B.Sc.(va)
PLANT BIOLOGY AND PLANT BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM
(CBCS) LOCF SYLLABUS (2023-
2025)

Part III-a. Core papers, b. Special papers, c. Allied papers)
(Part IV A3. N.M. Elective, b. I.D. Elective, c. S.B. Elective)

DEPARTMENT OF BOTANY

Madras Christian College (Autonomous)
B.Sc.(va) Plant Biology and Plant Biotechnology
Curriculum 2021-2022 – CBCS

STRUCTURE OF CBCS FOR UG - 2021 ONWARDS

SEMESTER I

Component		Course	Code	Hours	Credit	Marks ICA+ESE
Part I		Tamil or Other Languages		4	3	50+50
Part II		English		4	3	50+50
PART III						
1a	Major Core	Algology and Mycology – Theory	231BO1M01	6	5	50+50
2a	Major Core	Algology and Mycology – Practical	231BO1M02	4	3	50+50
1c	Allied I	Allied Botany I – Introduction to Plant Diversity - Theory	231BO1A01	4	3	50+50
3c	Allied I	Allied Botany I – Introduction to Plant Diversity – Practical	231BO2A02		-	50+50
Part IV						
[a]	General Course	Plants and People		4	3	50+50
[d]	Value Education			4	2	50+50
Part V						
	Extension Activities	NCC /NSS				
			Core	10	8	
			Elective			
			Sub Total	10	8	

STRUCTURE OF CBCS FOR UG - 2021 ONWARDS

SEMESTER II

Component		Course	Code	Hours	Credit	Marks ICA+ESE
Part I		Tamil or Other Languages		4	3	50+50
Part II		English		4	3	50+50
PART III						
3a	Major Core	Bryology, Pteridology and Gymnospermology - Theory	231BO2M01	4	3	50+50
4a	Major Core	Bryology, Pteridology and Gymnospermology - Practical	231BO2M02	3	2	50+50
1b	Major Elective	Algal Biotechnology or Fungal Biotechnology – Theory	231BO2M03	3	3	50+50
2c	Allied II	Botany II – Plant Anatomy, Physiology, Medicinal Botany and Biotechnology – Theory	231BO2A01	4	3	50+50
3c	Allied II	Bot. I & II Introduction to Plant Diversity & Plant Anatomy, Physiology, Medicinal Botany and Biotechnology. Combined Practical (Sem. I & II)	231BO2A02	4	4	50+50
Part IV						
[a]	General Course	Plants and People		4	3	50+50
[d]	Value Education			4	2	50+50
Part V						

	Extension Activities	NCC / NSS				
			Core	7	5	
			Elective	3	3	
			Sub Total	10	8	

STRUCTURE OF CBCS FOR UG - 2021 ONWARDS

SEMESTER III

Component		Course	Code	Hours	Credit	Marks ICA+ESE
Part I		Tamil or Other Languages		4	3	50+50
Part II		English		4	3	50+50
PART III						
5a	Major Core	Plant Anatomy, Embryology and Pollination Biology – Theory	231BO3M01	6	5	50+50
6a	Major Core	Plant Anatomy, Embryology and Pollination Biology – Practical	231BO3M02	4	3	50+50
4c	Allied II	Basic Biochemistry I – Theory	231BO3A01	4	3	50+50
6c	Allied II	Basic Biochemistry I – Practical	231BO4A02	4	-	50+50
Part IV						
[b]	Inter Disciplinary	Plant-Animal Interaction – Theory	231BO3I01	4	3	50+50
[c]	Environmental Studies					
Part V						
	Extension Activities	NCC /NSS				
			Core	10	8	
			Elective			
			Sub Total	10	8	

STRUCTURE OF CBCS FOR UG - 2021 ONWARDS

SEMESTER IV

Component		Course	Code	Hours	Credit	Marks ICA+ESE
Part I		Tamil or Other Languages		4	3	50+50
Part II		English		4	3	50+50
PART III						
7a	Major Core	Morphology and Taxonomy of Angiosperms - Theory	231BO4M01	4	3	50+50
8a	Major Core	Morphology and Taxonomy of Angiosperms - Practical	231BO4M02	3	2	50+50
2b	Major Elective	Basic and Applied Palynology or Biosocial Genetics – Theory	231BO4M03/ 231BO4M04	3	3	50+50
5c	Allied II	Basic Biochemistry II – Theory	231BO4A01	4	3	50+50
6c	Allied II	Basic Biochemistry II - Combined Practical (Sem. I & II)	231BO4A02	4	4	50+50
Part IV						

[a]	Skill Based	Personality Development		4	2	50+50
[d]	Environmental Studies	Environmental Studies		4	2	50+50
Part V						
	Extension Activities	NCC / NSS				
			Core	7	5	
			Elective	3	3	
			Sub Total	10	8	

STRUCTURE OF CBCS FOR UG – 2021 – 2022 ONWARDS

SEMESTER V

Component		Course	Code	Hours	Credit	Marks ICA+ESE
PART III						
9a	Major Core	Techniques in Biology and Instrumentation - Theory	231BO5M01	5	5	50+50
10a	Major Core	Cell Biology, Genetics and Molecular Biology - Theory	231BO5M02	6	5	50+50
11a	Major Core	Plant Biotechnology and Bