploid plants.	<ul style="list-style-type: none"> Apply tissue culture techniques in crop improvement 	K3
2.7	Cryopreservation and Germplasm conservation	<ul style="list-style-type: none"> Determine the techniques for cryopreservation and need of conservation 	K5
III	Plant Genetic Transformation methods		
3.1	Features of Ti and Ri plasmids and its use as vectors, 3.1.1. Binary vectors, 3.1.2. Viral vectors, 3.1.3. 35 S and other promoters, 3.1.4 Use of reporter genes and marker genes,	<ul style="list-style-type: none"> Summarize the application techniques in Genetic Engineering Identify the suitable vectors for expression of genes 	K2 K3

3.2	Gene transfer methods in plants: 3.2.1 Direct and indirect DNA transfer. 3.2.2 Chloroplast transformation and its advantages. 3.2.3 Transgene stability and gene silencing.	<ul style="list-style-type: none"> Apply the knowledge gained from Genetic Engineering in Crop plants Determine biotechnology techniques involved in crop improvement 	K3 K5
IV	Application of Biotechnology in Plant improvement		
4.1	Improvement of photosynthetic efficiency of plants;	<ul style="list-style-type: none"> Explain the concept of photosynthetic efficiency of plants 	K2
4.2	Concepts of transgenic plants	<ul style="list-style-type: none"> Apply the concepts of transgenic plants 	K3
4.3	Developing disease resistant Varieties- bacterial and fungal	<ul style="list-style-type: none"> Explain the disease resistant varieties of plants 	K5
4.4	Improvement of quality of seed storage Proteins	<ul style="list-style-type: none"> Interpret the improvement of seed storage proteins 	K2
4.5	Genetic engineering for extended shelf-life of fruits,	<ul style="list-style-type: none"> Apply the genetic engineering techniques 	K3
4.6	Development of stress tolerant plants	<ul style="list-style-type: none"> Explain the concept of stress tolerant plants 	K2
4.7	Regulation of gene expression under stress condition	<ul style="list-style-type: none"> Outline the gene expression under stress condition 	K2
4.8	Role of monoclonal antibodies in agriculture	<ul style="list-style-type: none"> Explain the role of monoclonal antibodies in Agricultural field 	K2
4.9	Antisense technology.	<ul style="list-style-type: none"> Demonstrate antisense technology 	K1
V	BIOPROSPECTING PLANTS:		
5.1	Molecular farming- benefits and risks,	<ul style="list-style-type: none"> Compare the molecular farming of both benefits and risk 	K5
5.2	Plantibodies	<ul style="list-style-type: none"> Explain plantibodies and their role in the environment 	K2
5.3	Edible vaccines.	<ul style="list-style-type: none"> Evaluate the importance of Edible vaccines. 	K5
5.4	Edible interferon's	<ul style="list-style-type: none"> Analyse the various components of Edible interferon's 	K4
5.5	Production of secondary metabolites.	<ul style="list-style-type: none"> Recognize the importance of secondary metabolites 	K2

5.6	Procedures involved in commercialization of transgenic crops.	<ul style="list-style-type: none"> Explain the detailed information of transgenic crops 	K2
5.7	Policy and technological options to deal with India's food surpluses and shortages.	<ul style="list-style-type: none"> Evaluate the various policy and technological options to deal with India's food surpluses and shortages 	K5
5.8	Ethical issues related to G.M. crop.	<ul style="list-style-type: none"> Analyze the ethical issues and GM crops 	K4
5.9	Biotechnology and intellectual property rights (IPR)	<ul style="list-style-type: none"> Interpret the intellectual property right 	K3
5.10	Plant genetic resources GATT & TRIPS	<ul style="list-style-type: none"> Explain the detailed information of GATT and TRIPS 	K2
5.11	Patent for higher plant genes	<ul style="list-style-type: none"> Discuss the detailed study of patents 	K5

Mapping Scheme for the Course Code: P21BY309

P21BY 309	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	-	L	-	M	M	-	M	-	L	-	-	-
CO2	H	-	-	M	H	H	-	H	M	M	-	H	L
CO3	H	-	M	L	H	H	-	H	M	M	-	H	L
CO4	H	-	M	-	M	M	-	M	H	-	-	M	M
CO5	H	-	H	-	H	L	-	M	M	M	-	M	H
CO6	H	-	-	H	M	-	L	M	M	H	-	H	M

L-Low M-Medium H-High

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Records - end survey

CORE PRACTICAL -V- PLANT PHYSIOLOGY

Semester : III

Course Code : P21BY3P5

Credits : 3

Hours/ Week :3

Course Outcomes:

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Experiment on physiological water properties with plant	K3	I
CO 2	Examine absorption spectrum of photosynthetic pigments	K4	I
CO 3	Estimate the total acidity in CAM plants	K5	I
CO 4	Analyse the activity of Catalase, Amylase & NR in young seeds	K4	I
CO 5	Distinguish the rate of germination under various temperature and salt condition	K4	I
CO 6	Improve the scientific reasoning and ability to interpret experimental data through experiential learning in Physiology	K6	I

Syllabus:

Plant Physiology- 45 Hours

- Determination of osmotic pressure of *Rheo discolor/Tradescantia* leaves/*Onion* peel by Plasmolytic method.
- Determination of Water Potential of potato tuber by weighing method/Density method.
- Determination of water potential of Plant samples by Chardakov's Method.
- Effect of temperature on membrane permeability
- Effect of pH on membrane permeability.
- Absorption spectrum of photosynthetic pigments.
- Demonstration of Hill reaction.
- Estimation of total acidity in CAM plants.
- In vivo* assay of NR and NIR
- Assay of catalase in young and sensed seeds
- Assay of amylase in germinating seeds
- Determination of growth curve under different conditions.
- Germination under stress (Salinity, temp. etc.)
- Seed viability testing under different conditions (Salinity, temp, Solvent)
- Spotters: Growth Regulators – IAA, GA, Cytokinin, Ethylene, Phytochrome, Cryptochrome, Biological Nitrogen Fixation – Root Nodule, Thigmonastic Movement – Ex: *Passiflora*, Nyctinastic Movements – Ex: *Oxalis*, Seismonastic Movements – Ex: *Mimosa pudica*, Respiroscope, Arc Auxanometer, Nano Photocells

TEXT BOOKS:

1. Gupta, N.P., Sangha Manju Bala, M.K. and Sunita Gupta. 2016. *Practical in Plant Physiology and Biochemistry*, Scientific Publishers, India.
2. Bajracharya. D., 2003. *Experiments in Plant physiology a Laboratory Manual*, Narosa Publishing house, Chennai.
3. Vijay Paul, 2004. *Laboratory Manuel: Experimental Plant Physiology-I*, Indian Agricultural Research Institute, New Delhi.

Web Links:

https://www.coabnau.in/uploads/1610774232_FundamentalofCropPhysiology3.1Pract.Manual-Jan2021.docx

SPECIFIC LEARNING OUTCOME (SLO):

UNIT	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
I	PLANT PHYSIOLOGY		
	a) Determination of osmotic pressure of <i>Rheo discolor/Tradescantia</i> leaves/ <i>Onion</i> peel by Plasmolytic method. b) Determination of Water Potential of potato tuber by weighing method/Density method. c) Determination of water potential (Chardakov's method) d) Effect of temperature on membrane permeability	<ul style="list-style-type: none"> • Determine the solute potential of plant cells in relation with water. • Determine the diffusion pressure deficit of potato tuber cells in relation with water. • Identify the water potential of plant cells. • Estimate the effect of different temperatures on the membrane permeability of plant cells 	K5 K5 K3 K6

	<p>e) Effect of pH on membrane permeability</p> <p>f) Absorption spectrum of photosynthetic pigments</p> <p>g) Demonstration of Hill reaction</p> <p>h) Estimation of total acidity in CAM plants.</p> <p>i) <i>In vivo</i> assay of NR and NIR</p> <p>j) Assay of catalase activity in young and sensed seeds</p> <p>k) Assay of amylase in germinating seeds</p> <p>l) Determination growth curve under different conditions.</p> <p>m) Germination studies under stress (Salinity, temp. etc.)</p> <p>n) Spotters: Growth regulators-IAA, GA, Cytokinin, Ethylene, Phytochrome, Cryptochrome, Biological Nitrogen Fixation - Root Nodule, Thigmonastic Movement – Ex: Passiflora, Nyctinastic Movement – Ex: Oxalis, Seismonastic Movements</p>	<ul style="list-style-type: none"> • Estimate the effect of different pH on the membrane permeability of plant cells. • Estimate the absorption spectra of the photosynthetic pigments. • Prove the occurrence of Hill’s reaction by chloroplast through dye reduction method • Determine the total acidity in CAM plants • Determine the activity of nitrate reductase enzyme in leaf tissue • Test the effect of time factor on the activity of the enzyme catalase in young and sensed seeds • Test the activity of amylase enzyme in germinating seeds • Compare the growth of green gram seeds in tap water and distilled water by paper towel method • Determine the germinability of green gram under different solvents, temperature & salinity. • Improve the scientific reasoning ability to interpret the Images, real specimens and apparatus in relation with plant physiology. 	<p>K6</p> <p>K6</p> <p>K5</p> <p>K5</p> <p>K4</p> <p>K6</p> <p>K6</p> <p>K4</p>
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	-Ex: Mimosa pudica, Respiroscope, Arc Auxanometer, Nano Photocells.		K5 K6
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L-Low (1) M-Medium (2) H-High (3)

Mapping Scheme for the Course Code: P21BY3P5

P21BY3P5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	L	H	-	L	M	-	M	H	L	H	H
CO2	H	M	L	H	-	L	M	-	-	H	L	H	H
CO3	H	M	H	H	M	L	L	M	L	H	L	H	M
CO4	H	L	L	M	L	L	M	L	L	H	L	H	M
CO5	H	L	M	H	L	L	L	M	L	H	L	M	H
CO6	H	L	L	H	-	L	L	L	L	M	M	H	M

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment in Practical works, Graph, Calculation & Interpretation, record submission.
2. Practical tests, Records etc.
3. End Semester Examination

Indirect

1. Course-end survey

CORE PRACTICAL VI - BIOCHEMISTRY, PHARMACOGNOSY AND PLANT BIOTECHNOLOGY

Semester: III

Credits : 3

Course Code: P21BY3P6

Hours/Week : 3

COURSE OUTCOMES

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

No	COURSE OUTCOMES (CO)	LEVEL	UNIT
CO 1	Experiment with detection of Biomolecules	K3	I
CO 2	Analyse the chromatographic techniques to identify the biomolecules	K4	I

CO 3	Inspect the presence of essential and non-essential substances in a given compound	K4	II
CO 4	Examine the presence of adulterant in the common food substances.	K4	III
CO 5	Explain the basic design and needs for a Plant Biotechnology lab	K5	III
CO 6	Develop synthetic seeds from various plants	K6	III

SYLLABUS:

Unit I: Phytochemistry

(15 HOURS)

1. Qualitative tests for phytochemicals Carbohydrate, protein, Secondary metabolites
2. Quantitative test of total starch, total protein, total amino acid and total lipid
3. Chromatography – TLC, Paper chromatography, sugars, phenols, aminoacids.

Unit II: Pharmacognosy

(15 HOURS)

4. Histochemical tests – Carbohydrates, Glycosides, Lipids, Volatile oils, resins, tannins, alkaloids etc.
5. Ash value test
6. Solubility test
7. Maceration and study of cells.
8. Epidermal and trichome study
9. Testing adulterants

Unit III: Biotechnology

(15 HOURS)

10. Essentials of plant tissue culture laboratory.
11. Good laboratory practices and safety guidelines.
12. Basic design and layout of plant tissue culture laboratory
13. Preparation of basal tissue culture medium and preparation of stocks
14. Micropropagation, callus induction and regeneration using different explants of plants.
15. Agrobacterium rhizogenes for hairy root culture.
16. Synthetic seed preparation.

TOPICS FOR SELF-STUDY

S. No	Topics for self-Study	REFERNCES
1	Methods of Phytochemical extraction	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750618/
2	Various trichomes in Plants	https://www.microscopemaster.com/trichomes-and-microscopy.html
3	Metallic adulterants	https://www.publichealthnotes.com/food-adulteration-types-of-food-adulteration-and-mitigation-measures/
4	Micropropagation of other plant parts	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/micropropagation

TEXT BOOKS:

1. David, L. NOelson and Michael, M. Cox. Lehninger. 2017. *Principles of Biochemistry* (7th edt) . W.H. Freeman company, New York.
2. Bob B. Buchanan, Wilhelm Gruissem and Russel, L. Jones. 2007. *Biochemistry and Molecular biology of plants*. Krishan Makhijanifo I.K. International Pvt. Ltd, New Delhi, India.
3. Jeremy M. Berg, John, L. Tymoczko and Lubert Stryer. 2006. *Biochemistry* (6th Edition). W. H. Freeman company, New York.

REFERENCE BOOK:

Rastogi, S.C. 2008. *Biochemistry*. Tata McGraw Hill publishing company Limited, New Delhi, India

Web Link:

https://onlinecourses.swayam2.ac.in/cec20_bt07/preview

SPECIFIC LEARNING OUTCOME (SLO):

UNIT	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSCATION
I	Phytochemistry		
1.1	-Qualitative tests for phytochemicals Carbohydrate, protein, Secondary metabolites	<ul style="list-style-type: none"> • Illustrate the presence of biomolecules in the sample • Experiment on the identification of biomolecules in the sample 	K2 K3
1.2 1.3	-Quantitative test of total starch, total protein, total amino acid and total lipid - Chromatography – TLC, Paper chromatography, sugars, phenols, amino acids.	<ul style="list-style-type: none"> • Define the chromatographic techniques in depth • Analyze the presence of molecules using the chromatographic techniques 	K2 K4
II	Pharmacognosy		
2.1 2.2 2.5 2.6	Histochemical tests – Carbohydrates, Glycosides, Lipids, Volatile oils, resins, tannins, alkaloids etc. - Ash value test - Solubility test - Maceration and study of cells - Epidermal and trichome study - Testing adulterants	<ul style="list-style-type: none"> • Experiment with the Pharmacognotical important plant molecules. • Inspect the presence of essential and non-essential substances in a given compound • Analyze the structure of internal tissues of plants during maceration • Examine the presence of adulterant in the given sample 	K3 K4 K4 K4
III	Biotechnology		
3.1	- Essentials of plant tissue culture laboratory.	<ul style="list-style-type: none"> • Define the layout of a plant biotechnology lab • List the important nutrients needed for <i>in vitro</i> plant culture 	K1

3.2	- Good laboratory practices and safety guidelines	<ul style="list-style-type: none"> Inspect the necessities of a lab Determine the <i>in vitro</i> plant culture and the nutrients needed for <i>in vitro</i> plant culture Develop synthetic seed preparations and plant plan the parameters needed for it 	K4
3.3	- Basic design and layout of plant tissue culture laboratory		K4
3.4	- Preparation of basal tissue culture medium and preparation of stocks		K5
3.5	- Micropropagation, callus induction and regeneration using different explants of plants		K6
3.6	Agrobacterium rhizogenes for hairy root culture		
3.7	Synthetic seed preparation		

Mapping Scheme for the Course Code: P21BY3P6.

P21BY 3P6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	-	-	-	-	H	L	L	M	M	L	H	-
CO2	H	M	L	-	-	L	L	-	L	H	M	H	-
CO3	H	L	-	-	L	-	-	-	M	H	L	H	L
CO4	H	L	L	-	M	-	-	-	M	M	-	H	L
CO5	M	L	-	M	-	L	M	L	-	M	H	-	L
CO6	M	-	-	L	L	M	L	L	M	-	-	L	-

L-Low M-Medium H-High

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Records - end survey

ELECTIVE: III- GREEN WEALTH

Semester : III

Course Code : P21BY:P1

Credits : 3

Hours/Week : 6

Course Outcomes:

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

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Agree the basic concept of taxonomy, cultivation practices and nutrition values of crops	K5	I
CO 2	Determine the medicinal values of plants	K5	II
CO 3	Make use of the concept of aesthetic value in plants	K3	III
CO 4	Discuss relationship between plants and their environment	K4	IV
CO 5	Develop the entrepreneurship skills using plant products	K6	V
CO 6	Create the skill about the nutritive values and medicinal properties, role of plants as environmental indicators and protectors, aesthetic values in training plants there by developing entrepreneurship skills	K6	I - V

SYLLABUS:

Unit 1 : Plants and Nutrition

(9 Hours)

- 1.0. Plants and their Nutrition
- 1.1. Basic taxonomic knowledge, cultivation practices and Nutritional values – Cereals and millets, Pulses, Nuts
- 1.2. Field visit to crop land and report.
- 1.3. Preparation of diet chart - (a) Normal children (b) Adult (c) Senior people (d) Pregnant woman (e) Lactating mother (f) Diabetic and diuretic people.
- 1.4. Preparation of Indian Traditional food
- 1.4.1. Recipes along with nutritional values (Cereals/millets to be used either singly or in combination)

Unit 2 : Plants and Medicine

(9 Hours)

- 2.0. Plants and their medicinal values
- 2.1. A brief knowledge of five plants used in first aid
- 2.2. Plants used to treat hypertension
- 2.3. Plants used to treat obesity
- 2.4. Plants used to treat blood sugar
- 2.5. Plants used to treat antifertility
- 2.6. Method of herbal preparations and administration

2.7. Maintenance of medicinal plants lively- Medicinal garden.

Unit 3 : Plants and Aesthetics

(9 Hours)

3.0 Plants and Aesthetics values

3.1. Vegetable carving

3.2. Bouquet

3.3. Jungle jewels

3.3.1. Ear drops

3.3.2. Studs

3.3.3. Bangles

3.3.4. Necklace

3.4. Cosmetics

3.4.1. Face packs

3.4.2. Skin cares

3.5. Jute

3.6. Coir items

Unit 4 : Plants and Environment

(9 Hours)

4.0. Plants and Environment

4.1. Plant indicators

4.2. Plants as wind breakers

4.3. Green house plants

4.4. Plants in disaster management

4.5. Plants as radiation, gas and noise absorbents

4.6. Plants as dust filters

4.7. Temperature mitigants.

Unit 5 : Plants and Entrepreneurship

(9 Hours)

5.0. Plants and Entrepreneurship

5.1. Learning skills -(a) Topiary (b) Bonsai (c) Formation of lawns (d) Kitchen garden (e) Herbal (medicinal) gardens (f) Hanging garden (g) Rock garden

5.2 Visit to botanical garden and report

Topics for self- study:

S. No	Topics for self-study	REFERENCES
1	methods of making plant jewels	https://betterdiamondinitiative.org/different-processes-manufacturing-jewelry/ https://www.halsteadbead.com/articles/handmade-jewelry-types-and-techniques
2	Uses of Plants	http://scienceindia.in/home/view_article/59

3	Ornamental plants growth	https://www.researchgate.net/publication/317170246_MEDICINALLY_USEFUL_ORNAMENTAL_PLANTS_OF_KITCHEN_GARDEN https://www.longdom.org/proceedings/ornamental-plants-and-their-role-in-human-psychology-14952.html
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TEXT BOOKS:

1. Ambast, S. P. 1986. *The Useful Plants of India*. Publications and Information Directorate, CSIR, New Delhi.
2. Pandey, B.P.1999. *Economic Botany*. S. Chand and company Pvt. Ltd., New Delhi.
3. Prajapati, N.D., Purohit, S.S. and Sharma, A.K. 2011. *A Handbook of Medicinal Plants*. Motilal Banarsidass Publishers Pvt. Ltd., New Delhi.
4. Sambamurty, A.V.S.S. and Subrahmanyam, N.S. 1989. *A Text Book of Economic Botany*. New Delhi.
5. Swaminathan, M. 1992. *Human Nutrition and Diet*. Bappco, Bangalore.
6. Verma, V. 2009. *Textbook of Economic Botany*. Ane Books, India.

REFERENCE BOOK:

Bose. T.K, Singh. L.J, Sadhu. M.K, Maitu. L.K. 2000. *Ornamental Plants and Garden designing*. Encyclopedia Vol. 1 & 2, Kolkatta.

Web LinK:

<https://m.economictimes.com/topic/online-course-portal-Swayam/3>

SPECIFIC LEARNING OUTCOME (SLO):

UNIT	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
1	PLANTS AND NUTRITION		
1.1	Plants and their Nutrition Basic taxonomic knowledge, cultivation practices and	<ul style="list-style-type: none"> Identify the basic taxonomic knowledge, cultivation practices and Nutritional values of 	K3

	Nutritional values – Cereals millets, Pulses and Nuts	Cereals millets, Pulses and Nuts	
1.2	Field visit to crop land and report	<ul style="list-style-type: none"> Survey the agriculture land and report preparation 	K4
1.3	Preparation of diet chart - (a) Normal children (b) Adult (c) Senior people (d) Pregnant woman (e) Lactating mother (f) Diabetic and diuretic people.	<ul style="list-style-type: none"> Construct a diet chart for (a) Normal children (b) Adult (c) Senior people (d) Pregnant woman (e) Lactating mother (f) Diabetic and diuretic people. 	K3
1.4	Preparation of Indian Traditional food Recipes along with nutritional values (Cereals/millets to be used either singly or in combination)	<ul style="list-style-type: none"> Judge the preparation of Indian Traditional food recipes along with nutritional values (Cereals/millets to be used either singly or in combination) 	K5
II	PLANTS AND MEDICINE		
2.1	Plants and their medicinal values- A brief knowledge of five plants used in first aid	<ul style="list-style-type: none"> Determine the Plants and their medicinal values Identify and Compare the five plants used in first aid 	K5 K4
2.2	Plants used to treat hypertension, Plants used to treat obesity Plants used to treat blood sugar Plants used to treat antifertility	<ul style="list-style-type: none"> Make use of plants used to treat hypertension, treat obesity, blood sugar and antifertility 	K3
2.6	Method of herbal preparations and administration	<ul style="list-style-type: none"> Evaluate the method of herbal preparations and administration 	K5
2.7	Maintenance of medicinal plants lively- Medicinal garden.	<ul style="list-style-type: none"> Analyse the maintenance of medicinal plants grown in Medicinal garden. 	K4

III	PLANTS AND AESTHETICS		
3.1	Plants and Aesthetics values	<ul style="list-style-type: none"> • Make use of the vegetable carving, Bouquet preparation method 	K3
3.2	Vegetable carving Bouquet		
3.3	Jungle jewels Ear drops, Studs Bangles and Necklace	<ul style="list-style-type: none"> • Develop the skill to prepare Jungle jewels 	K3
3.4	Cosmetics Face packs , Skin cares Jute and Coir items	<ul style="list-style-type: none"> • Build their capacity to make Cosmetics, Face packs, Skin cares, Jute and Coir items 	K3
IV	PLANTS AND ENVIRONMENT		
4.1,	Plants and Environment	<ul style="list-style-type: none"> • Utilize the Plants as a indicator and wind breakers 	K3
4.2	Plant indicators, Plants as wind breakers		
4.3,	Green house plants,	<ul style="list-style-type: none"> • Identify the green house plants • Analyze Plants in disaster management 	K3 K4
4.4	Plants in disaster management		
4.5,	Plants as radiation, gas and noise absorbents Plants as dust filters, Temperature mitigants.	<ul style="list-style-type: none"> • Identify the plants as radiation, gas and noise absorbents dust filters and Temperature mitigants 	K3
V	PLANTS AND ENTREPRENEURSHIP		
5.1	(a) Topiary (b) Bonsai (c) Formation of lawns (d) Kitchen garden (e) Herbal (medicinal) gardens (f) Hanging garden (g) Rock garden	<ul style="list-style-type: none"> • Analyze the (a) Topiary (b) Bonsai (c) Formation of lawns (d) Kitchen garden (e) Herbal (medicinal) gardens 	K4

		(f) Hanging garden (g) Rock garden	
5.2	Visit to botanical garden and report.	<ul style="list-style-type: none"> Develop their practical knowledge to visit botanical garden and report 	K6

Mapping Scheme for the Course Code: P20BY3:P1

P20BY 3:P1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	H	L	H	L	-	M	H	M	-	H
CO2	M	M	-	H	-	H	L	-	L	H	H	-	M
CO3	L	M	-	H	-	H	-	M	L	H	L	-	M
CO4	L	L	-	-	H	H	-	M	-	H	-	-	-
CO5	-	-	-	-	H	H	-	L	-	H	-	-	-
CO6	H	M	-	M	-	H	L	M	-	H	M	-	M

COURSE ASSESSMENT METHODS:

Direct

-
1. Continuous Assessment in Practical works, sectioning, record submission.
 2. Practical tests, Records etc.
 3. End Semester Examination

Indirect

-
1. Course-end survey

Naturopathy and Traditional Healthcare

Semester: III
Credits: 3

Course Code: P21BY3:P2
Hours/Week: 6

Course Outcome:

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

No	COURSE OUTCOME (CO)	Level	Unit
CO1	Explain the Indian Traditional Systems of Medicine	K2	1
CO2	Make use of the Health Importance, Health Management, Food Habits Nutritional Values, Nutritional deficiency and disorders	K3	1
CO3	Analyze the Philosophy of human body and mind, Values of Human Anatomy, Basic study of human physiology Biochemistry	K4	II
CO4	Apply the Principles and methods of Natural therapeutic practices	K3	III
CO5	Determine the Diet and Nutrition, Taste and its therapeutic actions Colours and its therapeutic actions.	K5	IV
CO6	Elaborate the administration procedures, Ethics in health care entrepreneurship.	K6	V

Syllabus:

UNIT 1 - Food and nutrition in Indian medicine systems (12 Hours)

1.1 Indian Traditional Systems of Medicine

(a) Introduction and History (b) AYUSH and its salient features

1.2 Health

(a) Definition (b) Importance (c) Health Management (d) Food Habits
(e) Nutritional Values (f) Nutritional deficiency and disorders

Unit II- Fundamentals of Anatomy of Human body (12 Hours)

2.1 Philosophy of human body and mind.

2.2 Values of Human Anatomy, Basic study of human physiology and importance of biochemistry.

Unit III – Principles and methods of Natural therapeutic practices (12 Hours)

3.1 Naturopathy treatments and effects.

3.2 Philosophy of yoga practices, and their therapeutic actions.

3.4 Meditation and its impacts on EEG

Unit IV- Diet and Nutrition (18 Hours)

- 4.1 Basic concept of Diet and Nutrition
- 4.2 Taste and its therapeutic actions
- 4.3 Colours and its therapeutic actions
- 4.4 Traditional concepts of diet .
- 4.5 Preparation of different diet charts
- 4.5.1 Traditional food recipes and its value.
- 4.6 Identification of raw foods and its Nutritional and therapeutic value.

Unit V- Hospital administration (15 Hours)

- 5.1 Hospital administration procedures
- 5.2 Ethics in health care entrepreneurship.

Practical session (18 Hours)

- 1. Food preparation under diet Therapy.
- 2. Yoga Demonstrations with practices.
- 3. Manipulative techniques in Naturopathy
- 4. Hospital administration training

Topic for self-learning

S. No	Topic	Reference
1	Types of Indian medicine	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2816487/
2	Naturopathy foods	https://vikaspedia.in/health/ayush/naturopathy

TEXT BOOKS:

- 1. Swaminathan, 1995. *Food & Nutrition*. The Bangalore Printing & publishing co ltd., Vol I, Second Edition, Bangalore.
- 2. Srilakshmi, 1997. *Food Science*. New Age International (P) Ltd, Publishers, Pune.
- 3. Mudambi .R. Sumathi & Rajagpal M.V, 1983. *Foods & Nutrition*, Willey Eastern Ltd, Second Edition, New Delhi.
- 4. B. K. S. Iyengar, 1995. *Light on Yoga: The Bible of Modern Yoga* by ISBN-13: 9780805210316. Knopf Doubleday Publishing Group.
- 5. T. K. V. Desikachar, 1999. *The Heart of Yoga: Developing a Personal Practice* ISBN-13:9780892817641- Inner Traditions/Bear & Company.
- 6. J L Jain, Nitin Jain and Sunjay Jain – S, *Fundamentals of Biochemistry* –Chand publishing ISBN -9788121924535.

7. PV Chadha, 1993. *Handbook of Experimental Physiology and Biochemistry*. ISBN-9788171791415.

WEB LINK:

https://www.googleadservices.com/pagead/aclick?sa=L&ai=DChcSEwiCne3Ny9ryAhWMCSsKHXhmCpYYABAAGgJzZg&ae=2&ohost=www.google.com&cid=CAESQeD20MIZlnD2vjgZu3H2m1Ug3PF-qd9SMN14UOWkTO1UuDnCxvaPFRvoCo-FnMTKxl3O3Io3f43rbMpkYk7ZpqkL&sig=AOD64_3ru_svx21LZun4_ndwFKyDkLuzLA&q&adurl&ved=2ahUKEwjQ9OXNv9ryAhWaSH0KHeRuCDIQ0Qx6BAGEEAE

https://www.googleadservices.com/pagead/aclick?sa=L&ai=DChcSEwiCne3Ny9ryAhWMCSsKHXhmCpYYABADGgJzZg&ae=2&ohost=www.google.com&cid=CAESQeD20MIZlnD2vjgZu3H2m1Ug3PF-qd9SMN14UOWkTO1UuDnCxvaPFRvoCo-FnMTKxl3O3Io3f43rbMpkYk7ZpqkL&sig=AOD64_1GYeMAO2eh3buuDbeT3SP_J-1mTw&q&adurl&ved=2ahUKEwjQ9OXNv9ryAhWaSH0KHeRuCDIQ0Qx6BAGCEAE

SPECIFIC LEARNING OUTCOME TABLE (SLO):

Unit	Contents	Learning Outcomes	Highest Blooms taxonomic level of transaction
I.	FOOD AND NUTRITION IN INDIAN MEDICINE SYSTEMS		
1.1	Indian Traditional Systems of Medicine (a) Introduction and History (b) AYUSH and its salient features	<ul style="list-style-type: none"> What is Indian system of medicine Compare the different types of medicinal systems 	K1 K2
1.2	Health (a) Definition (b) Importance (c) Health Management (d) Food Habits (e) Nutritional Values (f) Nutritional deficiency and disorders	<ul style="list-style-type: none"> Illustrate the importance and health management food habits Classify the Nutritional deficiency and disorders Analyze the nutritional values 	K2 K4 K4
II	FUNDAMENTALS OF ANATOMY OF HUMAN BODY		

2.1	Philosophy of human body and mind.	<ul style="list-style-type: none"> • Explain the Philosophy of human body and mind. • Evaluate Values of Human Anatomy, Basic study of human Outline • Determine the physiology and importance of biochemistry. 	K2
2.2\	Values of Human Anatomy, Basic study of human Outline physiology and importance of biochemistry.		K5
2.3			K5
III	PRINCIPLES AND METHODS OF NATURAL THERAPEUTIC PRACTICES		
3.1	Naturopathy treatments and effects.	<ul style="list-style-type: none"> • Make use of Naturopathy treatments and effects. • Take part in yoga practies, and their therapeutic actions. • Discuss the its impacts on EEG 	K3
3.2	Philosophy of yoga practies, and their therapeutic actions.		K4
3.3	Meditation and its impacts on EEG		K2
IV	DIET AND NUTRITION		
4.1	Basic concept of Diet and Nutrition	<ul style="list-style-type: none"> • Experiment concept of Diet and Nutrition • Examine the its therapeutic actions • Infer the Colours and its therapeutic actions • Perceive Traditional concepts of diet . • AdaptTraditional food recipes and its value 	K3
4.2	Taste and its therapeutic actions		K4
	Colours and its therapeutic actions		K2
4.3	Traditional concepts of diet .		K5
4.4	Preparation of different diet charts		K6
4.5	Traditionalfood recipes and its value.		
4.6	Identification of raw foods and its Nutritional and therapeutic value.		

V	Hospital administration		
5.1	Hospital administration procedures	<ul style="list-style-type: none"> • Explain the Hospital administration procedures • Analyze Ethics in health care entrepreneurship. 	K5
5.2	Ethics in health care entrepreneurship.		K4

Mapping Scheme for the CORE COURSE: P21BY3:P2

P21BY3:P2	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	L	-	M	M	M	H	M	H	H	-	L	H
CO2	M	-	L	L	L	L	-	L	L	H	M	L	H
CO3	L	-	L	L	L	M	-	L	-	M	L	M	H
CO4	M	H	-	-	M	L	-	-	L	M	L	-	H
CO5	M	-	L	L	L	-	L	-	M	H	M	-	H
CO6	H	L	M	-	-	-	L	-	M	M	-	L	H

L-Low (1) M-Medium (2) H-High (3)

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

Elective III - MEDICINAL PLANTS AND HUMAN WELFARE

Semester : III

Credits : 3

Course Code : P22BY:P3

Hours/Week : 6

Course Outcomes:

On completion of the course students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Understanding of principle and treatment methods of various Traditional system of medicines.	K2	I
CO 2	Comprehend the current trade status and application of medicinal plants in socio-economic growth.	K3	II
CO 3	Investigate the most suitable conservation method for medicinal plants using modern biotechnology and biochemistry tools to ensure their sustainable utilization.	K5	III and IV
CO 4	describes the classification and structural organisation of biochemicals, identifies the enzyme kinetics, and illustrates the regulatory process	K4	III – IV
CO 5	Evaluate bioactive compounds' knowledge-based drug products' efficacy and their various applications in drug industries.	K5	IV-VI
CO 6	Create new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society.	K6	V

SYLLABUS:

Unit- I Traditional system of Medicinal plants (15 Hours)

- 1.1 Medicinal plants- Scope and importance
- 1.2 Classification of medicinal plants
- 1.3 Cultivation of medicinal plants'
- 1.4 Processing and Utilization
- 1.5 Chemical nature of crude drugs- Extraction, Preparation and preservation of crude drugs
Ayurveda, Siddha and Unani systems of herbal medicine, Ethnobotany and ethnomedicine.

Unit – II Application of Medicinal Plants (15 Hours)

- 2.1 Traditional herbal teas'
- 2.2 Herbs for Women, Babies and Children
- 2.3 Concepts of Herbal Garden- Home, School herbal gardens

Unit – III Bioactive compounds of medicinal plants (15 Hours)

3.1 Classification and Estimation of primary metabolites – carbohydrates, fatty acids, aminoacids and protein,

3.2 Secondary metabolites- Classification, general characters and chemical nature

3.3 Extraction and Estimation methods for Glycosides, Tannins, Volatile oils, Resinous substances, Terpenoids, phenolic compounds and Alkaloids.

Unit – IV Biochemical Protection mechanisms. (15 Hours)

4.1 Plant defence mechanism- Antioxidants,

4.2 Reactive oxygen species

4.3 Enzymatic and non enzymatic antioxidants, Role of antioxidants

4.4 Estimation of antioxidants – Ascorbic acid, Alpha tocopherol.

4.5 Enzyme – Peroxidase, SOD and Catalase.

4.6 Free radical- types of free radicals- production of free radicals

Unit – V Collection, processing of Herbal drugs (15 Hours)

5.1 Medicinal plants - Post harvest technology, scope and importance.

5.2 Importance of herbal marketing- Future prospects and constraints of the herbal drug industry.

5.3 Regulatory status of herbal medicine in India.

5.4 Adulteration with reference to plant drug, types of adulterants and methods of adulteration.

Unit – VI Practicals (15 Hours)

Estimation of carbohydrates

Estimation of protein

Estimation of fatty acids

Estimation of phenols

Estimation of Flavonoids

Preparation of Crude extracts

Herbarium Preparation

Estimation of Ascorbic acid and α Tocopherol.

Topics for Self Study:

S. no	Self Study	References
1	Status of Indian Medicinal Plant trade	https://www.sciencedirect.com/science/article/abs/pii/S209549641930055X
2	CDRI	https://cdri.res.
3	CIAMP	https://www.cimap.res.in/english/index.php
4	Kani Tribe	https://en.wikipedia.org/wiki/Kani_tribe
5	Phytotherapeutic compounds	https://www.britannica.com/science/phytotherapy
6	NMPB	https://nmpb.nic.in/
7	Pharmacognosy	https://en.wikipedia.org/wiki/Pharmacognosy
8	Drug therapy	https://www.safeopedia.com/definition/5043/drug-therapy

TEXT BOOKS

1. Farooqi, A.A. and B. S. Sreeramu, 2004. Cultivation of medicinal and aromatic crops. Revised edition, Universities Press (India) Private Limited, Hyderabad.
2. Harbone, J. B. 1998. Phytochemical methods. A guide to modern techniques of plant analysis 3rd Edn (India) Private Limited, New Delhi.
3. WHO, 2002. Quality control methods for medicinal plant materials, World Health Organization, Geneva, A.I.T.B.S., Publishers and Distributors, New Delhi.
4. Halliwall, B. and J. M. Gutteridge, 1985. Free radicals in Biology and Medicine. Oxford University press.
5. Purohit, A. P., C. K. Kokate and S. B. Gokhale, 2021. A Text book of Pharmacognosy, 57th Edision, Nirali Prakashan Publication, Pune.

REFERENCES

1. Irfan Ali Khan and Atiya Khanum, 2006. Ethnomedicine and Human welfare, Ukaaz publication, Hyderabad.
2. Sharma, P.V, 2004. Classical Uses of medicinal plants, Chaukhambha vishvabharati publication, Varanasi.
3. Weiss Rudolf Fritz 2000 Herbal Medicine, 2nd Edition Thieme Medical Publishers, New York.
4. Trease and Evans, 2009. Pharmacognosy, Elsevier Publications, Edinburgh.
5. Pulok.K. Mukarjee (2019). Quality control and evaluation of Herbal Drugs, Kindle Edition, Elsevier, Edinburgh.

Web links:

1. <http://www.gallowglass.org/jadwiga/herbs/preparations.html>
2. <http://shawnacohen.tripod.com/thetribaltraditions/id51.html>
3. http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500003393.pdf

SPECIFIC LEARNING OUTCOMES (SLO):

UNIT/ SECTI ON	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMI C LEVEL OF TRANSACTION
1	Traditional system of Medicinal plants		
1.1	Medicinal plants- Scope and importance	<ul style="list-style-type: none">• List out the scope and importance of medicinal plants.	K2
1.2	Classification of medicinal plants	<ul style="list-style-type: none">• Distinguish different types of medicinal plants	K4
1.3	Cultivation of medicinal plants'	<ul style="list-style-type: none">• Discuss the cultivation of medicinal plants.	K6 K2

1.4	Processing and Utilization	<ul style="list-style-type: none"> • Explain the Process and utilization of medicinal plants. 	K5 K3
1.5	Chemical nature of crude drugs- Extraction, Preparation and preservation of crude drugs Ayurveda, Siddha and Unani systems of herbal medicine, Ethnobotany and ethnomedicine.	<ul style="list-style-type: none"> • What is herbal crude drug? • Classify the ethnopharmacological approach in herbal drug development. • Elaborate in detail about Indian traditional system ayurvedic system of medicine. 	K5 K4 K6
II	Application of Medicinal Plants		
2.1	Traditional herbal teas'	<ul style="list-style-type: none"> • List of ten healthy herbal teas you want to try. 	K2
2.2	Herbs for Women, Babies and Children	<ul style="list-style-type: none"> • Explain the herbal remedies commonly used in infants without efficacy 	K5
2.3	Concepts of Herbal Garden- Home, School herbal gardens	<ul style="list-style-type: none"> • Discuss the herbal garden and promoting herbal garden 	K6
III	Bioactive compounds of medicinal plants		
3.1	Classification and Estimation of primary metabolites – carbohydrates, fatty acids, aminoacids and protein,	<ul style="list-style-type: none"> • Classify the various types of primary metabolites. • Explain the structural of proteins, • Differentiate between protein and aminoacids. 	K4
3.2	Secondary metabolites- Classification, general characters and chemical nature.	<ul style="list-style-type: none"> • Define metabolisms. • Elaborate the character, chemical nature of secondary metabolites 	K4 K6
3.3	Extraction and Estimation methods for Glycosides, Tannins, Volatile oils, Resinous substances,	<ul style="list-style-type: none"> • Estimation methods for Glycosides, tannin • List out in details about phenols. 	K6 K4

	Terpenoids, phenolic compounds and Alkaloids.		
IV	Biochemical Protection mechanisms		
4.1	Plant defence mechanism- Antioxidants,	<ul style="list-style-type: none"> Define antioxidants. Explain the plant defence mechanisms. 	K2 K5
4.2	Reactive oxygen species	<ul style="list-style-type: none"> Demonstrate Reactive oxygen species 	K5
4.3	Enzymatic and non enzymatic antioxidants, Role of antioxidants	<ul style="list-style-type: none"> Compare and contrast between enzymatic and non enzymatic methods. List out the role of antioxidants. 	K2
4.4	Estimation of antioxidants – Ascorbic acid, Alpha tocopherol.	<ul style="list-style-type: none"> Estimation of antioxidant from crude plant extracts. Define alpha tocopherol. 	K4
4.5	Enzyme – Peroxidase, SOD and Catalase.	<ul style="list-style-type: none"> List out the role do enzymes superoxide dismutase catalase and peroxidase have? 	K5
4.6	Free radical- types of free radicals- production of free radical	<ul style="list-style-type: none"> Explain free radical and its types 	K5
V	Collection, processing of Herbal drugs		
5.1	Medicinal plants - Post harvest technology, scope and importance.	<ul style="list-style-type: none"> What is post harvest technology? Elaborate in detail on the main objectives of applying post harvest technology. 	K1 K6
5.2	Importance of herbal marketing- Future prospects and constraints of the herbal drug industry.	<ul style="list-style-type: none"> Explain the importance of herbal marketing. Discuss herbal drug industry. 	K5 K6

5.3	Regulatory status of herbal medicine in India.	<ul style="list-style-type: none"> List out the regulatory status of herbal medicine in India. 	K3
5.4	Adulteration with reference to plant drug, types of adulterants and methods of adulteration.	<ul style="list-style-type: none"> Define Adulterations. Classify the types of adulterants and adulteration, 	K4
VI	Practical		
6.1	<ul style="list-style-type: none"> Estimation of carbohydrates Estimation of protein Estimation of fatty acids Estimation of phenols Estimation of Flavonoids Preparation of Crude extracts Herbarium Preparation Estimation of Ascorbic acid and α Tocopherol. 	<p>Explain and estimations of primary and secondary metabolites.</p> <p>Estimation of protein methods.</p>	K5

Mapping Scheme for the Course Code: P22BYP3

P22BY P3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	M	-	-	-	-	-	-	L	-	-	-
CO2	M	-	L	M	M	H	M	L	-	M	L	L	M
CO3	L	-	L	M	L	H	M	L	-	-	L	M	-
CO4	H	M	H	-	-	-	L	L	-	M	M	M	-
CO5	M	M	M	-	-	M	-	-	-	-	-	-	-

CO6	M	-	H	-	-	M	M	M	-	M	L	M	M
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COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

Generic Elective Courses for Post Graduate Programmes (2022 - 2024)

Total Hours: 15 Hours

Course Type: Generic Elective 1

Semester – III / IV	Bioethics and Research Publication	Code: P22BY3G1
Credits: 1	Ethics	Hours Per Week: 1

COURSE OUTCOMES

On Completion of the Course, the students will be able to:

Sl. No	Course Outcomes	Level	Unit
CO-1	Understand of ethical issues related to plants, animal and environment	K2	I
CO-2	Elaborate on various kinds of biosafety, safety assessment and recommended biosafety level	K6	II
CO-3	Explain the write research paper, thesis, publish ethically and ways for avoiding plagiarism	K5	III
CO-4	Analyse the open access of publishing, predatory publishing and use of plagiarism software	K4	IV
CO-5	Analyse and interpret quantitative data any statistical methods	K4	V

CO-6	Students will become leaders in the groups and community both in term of scientific expertise and their understanding of bioethical issues	K6	I-V
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Unit I: Bioethics: Introduction - ethical conflicts in biological sciences - interference with nature, bioethics in healthcare - bioethics in research –human and animal experimentation, animal rights and animal welfare - Genetically engineered food-. Protection of environment and biodiversity- Biopiracy.

Unit II: Biosafety- Primary containment for biohazards- biosafety levels of specific microorganisms - recommended biosafety levels for infectious agents and infected animals- principles of safety assessment of transgenic plants - environmental risk assessment and food and feed safety assessment.

Unit III: Publication ethics: Plagiarism – concept and problem that leads to unethical behaviour – violation of publication ethics - predatory publishers and journals - redundant publications – overlapping publications

Unit IV: Open access publishing – initiatives – software tool to identify predatory publications - Journal finder – journal suggestions – journal suggestor- Publication misconduct – specific ethical issues – authorship – conflicts of interest – complaints and appeals - examples of fraud – use of plagiarism software – urkund – Turnitin.

Unit V: Databases and Research Metrics – Indexing databases – Citation databases: Web of Science, Scopus – Impact Factors of journal as per Journal Citation Report, SNIP, SJR, IPP. Cite Score – Metrics: h-index, g index, i10 index, altmetrics

Text Books:

- 1.Kuhse, H. (2010). *Bioethics: An anthology*. Malden, MA: Blackwell.
2. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem formulation in the environmental risk assessment for genetically modified plants. *Transgenic Research*, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
- 3.Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
- 4.Bairagi, Vinayak, and Mousami V. Munot, eds. *Research methodology: A practical and scientific approach*. CRC Press, 2019.
- 5.Kumar, Ranjit. *Research methodology: A step-by-step guide for beginners*. Sage, 2018.

References :

1. Kothari, Chakravanti Rajagopalachari. *Research methodology: Methods and techniques*. New Age International, 2004.
2. Richard, Pring. *Philosophy of Educational Research*. Continuum, 2000.
3. Surbhi Jain, *Research Methodology in Arts, Science and Humanities*. Society Publishing, 2019.

Web links

International Union for the Protection of New Varieties of Plants. <http://www.upov.int>

National Biodiversity Authority. <http://www.nbaindia.org>

Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India.

<http://www.envfor.nic.in/divisions/csuv/geac/annex-5.pdf>

Core X - RESEARCH METHODOLOGY

Semester : IV
Credits : 4

Course Code : P21BY410
Total Hours : 6

Course Outcomes:

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Elaborate on various kinds of research, objectives of doing research, process, research design and sampling	K6	I
CO 2	Identify and discuss the complex issues inherent in selecting a research problem and implementing a research project	K3	I
CO 3	Explain the importance of selecting appropriate sample and experimental design for studies related to various disciplines of biological sciences	K5	II
CO 4	Explain the basic concepts of biostatistics and interpret for their biological problems	K5	III
CO 5	Discuss the thesis writing, tables and figures	K5	IV

CO 6	Design a Research articles based on various format, manuscript and Judge the Indexing and abstracting	K6	V
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SYLLABUS:

Unit 1: Research planning and Literature Collection

(18 Hours)

- 1.1. Research
 - (a) Objectives (b) Types- Basic, Applied, Quantitative and Qualitative and Problem oriented (c) Essential steps in Research (d) Significance
- 1.2. Review of Literature
 - (a) Need for review (b) Objectives (c) Sources - Primary, Secondary and Tertiary sources
- 1.3. Internet basics (a) web browsing (b) web sites (Biological website) (c) web pages-links (d) Bibliometrics databases
- 1.4. Monographs and Reprints

Unit 2: Methodology and data collection

(18 Hours)

- 1.1. Sample – (a) Types (b) Sampling Techniques – Survey and Questionnaires.
- 1.2. Hypothesis – (a) Definition (b) Qualities of a good Hypothesis (c) characteristics,
 - 1.2.1. Types Of Hypothesis- (a) Null (b) Alternative (b) Formulating (c) Simple (d) Complex (e) Statistical.
 - 1.2.2. Level of significance.
- 1.3. Principles of experiments – Definition
 - 1.3.1. Types of field Experiments- (a) Provenance (b) Progeny (c) Clonal (d) fertilizer, (e) Agronomic 1.3.2. Components in Experiments- (a) Randomization(b) Replication (c) Local control (d) Size and shape of the plot (e) experimental Errors
- 1.4. Experimental Design - (a) Completely Randomized Design (CRD) (b) Randomized Complete Block Design(RCB).
- 1.5. Collection of Primary Data
 - (a) Observation Method (b) Interview Method (c) Collection of Data through Questionnaires (d) Collection of Data through Schedules (e) Difference between Questionnaires and Schedules (f) Collection of Secondary Data

Unit 3: Computation and presentation of data

(18 Hours)

- 3.1. Definition, Scope and Importance
 - 3.1.1. Data Presentation: tabulation, graphical presentation
- 3.2. Measure of Central values- Mean, Median and Mode
- 3.3. Measure of Dispersion- Absolute and Relative Dispersion
- 3.4. Skewness and kurtosis
- 3.5. Probability- (a) Binomial (b) Poisson (c) normal distributions.
- 3.6. Correlation and regression- Types, Methods and analysis
- 3.7. Student Test – definition and types
- 3.8. Chi-square Test- (a) Introduction (b) Distribution (c) significance

3.9. ANOVA- (a) definition (b) test of ANOVA - one and two way ANOVA

Unit 4: Structure of thesis and Laboratory safety

(18 Hours)

4.1. Report

4.1.1. Thesis chapterization- (a) Title (b) Abstract (c)Introduction (d) Materials and methods (e) results (f) discussion (g) conclusion (h) Bibliography.

4.2. Tables – (a) Need and use of for table (b) Introduction and Placement of a table (c) Format of a table- Numbering, Title, Units and Footnotes.

4.3 Figures- (a) Need and use of Figures (b) Placement of Figures, (c) Numbering and Caption (d) Preparation of Statistical Diagrams

4.4 Laboratory safety-

4.4.1. Harzards – (a) Biohazardous (b) Chemical (c) Fire (d) Electrical (e) Radiation

4.4.2. Safety Measures- (a) Personal- PPE (b) Laboratory animals and plants Safety (d) Disposal of Biohazardous and Chemical waste

Unit 5 : Manuscript for publication and Presentation

(18 Hours)

5.1. Format of research articles – (a) Writing Reviews (b) Scientific article (c) short communication.

5.2. Manuscripts for presentation – (a) Oral (b) Poster presentation

5.3. Indexing and abstracting- (a) indexes and evaluation tools (h-index, Page Rank, *Impact Factor*) (b) Evaluation of the Impact Factor (c) Collective platforms with Free Access (d) The use of bibliometrics in research - Citation Research, Citation Indexing, Plagiarism, tailored research and retraction.

Topics for Self-Study:

Monography	https://www.biologyonline.com/dictionary/monograph
google scholar citations	https://unimelb.libguides.com/researcher_profiles/googlescholar
Plagiarism tools- urkund, turn-it-in	http://www.publishingindia.com/ijils/52/plagiarism-detection-tools-ithenticate-turnitin-and-urkund/533/3822/
Econometrics	https://www.imf.org/external/pubs/ft/fandd/2011/12/basics.htm
exposition and SEO key words	https://www.semrush.com/blog/keyword-research-guide-for-seo/

TEXT BOOKS:

1. Kothari, C.R. and Gaurav Garg. 2020. *Research Methodology methods and Techniques*, New Age International Publishers, Bangaluru, India.
2. Gurumani, N. 2011. *Research Methodology for Biological sciences*, MJP publishers, Chennai, Tamil Nadu, India.

3. Willard Hobart, H., Merritt Lynne, L. and Dean John A.1965. *Instrumental Methods of Analysis*. Dan Nostrand Co., New York.
4. Daniel, W.W. 1983. *Biostatistics: A Foundation for Analysis in the Health Science*. John Wiley and Sons Inc., New York.
5. Gurumani, N. 2004. *An Introduction to Bio Statistics*. MJP Publishers, Chennai, Tamil Nadu, India.

REFERENCE BOOKS:

1. Misra, R.P. 2000. *Research Methodology - Ahandbook, Concept*. Publg Company, New Delhi, India.
2. Gupta, S.P., 1990. *Statistical Methods*, Sultan Chand & Sons, New Delhi.
3. Pillai and Bagavathi, 2008. *Statistics*, S.Chand & Company Ltd, New Delhi

SPECIFIC LEARNING OUTCOME (SLO):

UNIT	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
I	Research planning and Literature Collection		
1.1	Research (a) Objectives (b) Types- Basic, Applied, Quantitative and Qualitative and Problem oriented (c) Essential steps in Research (d) Significance	<ul style="list-style-type: none"> • Define Research • Illustrates the research objectives • Discuss the various types of research and its significance 	K1 K2 K6
1.2	Review of Literature (a) Need for review (b) Objectives (c) Sources - Primary, Secondary and Tertiary sources	<ul style="list-style-type: none"> • Explain review of literature. • Classify various types research sources for review 	K2 K4
1.3	Internet basics (a) web browsing (b) web sites (Biological website) (c) web pages -links (d) Bibliometrics databases	<ul style="list-style-type: none"> • Importance of web browsing and biological web sites. • Determine the Bibliometric databases • Explain web pages links 	K5 K2

2.4	Data : Collection of Primary Data (a) Observation Method (b) Interview Method (c) Collection of Data through Questionnaires (d) Collection of Data through Schedules (e) Difference between Questionnaires and Schedules (f) Collection of Secondary Data	<ul style="list-style-type: none"> • Explain the necessity of data collection 	K5
III	COMPUTATION AND PRESENTATION OF DATA		
3.1	Biostatistics-Definition, scope and importance	<ul style="list-style-type: none"> • Define the subject by own 	K1
3.1.1	Data presentation - Tabulation and Graphical Representation of Data	<ul style="list-style-type: none"> • Organize statistical tables • Interpret the graphical representation on data • Distinguish among various graphical methods of data presentation 	K2, K3, K4
3.2	Measures of Central Values -Mean - Median - Mode	<ul style="list-style-type: none"> • Explain the use of mean, median and mode value in statistics. 	K5
3.3	Measure of dispersion - Absolute and Relative measure of dispersion	<ul style="list-style-type: none"> • Recall the use of dispersion • Compare the different dispersion methods 	K2 K4
3.4	Skewness and kurtosis	<ul style="list-style-type: none"> • Distinguish between a symmetrical and a skewed distribution 	K4

		<ul style="list-style-type: none"> Interpret the coefficient of kurtosis. 	K5
3.5	Probability Binomial distribution Poisson Distribution Normal distribution	<ul style="list-style-type: none"> Make use of the concept of probability in biological studies Interpret Binomial distribution Utilize Poisson distribution for biological studies 	K1, K2 K3
3.6	Correlation and regression	<ul style="list-style-type: none"> Identify the direction and strength of a linear correlation between two factors. Interpret the Pearson correlation coefficient and the coefficient of determination, and test for significance. 	K3 K5
3.7	Student test Definition and types	<ul style="list-style-type: none"> Define the student test Distinguish among the different types of student test 	K1 K4
3.8	Test of Significance -Introduction, Definition, distribution and significance	<ul style="list-style-type: none"> Make use of the test of significant functions in statistical survey 	K3
3.9	ANOVA – Definition, test of ANOVA, One way ANOVA Two way ANOVA	<ul style="list-style-type: none"> Understand what is between-group and within-group variability consist of and represent. Analyze the degrees of freedom (df), between-group variance (MSBG), within-group variance (MSWG), and the F-ratio (F) for the one-way ANOVA. 	K1 K4
IV	STRUCTURE OF THESIS AND LABORATORY SAFETY		
4.1	Report-Thesis chapterization- (a) Title (b) Abstract (c)Introduction (d) Materials and methods (e)	<ul style="list-style-type: none"> Explain the thesis chapterization- (a) Title (b) Abstract (c) Introduction (d) Materials and methods (e) 	K5

	results (f) discussion (g) conclusion (h) Bibliography.	Results (f) discussion (g) Conclusion (h) Bibliography.	
4.2	Tables – (a) Need and use of for table (b) Introduction and Placement of a table (c) Format of a table- Numbering, Title, Units and Footnotes.	<ul style="list-style-type: none"> Analyse the tables, Interpret the data 	K4
4.3	Figures- (a) Need and use of Figures (b) Placement of Figures, (c) Numbering and Caption (d) Preparation of Statistical Diagrams	<ul style="list-style-type: none"> Evaluate Figures Examine the placing, preparation of statistical diagrams. 	K5
4.4	Laboratory safety- Harzards – (a) Bio-hazardous (b) Chemical (c) Fire (d) Electrical (e) Radiation Safety Measures- (a) Personal- PPE (b) Laboratory animals and plants Safety (d) Disposal of Bio-hazardous and Chemical waste	<ul style="list-style-type: none"> Analyse Laboratory safety- Hazards Disposal of Bio-hazardous and Chemical waste Evaluate the proper usage and disposal of lab things. 	K4
V	MANUSCRIPT FOR PUBLICATION AND PRESENTATION		
5.1	Format of research articles – (a) Writing Reviews (b) Scientific article (c) Short Communication	<ul style="list-style-type: none"> Compile the sources of data Construct and Design a research and review article 	K6
5.2	Manuscripts for presentation (a) Oral (b) Poster Presentation	<ul style="list-style-type: none"> Create a manuscript in oral or poster presentation format 	K6
5.3	Indexing and Abstracting – (a) Indexes and evaluation tools (h-	<ul style="list-style-type: none"> Adapt the Indexing tools, Impact factor and Bibliometrics in Research work. 	K6

	index, Page Rank, Impact Factor) (b) Evaluation of the Impact Factor (c) Collective platforms with free access (d) The use of bibliometrics in research- Citation Research, Citation indexing, Plagiarism, tailored research and retraction.	<ul style="list-style-type: none"> Formulate the research article based on the Research ethics. 	K6
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Mapping Scheme for the Course Code: P21BY410.

P21BY 410	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	-	L	H	M	M	L	-	L	L	H	L	L
CO2	L	L	M	H	L	-	-	-	L	-	M	-	-
CO3	M	-	-	H	L	L	-	M	-	M	-	-	L
CO4	-	M	-	M	-	L	L	-	M	-	L	L	-
CO5	L	L	L	H	M	-	-	-	M	M	-	-	M
CO6	-	L	-	H	-	-	-	M	-	L	L	H	-

L-Low (1) M-Medium (2) H-High (3)

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

Elective IV - FORESTRY AND CONSERVATION BIOLOGY

Semester: IV

Credits: 4

Course Outcomes:

On completion of this course, the students will be able to:

Course Code: P21BY4:A

Hours/Week: 5

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Appraise the knowledge about the various aspects of Forest and its Values	K4	I
CO 2	Describe the various Forest Resources of World and in India	K4	I
CO 3	Apply the methods of afforestation and forest management	K3	II
CO 4	Analyze the usage of resources and its management	K4	III
CO 5	Criticize the available measures for conserving resources	K4	IV
CO 6	Asses Ecotourism within broader cultural, environmental, political and economic dimensions of society. Analyse tourism practices for their implications locally and globally.	K5	V

SYLLABUS:

Unit – 1: Forest and its Values

(18 HOURS)

General introduction to Forest.

1.1. Forest Types

1.1.1. (a.)tropical, (b.)temperate, (c.)evergreen, (d.)semi-evergreen and (e.) deciduous.

1.2. World Forest Cover.

1.3. Forest Resources of World and in India

1.3.1. Major and minor forest products

1.3.2. Wood and Non Wood forest products

Unit – 2: Deforestation and Forest management

(18 HOURS)

Deforestation

2.0.1. Causes and Effect (ecological, environmental, sociological and economical

2.0.2. Forest Degradation in India.

2.1. Sustainable Forest Management

2.2. Afforestation programme

2.2.1. silviculture

2.2.2. Agroforestry,

2.2.3. social forestry

2.2.4. People's movement

2.3. Monitoring the establishment of forest.

2.4. Integrated forest management

2.4.1. Wasteland reclamation using VAM and soil microbes,

2.4.2. Prevention of soil erosion

2.5. Forest trade Management.

Unit – 3: Sustainable Development

(18 HOURS)

Introduction, Parameter and Approaches to the Study of Sustainable Development.

3.2. Issues and Challenges

3.2.1. Developmental Issues

3.2.2. Natural Resource Exploitation

3.2.3. Patterns of Industrialisation.

- 3.3. Initiatives towards Sustainable Development
- 3.3.1. State, Regional, Global, Civil and Community Initiatives.
- 3.4. Resource management:
- 3.4.1. Meaning & concept.
- 3.4.2. Management of Agricultural system.
- 3.4.3. Waste resources.

Unit – 4: Threats in forest management

(18 Hours)

- Forest fragmentation.
- 4.2. Monoculture and its limitations
- 4.3. Alien and invasive species.
- 4.4. Restoration ecology and invasive species management.
- 4.5. Conservation strategies for non-renewable and renewable energy resources- Bioenergy.
- 4.6. Categories of protection types
- 4.6.1. Wildlife Management & conservation efforts for threatened species.
- 4.6.2. IUCN, WWF and CITES.
- 4.6.3. Environmental priorities in India.
- 4.7. Soil conservation.
- 4.7.1. Rural and urban planning.
- 4.7.2. Land use pattern for India.
- 4.8. Indian policies and legislature on conservation of resources.

Unit – 5: Eco-tourism

(18 Hours)

- 5.1. Introduction:
- 5.1.1. Ecotourism- Definition
- 5.1.2. History and principles of tourism,
- 5.1.3. Ecotourism marketing,
- 5.2. Economics and benefits of ecotourism
- 5.3. Cultural issues and negative aspects of ecotourism,
- 5.4. Ecotourism companies
- 5.5. Environmental Impacts of Tourism
- 5.6. Ecotourism in India.

TOPICS FOR SELF-STUDY:

S. no.	Topics for Self-study	References
1	World ecotourism	https://www.unwto.org/sustainable-development/ecotourism-and-protected-areas
2	Vegetation belts	https://www.civildaily.com/the-5-types-of-natural-vegetation-in-india-and-their-characteristics/
3	Environmental studies	https://www.tutorialspoint.com/environmental_studies/environmental_studies_environment.htm
4	Ecotourism resources and Eco Club	https://www.bigvolcano.com.au/ercentre/assoc.htm

TEXT BOOKS:

1. Hunter, Jr. and Malcolm, L.1990. *Wildlife, Forests and Forestry; Principles of Managing Forests for Biological Diversity*. Prentice-Hall Inc. New Jersey.
2. Shukla, P.C. and Chandal.2009. *A Textbook of Plant Ecology*. S. Chand and Company Ltd., New Delhi, India.
3. Honey and Martha.2008. *Ecotourism and Sustainable Development: Who Owns Paradise?* (2nd Edt.) Washington, DC.
4. Weaver, D.2008. *Ecotourism* (2nd edt.). John Wiley & Sons Australia, Ltd., Australia.
5. Peter. P. Rogers , Kazi. F. Jalal, John. A. Boyd. 2008. *An Introduction to Sustainable Development*. Published by Earth scan Ltd.
6. Agarwal, V.G. 1985. *Forests in India*. Oxford and IBH, New Delhi, India.
7. Dutta, A. 2001. *Biodiversity and Ecosystem Conservation*. Kalyani Publisher, Kolkata, India.

Reference Books:

1. Jha, L.K. 1997. *Natural Resource Management*. APH Publishing Corporation, New Delhi, India.
2. Oliver S. Owen. 1980. *Natural Resources conservation - An Ecological approach* (3rd Ed.), Macmillan Publishing Co. Inc. New York.

Web Links:

<https://tourismnotes.com/eco-tourism/>
<https://www.ohio.edu/education/recreation-sport-pedagogy/ecotourism>

SPECIFIC LEARNING OUTCOME (SLO):

UNI T	CONTENT	LEARNING OUTCOME	HIGHEST BLOOM TAXONOMIC LEVEL OF TRANSACTION
1	Forest and its Values		
1.0	General introduction to Forest. Forest Types (a) Tropical, (b) Temperate, (c) Evergreen, (d) Semi-evergreen and (e) Deciduous.	<ul style="list-style-type: none"> • Explain the simple concepts of Forest - types and its values 	K2

1.1	World Forest Cover – Current Global Forest Resources Assessment.	<ul style="list-style-type: none"> Recognize the importance and study of current forest resources in world 	K2
1.2.	Forest Resources of World and in India 1.2.1. Major and minor forest products 1.2.2. Wood and Non Wood forest products	<ul style="list-style-type: none"> Examine about the different forest resources. 	K4
II	Deforestation and Forest management		
2.0	Deforestation	<ul style="list-style-type: none"> Define the deforestation 	K1
2.0.1.	Causes and Effect (ecological, environmental, sociological and economical)	<ul style="list-style-type: none"> List out the causes and effect of deforestation 	K1
2.0.2	Forest Degradation in India.	<ul style="list-style-type: none"> Relate the reason in India 	K1
2.1	Sustainable Forest Management	<ul style="list-style-type: none"> Apply sustainable forest management 	K3
2.2	Afforestation programme	<ul style="list-style-type: none"> Illustrate afforestation programs 	K2
2.2.1	Silviculture	<ul style="list-style-type: none"> Apply the methods 	K3
2.2.2	Agroforestry,		
2.2.3	social forestry		
2.3	People's movement	<ul style="list-style-type: none"> Summarize the peoples movement 	K2
2.4	Monitoring the establishment of forest.	<ul style="list-style-type: none"> Infer the measures for forest establishment 	K2
2.4.1	Integrated forest management	<ul style="list-style-type: none"> Recall the forest management strategies 	K1
2.4.2	Wasteland reclamation using VAM and soil microbes,	<ul style="list-style-type: none"> Select the method of reclamation 	K3
2.5	Prevention of soil erosion	<ul style="list-style-type: none"> Apply the methods for soil erosion 	K3
2.6	Forest trade Management.	<ul style="list-style-type: none"> Interpret forest trade management 	K2
III	Sustainable Development		
3.1.	Introduction, Parameter and Approaches to the Sustainable Development Study	<ul style="list-style-type: none"> Define Sustainable Development 	K1
3.2	Sustainable Development.	<ul style="list-style-type: none"> Recall the concept 	K1
3.2.1	Issues and Challenges	<ul style="list-style-type: none"> Compare the issue and challenges related to it 	K2
3.2.2	Developmental Issues	<ul style="list-style-type: none"> Solve problems related to the development of sustainability 	K3
3.2.3	Natural Resource Exploitation	<ul style="list-style-type: none"> Contrast over the exploitation of natural resources 	K4
3.3	Patterns of Industrialization.	<ul style="list-style-type: none"> Develop the patterns of Industrialization 	K3

3.3.1.	Initiatives towards Sustainable Development	<ul style="list-style-type: none"> Explain the measures for sustainability 	K2
3.4.	State, Regional, Global, Civil and Community Initiatives.	<ul style="list-style-type: none"> Compare the various initiatives. 	K4
3.4.1.	Resource management: Meaning & concept.	<ul style="list-style-type: none"> Define resource management system 	K1
3.4.2	Management of Agricultural system.	<ul style="list-style-type: none"> Recall the agricultural management systems 	K2
3.4.3	Waste resources	<ul style="list-style-type: none"> Make use of waste resources. 	K3
IV	Threats in forest management		
4.1	Forest fragmentation.	<ul style="list-style-type: none"> Relate forest fragmentation 	K1
4.2	Monoculture and its limitations	<ul style="list-style-type: none"> Define monoculture 	K1
4.3	Alien and invasive species	<ul style="list-style-type: none"> Compare alien and invasive species. 	K2
4.4	Restoration ecology and invasive species management.	<ul style="list-style-type: none"> Organize ecological restoration and species management 	K3
4.5	Conservation strategies for non-renewable and renewable energy resources- Bioenergy.	<ul style="list-style-type: none"> Develop conservation strategies 	K3
4.6	Categories of protection types	<ul style="list-style-type: none"> Categorize the forest protection methods 	K4
4.6.1	Wildlife Management & conservation efforts for threatened species.	<ul style="list-style-type: none"> Define wild life management and conservation measures. 	K2
4.6.2	IUCN, WWF and CITES.	<ul style="list-style-type: none"> Define the agencies 	K2
4.6.3	Environmental priorities in India.	<ul style="list-style-type: none"> Explain the forest priority areas in India 	K2
4.7	Soil conservation.	<ul style="list-style-type: none"> Make use of soil conservation strategy 	K3
4.7.1	Rural and urban planning.	<ul style="list-style-type: none"> Identify the eco-friendly models 	K2
4.7.2	Land use pattern for India.	<ul style="list-style-type: none"> Interpret the land use patterns 	K2
4.8	Indian policies and legislature on conservation of resources	<ul style="list-style-type: none"> Make use of the legal measures to protect the resources. 	K3
V	Ecotourism		
5.1	Definition	<ul style="list-style-type: none"> Recall the Ecotourism definition 	K1
5.1.1	History and principles of tourism	<ul style="list-style-type: none"> Outline of history and principles of ecotourism 	K2
5.1.2	Ecotourism marketing	<ul style="list-style-type: none"> Classify the marketing strategies in Ecotourism 	K2
5.2	Economics and benefits of ecotourism	<ul style="list-style-type: none"> Estimate to the income and benefits of ecotourism 	K5

5.3	Cultural issues and negative aspects of ecotourism	<ul style="list-style-type: none"> Analyze Cultural issues and negative aspects of ecotourism 	K4
5.4	Ecotourism companies	<ul style="list-style-type: none"> List out the Ecotourism companies 	K4
5.5	Environmental Impacts of Tourism	<ul style="list-style-type: none"> Analyze Environmental Impacts of Ecotourism 	K4
5.6	Ecotourism in India	<ul style="list-style-type: none"> Evaluate Indian Ecotourism 	K5

Mapping Scheme for the Course Code: P21BY4:A

P21BY 4:A	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	M	-	M	L	-	-	H	M	M	L	H
CO2	H	M	L	-	L	M	L	L	L	M	L	L	M
CO3	M	L	-	M	M	M	H	H	L	H	M	L	L
CO4	M	-	-	M	L	L	-	H	L	H	L	-	-
CO5	L	-	L	H	L	-	-	H	-	M	L	-	L
CO6	L	-	-	M	L	-	-	L	-	-	-	-	-

L-Low M-Medium H-High

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

Elective IV– GREEN AUDIT

Semester: IV

Credits: 4

Course Code: P21BY4:B

Hours/Week:5

Course Outcome

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

No	COURSE OUTCOME (CO)	Level	Unit
CO 1	Tell about the ancient history and establishment of the campus and their immediate beneficiaries.	K1	I

CO 2	Examine the Biodiversity abode in the campus especially the flora and fauna with their seasonal variations and develop the aesthetic sense.	K4	II
CO 3	Evaluate the eco climatic conditions prevailing in the campus	K5	III
CO 4	Analyze the campus Ecology and give significant contribution in the maintenance of Plastic-free campus and Green Campus.	K4	IV
CO 5	Formulate major and minor research regarding any Ecological Survey, Quadrat analysis, Identification of species, Preparation of check lists, etc.,	K6	V
CO 6	Summarize the role of campus ecology as a tool of conservation, tree management	K2	I - V

Syllabus:

Unit I : Understanding the Campus: (15 Hours)

Origin and history – departments – etymology – Building designs – Architecture – various facilities – organizational set up – Green campus – Beneficiaries.

Unit II : Biodiversity: (15 Hours)

Flora and Fauna – seasonal variations – exotic plants and weeds – Horticultural species – Arboretum – species of Birds and animals – Importance of flora and fauna.

Unit III : Ecoclimate: (15 Hours)

Serenity of the Campus – ecological factors – rainfall – temperature – altitude – impact of plants – campus as an ecosystem – litter fall – rain water harvesting – Water crisis and conservation.

Unit IV: Waste regulation: (10 Hours)

waste disposal – litter vs solid waste – basics of solid waste management – pollution (air, water and environment) – ecological ethics – importance of diversity – atmospheric cleanliness – future scope.

Unit V: Eco-watching: (10 Hours)

Tree cover – quadrat analysis (density, abundance and frequency) – basics of Bird watching – tree identification – unique trees and animals – litter drop method – basics of aerobiology.

Unit VI: Practicals (10 Hours)

- Draw a layout of College Campus
- Tree identification in Arboretum
- Calculation of Annual Rainfall and temperature prevailing in College Campus

- Analysis of Litter fall – litter drop method
- Strategies of Solid Waste Management practising in the College Campus
- Calculation of Carbon sequestration
- Quadrat analysis (density, abundance and frequency calculation)
- Field Exposure – Campus Bird watching
- Calculation of Exotic species of Flora and Fauna
- Preparation of check-list of unique trees
- Quality analysis of Campus – Air, Water, Soil

Self-study topic's	Web link
Climate in India	https://www.toppr.com/guides/geography/climate/climate-of-india/ https://www.newworldencyclopedia.org/entry/Climate_of_India
The Environmental Design Research Association (EDRA)	https://www.edra.org/default.aspx
Assessing and Designing Campus Environments	http://campusecologist.com/files/tmem/home.htm

TEXT BOOKS :

1. Anonymous, 2016. *Green Audit Report*. The American College, Madurai.
2. Odum, E. & Barrett G.W. 2005. *Fundamentals of Ecology*. Cenage Learning India Private Limited ISBN 8131500209, 9788131500200
3. Sharma, P. D. 2017. *Ecology and Environment*. Rastogi Publications ISBN: 9789350781227.

REFERENCE BOOKS

1. Anonymous 2005. *The American college*. Commemorative publication SCILET
2. Bor N. L. & Raizada M.B. 2000 *Some Beautiful Indian Climbers and Shrubs*, Bombay Natural History Society. Bombay
3. Mc Cann, C. 1966. *100 Beautiful trees of India – A descriptive and pictorial handbook*. D.B.Taraporevala Sons & Co Private Ltd, Bombay.
4. Sahni K C. 1998. *The Book of Indian Trees*. Bombay Natural History Society. Bombay. ISBN – 13: 978 – 0195645897
5. Santapau, H. 1966. *Common trees, India land and the people*, National book Trust India New Delhi. ISBN: 81 – 237 – 0288 – 4

Web Link:

<https://www.coursera.org/lecture/environmental-safety/environmental-audit-5tVWv>

<https://www.learnirect.com/course/environmental-auditing-and-reporting>

Specific Learning Outcomes (SLO):

Unit	CONTENT	LEARNING OUTCOME	Highest Bloom taxonomic level of transaction
I	Understanding the Study area		
	Origin and history – departments – etymology – Building designs – Architecture – various facilities – organizational set up – Green campus – Beneficiaries.	Outlineout the ancient history and establishment of the campus and their immediate beneficiaries.	K2
II.	Biodiversity		
	Flora and Fauna – seasonal variations – exotic plants and weeds – Horticultural species – Arboretum – species of Birds and animals – Importance of flora and fauna.	Examine the Biodiversity abode in the campus especially the flora and fauna with their seasonal variations and develop the aesthetic sense.	K4
III	Ecoclimate		
	Serenity of the Campus – ecological factors – rainfall – temperature – altitude – impact of plants – campus as an ecosystem – litter fall – rain water harvesting – Water crisis and conservation.	Evaluate the eco climatic conditions prevailing in the campus	K5
IV	Waste regulation		
	Waste disposal – litter vs solid waste – basics of solid waste management – pollution (air, water and environment) – ecological ethics – importance of diversity – atmospheric cleanliness – future scope.	Analyze the campus Ecology and give significant contribution in the maintenance of Plastic-free campus and Green Campus.	K4
V	Eco-watching		
	Tree cover – quadrat analysis (density, abundance and frequency) – basics of Bird watching – tree identification – unique trees and animals – litter drop method – basics of aerobiology.	Formulate major and minor research regarding any Ecological Survey, Quadrat analysis, Identification of species, Preparation of check lists, etc.,	K6

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Mapping Scheme for the Course code: P21BY4:B.

P21BY4:B	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	L	L	-	H	L	L	M	M	M	L	L	L
CO2	M	H	L	-	L	-	L	-	-	M	L	L	M
CO3	M	H	M	-	L	M	M	M	L	L	H	L	L
CO4	M	M	H	M	L	M	H	M	M	H	H	L	M
CO5	M	L	M	-	-	L	L	L	M	L	L	M	M
CO6	H	H	M	M	M	M	M	M	M	H	H	H	M

L-Low (1) M-Medium (2) H-High (3)

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

Elective IV – WOOD SCIENCE TECHNOLOGY

Semester : IV

Course Code : P22BY4:C

Credits : 4

Hours/Week : 5

Course Outcomes:

On completion of the course students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Outline the general features of wood structure	K2	I
CO 2	Understand the physical nature of wood	K2	II
CO 3	Organize chemical nature of wood	K3	II
CO 4	Identify the wood deteriorating agents	K3	III
CO 5	Examine the importance of wood seasoning	K4	IV

CO 6	Discuss the application of wood science technology in the production of various kind of products	K5	V
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Syllabus

Unit I

Wood Structure and Identification

- 1.1 Wood formation – Cambium and its derivatives; secondary growth.
- 1.2 General and Physical features of Wood:
 - 1.2.1 Features visible on the cross surface of log – sapwood and heartwood,
 - 1.2.2 Growth rings & growth marks; rays, pored and non-pored woods,
 - 1.2.3 Features visible on longitudinal surface of wood, color, luster, odor & taste, weight, grain, texture, figure.
- 1.3 Hand lens features of wood-softwood & hardwood.
- 1.4 Microscopic features of softwoods and hardwoods
 - 1.4.1 Diagnostic features useful in identification.

Unit II

Wood Physics and Chemistry

- 2.1 Wood Physics -wood-liquid relations
 - 2.1.1 Moisture content.
 - 2.1.2 Hydrogen bonding - crystalline & amorphous zones.
 - 2.1.3 Theories of water sorption applied to wood
 - heat of wetting, swelling pressure, equilibrium moisture content and fiber saturation point, sorption hysteresis and thermodynamics.
 - 2.1.4 Shrinkage and swelling,
 - 2.1.5 Capillary movement and diffusion of water in wood -Permeability of wood to gases.
- 2.2 Wood Chemistry -Ultra-structure of wood anatomy
 - 2.2.1 Ultra structure of cell walls,
 - 2.2.2 Cell wall components and distribution
- 2.3 Chemical composition and analysis of wood
 - 2.3.1 Chemical components – macromolecular substances and low molecular substances.
- 2.4 Analysis of wood
 - 2.4.1 Sampling and sample preparation
 - 2.4.2 Determination of water content.
 - 2.4.3 Extractives Inorganic substances
 - 2.4.4 Delignification methods

Unit III

Wood Biodegradation

- 3.1 Wood degradation – a natural process of nutrient cycling.
- 3.2 Qualitative and Quantitative aspects of wood degradation.
- 3.3 Degradation due to Insects:
 - 3.3.1 Damage due to wood boring insect species, Injury and control.
 - 3.3.2 Nature of damage – Galls, Cankers etc.,
 - 3.3.3 Termites and their importance in forestry
 - Major and minor wood destroying termites associated with forest and in building

structures.

-Termite control.

3.3.4 Wood Deterioration by Fungi:

-Types of Fungal Deterioration –

- Decay Types- white rot, Brown rot, soft rot, Sap stain, molds, discoloration and blemishes.

-Wood deterioration by other agents- Decay by bacteria, wind, rain temperature (weathering) effects, fire, grazing, logging and other wood working tools Creep (Failure in service life due to aging).

Unit IV

Wood Seasoning

4.1 Objectives and importance of Wood seasoning.

4.2 Protection of logs,

4.2.1 protection of green sawn timber from fungal stains, insect attack and chemical stain.

4.2.2 Prevention of end cracks and surface cracks, stacking stickers.

4.3 Recommended moisture content of seasoned timber for different end uses in different climatic zones and permissible tolerances.

4.4 Factors affecting drying rate of timber

– Thickness, moisture content, temperature, relative humidity and velocity of the drying air, diffusion and permeability

4.5 Seasoning defects

-Surface & Internal cracking,

-end splitting, cupping collapse, bow, spring, crookedness

- Their causes and prevention.

Unit V

Application of Wood Technology

5.1 Harvesting of Wood

5.1.1 Marking, felling and processing

5.2 Utilization of wood – Primary mechanical processing of wood – Roundwood products, sawn wood, veneer, plywood and laminated wood, particleboard, fibreboard and pulp.

5.3 Plywood making – Pressing equipment – Cold & Hot pressing

5.4 Wood Treatment – Drying

Topic for self-study:

Self-study	Link
Anatomical features of timber species,	https://jwoodscience.springeropen.com/articles/10.1186/s10086-020-01905-z
Silviculture	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/silviculture

Manufacture of Plywood	https://www.clp-inc.com/how-is-plywood-made/
Wood based Industries	https://scorebetter.in/forest-based-industries-in-india/
Ecology of microbial invasion of wood	https://www.nature.com/articles/ismej20079
Wood mechanics	https://www.researchgate.net/publication/6919235_Wood_mechanics_allometry_and_life-history_variation_in_a_tropical_rain_forest_tree_community
Timber engineering	https://www.burohappold.com/specialisms/timber-engineering-and-timber-design/

Text Books:

1. Panshim, A.J, Zeeauw, C.D., (1980), *Text Book of Wood Technology*, USA, McGraw Hill Book.
2. Panshin, A.J., (1980), *Text Book of Technology structure, Identification, Properties and Uses of the Commercial Woods*, New York, McGraw-Hill Book Company.
3. Pandey, C.N, Jain, V.K., (1992), *Wood Seasoning technology*, Dehradun: ICFRE

Reference Books:

1. Hon, D.N.S., Shiraishi N., (2001), *Wood and Cellulosic Chemistry*, New York, Marcell, Dekker, Inc.
2. Young, R.A., Giese, R.L., (2003), *Introduction to Forest Ecosystem Science and Management*, United States of America, Willey.
3. Sinha, R.K, (2007), *Sustainable development striking a balance between economy and ecology*, Jaipur: Pointer Publishers.
4. Unger A, Schnienied, Unger W, (2001), *Conservation of Wood Artifacts*, Germany: Springer Verlag Berlin Heidelberg.
5. Goodell, B., Nicholas, D.D., Schultz, T.P., (2003), *Wood Deterioration and Preservation Advances in Our Changing world*, Washington, American Chemical Society.

6. Thompson, R., (1991), *The Chemistry of Wood Preservation*, Cambridge, The Royal Society of Chemistry.

7. Maltcheck, C.K., Kubler, I.L., (1997), *Wood-The Internal Optimization of Trees*, New York, Springer-Verlag Berlin Heidelberg.

SPECIFIC LEARNING OUTCOMES (SLO):

Unit	Content	Learning Outcome	Highest Bloom taxonomic level of transaction
Unit –I Wood Structure and Identification 1.1	Wood formation – Cambium and its derivatives; secondary growth.	Explain the derivatives of Cambium. Discuss the secondary growth pattern in Stem.	K2 K6
1.2 1.2.1 1.2.2 1.2.3	General and Physical features of Wood: Features visible on the cross surface of log – sapwood and heartwood, Growth rings & growth marks; rays, pored and non-pored woods, Features visible on longitudinal surface of wood, color, luster, odor & taste, weight, grain, texture, figure.	List the general features of wood Compare the physical features on the cross surface of log of sapwood and heartwood. Distinguish growth ring from growth marks. Distinguish between pored and non-pored woods Identify the features on longitudinal surface of wood, in the context of	K1 K2 K4 K4

		colour, luster, odor & taste.	K3
1.3	Hand lens features of wood-softwood & heartwood.	Compare the hand lens features of softwood and heartwood.	K2
1.4 1.4.1	Microscopic features of softwoods and hardwoods Diagnostic features useful in identification.	Identify the microscopic features of softwoods and hardwoods.	K3
Unit – II Wood Physics and Chemistry 2.1 2.1.1 2.1.2 2.1.3 2.1.4 2.1.5	Wood Physics -wood-liquid relations Moisture content. Hydrogen bonding - crystalline & amorphous zones. Theories of water sorption applied to wood -heat of wetting, swelling pressure, equilibrium moisture content and fiber saturation point, sorption hysteresis and thermodynamics. Shrinkage and swelling, Capillary movement and diffusion of water in wood - Permeability of wood to gases.	Outline the crystalline and amorphous zones of wood. Elaborate the theories related with water sorption applied to wood. Explain the permeability of wood to gases.	K2 K6 K5

2.2	Wood Chemistry -Ultra-structure of wood anatomy	Summarize the ultra-structure of wood anatomy.	K2
2.2.1	Ultra structure of cell walls, Cell wall components and distribution	Summarize the cell wall components.	K2
2.2.2			
2.3	Chemical composition and analysis of wood	Identify the chemical composition of wood.	K3
2.3.1	Chemical components – macromolecular substances and low molecular substances.	Examine the macromolecular and low molecular substances of wood	K4
2.4	Analysis of wood	How would you prepare a sample for the analysis of wood?	K1
2.4.1	Sampling and sample preparation	Explain the determination of water content & inorganic substances	K5
2.4.2	Determination of water content. Extractives Inorganic substances	Categorize the delignification methods.	
2.4.3	Delignification methods		
2.4.4			K4
Unit – III			
Wood Biodegradation	Wood degradation – a natural process of nutrient cycling.	Recall the nutrient cycling	K1
3.1			

3.2	Qualitative and Quantitative aspects of wood degradation.	Distinguish qualitative and quantitative nature of wood degradation.	K2
3.3 3.3.1 3.3.2 3.3.3 3.3.4	<p>Degradation due to Insects: Damage due to wood boring insect species, Injury and control. Nature of damage – Galls, Cankers etc., Termites and their importance in forestry -Major and minor wood destroying termites associated with forest and in building structures. -Termite control. Wood Deterioration by Fungi: -Types of Fungal Deterioration – - Decay Types- white rot, Brown rot, soft rot, Sap stain, molds, discoloration and blemishes. -Wood deterioration by other agents- Decay by bacteria, wind, rain temperature (weathering) effects, fire, grazing, logging and other wood working tools Creep (Failure in service life due to aging).</p>	<p>Evaluate the damage caused due to wood boring insect species & its control.</p> <p>List out the nature of damage of wood by galls.</p> <p>Explain the major and minor wood destroying termites & its control.</p> <p>Elaborate the various types of fungal deterioration.</p> <p>Categorize the types of wood decay.</p>	<p>K5</p> <p>K5</p> <p>K6</p>

		Identify the various abiotic factors causing wood deterioration.	K4 K3
Unit 4 Wood Seasoning 4.1	Objectives and importance of Wood seasoning.	List the objectives and importance of wood seasoning.	K4
4.2. 4.2.1	Protection of logs Protection of green sawn timber from fungal stains, insect attack and chemical stain.	Summarize the protection measures of green sawn timber from fungal stains, insect attack and chemical stain.	K2
4.2.2	Prevention of end cracks and surface cracks, stacking stickers.	List the ways of prevention of end cracks and stacking stickers.	K1
4.3	Recommended moisture content of seasoned timber for different end uses in different climatic zones and permissible tolerances.	What would be the recommended moisture content of seasoned timber?	K1
4.4	Factors affecting drying rate of timber – Thickness, moisture content, temperature, relative humidity and velocity of the drying air, diffusion and permeability	Explain the factors affecting the drying rate of timber.	K5
4.5	Seasoning defects	Identify the various kind of effects caused due to	K3

	-Surface & Internal cracking, -end splitting, cupping collapse, bow, spring, crookedness -Their causes and prevention.	seasoning defects occur in wood.	
Unit 5 Application of Wood Technology 5.1 5.1.1	Harvesting of Wood Marking, felling and processing	Criticize about wood marking and felling during the harvesting process	K5
5.2	Utilization of wood – Primary mechanical processing of wood – Roundwood products, sawn wood, veneer, plywood and laminated wood, particleboard, fibreboard and pulp.	Elaborate the mechanical processing of plywood.	K6
5.3	Plywood making – Pressing equipment – Cold & Hot pressing	Explain the plywood making by using cold & hot-pressing methods.	K5
5.4	Wood Treatment – Drying	Summarize the drying process of wood treatment.	K2

Mapping Scheme for the Course Code: P22BY4:C

Mapping Scheme for the PO, PSOs and Cos (Course: Wood Science Technology)

PG22BY4	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PSO	PSO	PSO	PSO
:C	1	2	3	4	5	6	7	8	9	1	2	3	4	

CO1	H	H	L	-	M	L	-	-	-	H	-	H	L
CO2	H	M	L	-	L	L	-	-	-	H	-	M	M
CO3	H	M	L	-	L	L	-	-	-	H	-	M	M
CO4	H	H	L	-	H	M	-	-	-	H	-	L	L
CO5	H	M	L	-	L	M	-	-	-	H	-	M	M
CO6	H	H	H	-	-	H	-	-	-	L	-	-	-

L – Low (1) M-Medium (2) H-High (3)

COURSE ASSESSMENT METHODS:

Direct

1. Continuous Assessment by conducting Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
3. End Semester Examination.

Indirect

1. Course-end survey

ELECTIVE V – PROPAGATION TECHNIQUES

Semester : IV
Credits : 4

Course Code : P22BY4:D
Hours/Week : 5

Course Outcomes:

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

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Explain the horticultural techniques	K2	I

CO 2	Apply the nursey techniques and develop a garden scientifically	K3	II
CO 3	Explain the use of organic fertilizers and develop it	K5	III
CO 4	Analyze the propagation techniques	K4	IV
CO 5	Examine the use of propagation techniques in other plants	K5	V
CO 6	Apply the techniques in pruning, budding	K3	VI

Syllabus:

Unit – I : Introduction and Principles of Horticulture (15 Hours)

- 1.1 Definition of Horticulture.
- 1.2 Importance of horticulture in terms of economy, production, employment, generation, environmental protection and human resource development.
- 1.3 Scope for horticulture in India. Nutritive value of horticultural crops.
- 1.4 Divisions of horticulture with suitable examples and their importance.
- 1.5 Classification of horticulture crops based on soil and climatic requirements.

Unit – II Nursery techniques (15 Hours)

- 2.1 Definition of a nursery.
- 2.2 Different types of nursery beds – flat beds, raised beds and sunken beds, their merits and demerits.
- 2.3 Different nursery techniques and their management.
- 2.4 Vegetable gardens, nutrition and kitchen garden, truck garden, Vegetable forcing, market gardens and roof gardens.
- 2.5 Different steps in planning and layout establishment and management of orchards.
- 2.6 Different s systems of planting orchards - square, rectangle, quincunx, hexagonal and contour systems of planting – their merits and demerits.
- 2.7 Calculation of planting densities in different systems of planting.

Unit – III Nursery techniques (15 Hours)

- 3.1 Pruning: Definition, objectives.
- 3.2 Principles and methods of pruning of fruit crops.
- 3.3 Training: Definition, objectives.

- 3.4 Principles and methods of training of fruit crops: Open centre, closed centre and Modified leader systems, their merits and demerits.
- 3.5 Bearing habits in horticultural crops.
- 3.6 Irrigation: definition, different methods of irrigation followed in horticultural crops, their merits and demerits.
- 3.7 Manures and fertilizers: Definition, different methods of application of manures and fertilizers to horticultural crops.

Unit – IV: Pre-harvesting and Propagation of Horticultural Plants (10 Hours)

- 4.1 Cropping systems: Inter cropping and multi – tier cropping, their merits and demerits with suitable examples.
- 4.2 Practical uses of growth regulators in horticulture.
- 4.3 Fruitfulness and unfruitfulness: Definitions, Factors influencing the fruitfulness and unfruitfulness with suitable examples.
- 4.4 Rejuvenation of old orchards, Importance of rejuvenation: Top working and Frame working.
- 4.5 Maturity: Definition, Different methods to judge maturity in horticultural crops.

Unit- V Plant Propagation (10 Hours)

- 5.1 Propagation: Definition, Methods, Sexual and asexual, advantages and disadvantages of each method, Asexual method of propagation, propagation by division and separation.
- 5.2 Propagation by cuttings: Definition of cutting, Different methods of cuttings, semi hard wood, soft wood and herbaceous stem cuttings, examples for each type; Leaf cuttings.
- 5.3 Plant propagation by layering: Definition of layering and layer; Types of layering : Ground layering – Tip layering, Simple layering, Trench layering, Mound or Stool layering and Compound or Serpentine layering, examples for each type; Air layering examples.
- 5.4 Plant propagation by grafting: Definition; methods of grafting: Attached scion methods of grafting, Simple inarching or approach grafting; Detached scion methods of grafting: Pre-curing of scion, Side grafting methods: Veneer grafting, Apical grafting methods, Epicotyle grafting, Soft wood grafting, Double working,

Top working.

- 5.5** Plant propagation by budding: Definition of budding; Methods of budding: T-budding and Inverted T- budding, patch budding and ring budding

Unit – VI

(10 Hours)

1. Study of tools and implements in horticulture.
2. Layout of different planting systems.
3. Layout of nutrition garden.
4. Preparation of nursery beds for sowing of vegetable seeds.
5. Digging of pits for fruit plants.
6. Preparation of fertilizer mixtures and field application.
7. Identification and management of nutritional disorders in vegetables.
8. Study and practicing of different propagation methods by cutting, layering, division.
9. Study and practicing of different propagation methods by grafting and budding.

TOPICS FOR SELF- STUDY:

S.No	Topics for self-study	References
1	Pruning techniques	https://aces.nmsu.edu/pubs/_h/H156/welcome.html
2	Bonsai	https://www.bonsaiempire.com/basics

TEXT BOOKS:

- 1 Edmond, J.B., Sen., T.L., Andrews, F.S, Halfacre R.G, 1963. *Fundamentals of Horticulture*, Tata McGraw Hill Publishing Co., New Delhi.
- 2 Kumar, N.1990. *Introduction to Horticulture*,. Rajyalakshmi Publications, Nagarcovil, Tamilnadu.
- 3 Jitendra Singh, 2002. *Basic Horticulture*. Kalyani Publishers, Hyderabad.
- 4 Sadhu, M.K. 1996. *Plant Propagation*. New Age International Publishers, New Delhi.
- 5 Mukherjee, S.K. and Majumdar, P.K.1973. *Propagation of Fruit Crops*, ICAR, New Delhi.
- 6 Ganner, R.J. and Choudari, S.A. 1972. *Propagation of Tropical Fruit Trees*, Oxford & IBH Publishing Co., New Delhi.

- 7 Sarma, R.R. 2002. *Propagation of Horticultural Crops: Principles and Practices*, Kalyani Publishers, New Delhi.

WEB LINKS:

1. https://www.googleadservices.com/pagead/aclk?sa=L&ai=DChcSEwjB1bHI59ryAhWdk2YC HUTOB20YABAAGgJzbQ&ae=2&ohost=www.google.com&cid=CAESQeD2m6mFj-0zDFma4J5NhbWkkifVtDa6rMUrbFtNQ8HR0a0yPqGA86KzyIvzLX9DihNyRm9yGncxtPAp0nJ_fo4C&sig=AOD64_1TmJKjZn1Pfd7PiLY-pfx0P2Jexw&q&adurl&ved=2ahUKewjt7qn159ryAhVDbn0KHVH7DDsQ0Qx6BAgCEAE
2. <https://www.hortcourses.com/courses/nursery-growers-course-607.aspx>
3. <http://ecoursesonline.iasri.res.in/course/view.php?id=133>

Specific Learning Outcome (SLO):

Unit	CONTENT	LEARNING OUTCOME	Highest Bloom taxonomic level of transaction
I	Introduction and Principles of Horticulture		
1.1	Definition of Horticulture.	<ul style="list-style-type: none"> • Explain the importance of horticulture • Make use of the technique in various fields • Define the quality of horticorps 	K2
1.2	Importance of horticulture in terms of economy, production, employment, generation, environmental protection		K3
1.3	human resource development. Scope for horticulture in India. Nutritive value of horticultural crops.		K1
1.4	Divisions of horticulture with suitable examples and their importance.		
1.5	Classification of horticulture crops based on soil and climatic requirements.		
II	NURSERY TECHNIQUES		
2.1	Definition of a nursery.	<ul style="list-style-type: none"> • Explain the basic nursery techniques 	K2
2.2	Different types of nursery beds –		K4

<p>2.3</p> <p>Vegetable gardens, nutrition and kitchen garden, truck garden, Vegetable forcing, market gardens and roof gardens.</p> <p>2.4</p> <p>Different steps in planning and layout establishment and management of orchards.</p> <p>Different systems of planting orchards - square, rectangle, quincunx, hexagonal and contour systems of planting – their merits and demerits.</p> <p>Calculation of planting densities in different systems of planting.</p>	<p>flat beds, raised beds and sunken beds, their merits and demerits.</p> <p>Different nursery techniques and their management.</p>	<ul style="list-style-type: none"> • Analyse the use of these techniques in preparing new plants • Explain the techniques for various garden methods. • Make use of the planning strategies of garden preparation 	<p>K2</p> <p>K3</p>
<p>III</p>	<p>Nursery Techniques</p>		
<p>3.1</p> <p>3.2</p> <p>3.3</p> <p>3.4</p> <p>3.5</p> <p>3.6</p>	<p>Pruning: Definition, objectives.</p> <p>Principles and methods of pruning of fruit crops.</p> <p>Training: Definition, objectives.</p> <p>Principles and methods of training of fruit crops: Open centre, closed centre and Modified leader systems, their merits and demerits.</p> <p>Bearing habits in horticultural crops.</p> <p>Irrigation: definition, different methods of irrigation followed in</p>	<ul style="list-style-type: none"> • Explain the use of various pruning techniques • Analyse the use of pruning in edible fruit crops • Make use of the training techniques 	<p>K2</p> <p>K4</p> <p>K3</p>

5.2	of cutting, Different methods of cuttings, semi hard wood, soft wood and herbaceous stem cuttings, examples for each type; Leaf cuttings.	<ul style="list-style-type: none"> Define the propagation of vegetative and non-vegetative crops Analyse the use of layering and examine the possibilities in other crops. Experiment the layering technique on the other plants. 	K2
5.3	Plant propagation by layering: Definition of layering and layer; Types of layering : Ground layering – Tip layering, Simple layering, Trench layering, Mound or Stool layering and Compound or Serpentine layering, examples for each type; Air layering examples.		K5
5.4	Plant propagation by grafting: Definition; methods of grafting: Attached scion methods of grafting, Simple inarching or approach grafting; Detached scion methods of grafting: Pre-curing of scion, Side grafting methods: Veneer grafting, Apical grafting methods, Epicotyle grafting, Soft wood grafting, Double working,		K6

Mapping Scheme for the Course Code: P22BY4:D

P22BY4:D	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	L	L	-	H	L	L	M	M	M	L	L	L
CO2	M	H	L	-	L	-	L	-	-	M	L	L	M
CO3	M	H	M	-	L	M	M	M	L	L	H	L	L

CO4	M	M	H	M	L	M	H	M	M	H	H	L	M
CO5	M	L	M	-	-	L	L	L	M	L	L	M	M
CO6	H	H	M	M	M	M	M	M	M	H	H	H	M

ELECTIVE V – SOILLESS AGRICULTURE

Semester : IV

Course Code : P22BY4:E

Credits : 4

Hours/Week : 5

Course Outcomes:

On completion of this course, the students will be able to:

No	COURSE OUTCOMES (CO)	Level	Unit
CO 1	Explains basics of hydroponics including its importance, history and classification	K2	I
CO 2	Compares the different methods of hydroponics and solid media types	K 4	II
CO 3	Analyzes cropping system of hydroponics with suitable plant selection	K4	III
CO 4	Summarizes the guidelines for measures and management of hydroponics	K2	IV
CO 5	Evaluates various entrepreneurial activities in hydroponics	K5	V
CO 6	Elaborates some hands-on experience related to hydroponics	K5	VI

Syllabus:

UNIT I: Introduction to hydroponics (15 Hours)

- 1.1 Introduction: History, Importance and Classification of hydroponics
- 1.2 Government Schemes for hydroponics

UNIT II: Hydroponics techniques (15 Hours)

- 2.1 Basic requirements of hydroponics
- 2.2 Methods of hydroponics: Circulating methods (closed system), Non-circulating method (open systems),
- 2.3 Solid media culture (Aggregate systems), Aeroponics – electrical equipment available in a hydroponic unit

UNIT III: Sowing and crop establishment in hydroponics (15 Hours)

- 3.1 Growing Media - types, properties, uses
- 3.2 Identify the crops and their suitability to hydroponics system; Seeding and establishment

UNIT IV: Hydroponics measurement and management (10 Hours)

- 4.1 Types of crops using in a hydroponics system
- 4.2 Biotic and abiotic factors management
- 4.3 Disease and pest management
- 4.4 Harvest and post-harvesting

UNIT V: Advancement and entrepreneurial activities in hydroponics (10 Hours)

5.1 Recent techniques, Future perspective

5.2 Expose to various small enterprises related to hydroponics through case studies

Unit – VI Practicals (10 Hours)

6.1. Identification of different techniques in hydroponics

6.2. Growing the following in hydroponics solution formulated by students; A leafy vegetable/ a fruit vegetable

6.3. Growing the following in hydroponics solution formulated by students: a medicinal herb / aromatic plant

6.4. Safety measures in a greenhouse

6.5. Comparative analysis of two plant growth

Topics for self-study

S.No	Topic for Self-study	References
1	Hydroponics systems	https://www.freshwatersystems.com/blogs/blog/what-are-hydroponic-systems
2	Nursery techniques	https://agritech.tnau.ac.in/horticulture/horti_nursery%20techniques.html
3	Hydroponic opportunity	https://onlinelibrary.wiley.com/doi/epdf/10.1111/wej.12617
4	Hydroponics business plan	https://onlinelibrary.wiley.com/doi/epdf/10.1111/wej.12617

TEXT BOOK:

1. Benton Jones, Jr. J, 1997. *Hydroponics: A Practical Guide for the Soilless Grower*, CRC Press, United States.
2. John Mason, 1990. *Commercial hydroponics: How to grow 86 different plants in hydroponics*, Kangaroo Press, Kenthurst, NSW, Australia
3. Keith Roberto, 2005. *How-to hydroponics*, Farmingdale: Distributed by Future Garden, New York.
4. Dudley Harris; A M M Berrie; Ian G : Walls, 1974. *Hydroponics, growing without soil easy-to-follow instructions for the flatdweller, modern gardener and commercial grower*, Newton Abbot, David & Charles, United Kingdom.

REFERENCE BOOKS:

1. Andy Jacobson, 2016. *Hydroponics: A Step-By-Step Hydroponic Gardening Guide to Grow Fruit, Vegetables, and Herbs at Home*, Kindle Edition, Washington, USA.
2. Benton Jones, J., 2016. *Hydroponics: A Practical Guide for the Soilless Grower (2nd Edition)*, CRC Press, Kindle Edition, Washington, USA.
3. Howard M. Resh, 2015. *Hydroponics for the Home Growers*, CRC Press, Kindle Edition, Washington, USA

WEBSITES LINK:

<https://www.verticalroots.com/the-what-and-why-of-hydroponic-farming/>

<https://www.nal.usda.gov/afsic/hydroponics>

SPECIFIC LEARNING OUTCOMES (SLO):

Unit/ Section	Content	Learning Outcome	Highest Bloom taxonomic level of transaction
I	Introduction to hydroponics		
1.1	Introduction: History, Importance and Classification of hydroponics	<ul style="list-style-type: none"> • Illustrate basics of hydroponics such as introduction, history and classification 	K2
1.2.	Government Schemes for hydroponics	<ul style="list-style-type: none"> • Recommend some government schemes related to soil less farming 	K5
II	Hydroponics techniques		
2.1	Basic requirements of hydroponics	<ul style="list-style-type: none"> • Demonstrates basics principles of hydroponics 	K2
2.2	Methods of hydroponics: Circulating methods (closed system), Non-circulating method (open systems)	<ul style="list-style-type: none"> • Discovers various techniques in hydroponics 	K4
2.3	Solid media culture (Aggregate systems), Aeroponics – electrical equipment available in a hydroponic unit	<ul style="list-style-type: none"> • Elaborates different solid media cultures related to hydroponics 	K6
III	Sowing and crop establishment in hydroponics		
3.1	Growing Media - types, properties, uses	<ul style="list-style-type: none"> • Compares some growing media used for crop establishment through hydroponics 	K5
3.2	Identify the crops and their suitability to hydroponics system; Seeding and establishment	<ul style="list-style-type: none"> • Categorize suitable methods for crop establishment in hydroponics 	K4
IV	Hydroponics measurement and management		

4.1	Types of crops using in hydroponics system	<ul style="list-style-type: none"> Explains various types of hydroponics system 	K2
4.2	Biotic and abiotic factors management	<ul style="list-style-type: none"> Interpret impacts of biotic and abiotic factors 	K2
4.3	Disease and pest management	<ul style="list-style-type: none"> Finds disease and pest management during farming 	K1
4.4	Harvest and post-harvesting	<ul style="list-style-type: none"> Simplifies harvesting techniques 	K4
V	Advancement and entrepreneurial activities in hydroponics		
5.1	Recent techniques, Future perspective	<ul style="list-style-type: none"> Discuss some advanced techniques in hydroponics 	K6
5.2	Expose to various small enterprises related to hydroponics through case studies	<ul style="list-style-type: none"> Explains various enterprises skills with few case studies 	K2
VI	Practical		
6.1	Identification of different techniques in hydroponics	<ul style="list-style-type: none"> Develop hydroponics farming methods 	K3
6.2	Growing the following in hydroponics solution formulated by students; A leafy vegetable/ a fruit vegetable	<ul style="list-style-type: none"> Build hydroponic growing solution for leafy vegetables and fruits 	K3
6.3	Growing the following in hydroponics solution formulated by students: a medicinal herb / aromatic plant	<ul style="list-style-type: none"> Experiment with medicinal herb and aromatic plant growth using soilless farming 	K3
6.4	Safety measures in a greenhouse	<ul style="list-style-type: none"> Organize few safety measures during farming 	K3

Mapping Scheme for the Course Code: P22BY4:E

P22BY4 :E	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	-	-	M	-	M	-	L	-	L	-	-	L
CO2	L	L	-	H	L	H	-	L	-	M	-	-	M
CO3	L	-	-	H	L	H	-	M	M	M	-	-	M
CO4	-	-	-	H	M	H	-	M	M	M	-	-	M
CO5	-	-	-	M	M	M	-	L	-	M	-	-	L
CO6	L	L	-	H	M	H	M	M	M	M	-	-	M

L-Low (1) M-Medium (2) H-High (3)

Course Assessment Methods:

Direct

- 1. Continuous Assessment in** Class test, Group Discussion and Quiz.
2. Assessment also done through Seminar Presentation, submission of Assignments and Model Making and Model exams.
- 3. End Semester Examination**

Indirect

1. Course-end survey

PG PROGRAMME ARTICULATION MATRIX

COURSE NAME	COURSE CODE	CORRELATION WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
Plant Diversity	P21BY101	H	H	-	L	H	H	L	M	H	H	-	H	H
Plant Anatomy, Embryology and Morphogenesis	P21BY102	H	M	L	L	H	H	M	L	L	M	M	M	H
Ecology and Phytogeography	P21BY103	H	M	L	L	H	H	L	H	M	H	M	M	H
Plant Diversity- Practical	P21BY1P1	H	H	-	L	H	H	L	L	L	H	L	M	H
Plant Anatomy, Embryology and Morphogenesis- Practical	P21BY1P2	H	M	-	M	H	H	L	L	L	L	-	M	H
Trends in Agriculture	P21BY1:A	H	M	-	M	H	H	L	M	L	H	-	-	-

Entrepreneurial Botany	P21BY1:B	H	M	-	H	H	M	L	M	-	L	L	M	-
Plant Taxonomy and Systematics	P21BY204	H	H	-	M	H	H	H	H	H	H	H	H	H
Cell biology, Genetics and Molecular biology	P21BY205	-	L	H	H	L	H	M	L	M	M	-	H	H
Microbiology and Plant pathology	P21BY206	-	M	H	H	M	M	L	-	-	M	-	H	H
Plant Systematics	P21BY2P3	H	H	-	M	H	H	H	H	H	H	H	H	H
Cell biology, Genetics, Microbiology and Plant Pathology	P21BY2P4	-	M	H	H	M	M	M	-	H	-	H	H	H
Tidal Forestry / Microbial food Processing	P21BY2:A/ P21BY2:B	M	M	M	H	H	H	M	H	H	H	H	H	H
Plant Physiology	P21BY307	M	L	L	H	H	H	H	H	H	M	H	H	H
Biochemistry, Biophysics & Pharmacognosy	P21BY308	M	M	L	M	M	H	M	M	M	M	M	H	H
Plant Biotechnology	P21BY309	-	L	M	H	H	H	H	H	H	M	H	H	H
Plant Physiology	P21BY3P5	L	L	L	M	H	H	H	M	H	H	H	H	H

Biochemistry, Pharmacognosy and Plant Biotechnology	P21BY3P6	L	-	L	H	M	H	H	M	H	L	H	H	H
Green Wealth	P21BY3:P1/	-	-	-	H	M	M	H	L	H	-	-	-	M
Naturopathy and Traditional health care	P21BY3:P2	-	-	-	M	L	M	M	M	H	L	H	-	-
Research Methodology	P21BY410	M	M	-	M	H	H	H	H	H	H	H	M	H
Forestry and Conservation Biology	P21BY4:A	H	M	-	L	H	M	L	H	L	M	-	-	M
Green Audit	P21BY4:B	H	H	-	-	H	H	-	H	L	H	L	-	L
Propagation Techniques	P21BY4:C	M	M	-	-	M	H	-	L	M	-	-	L	L
Soilless Agriculture	P21BY4:D	H	M	-	L	L	M	M	M	-	L	M	L	-
Project	P21BY4PJ													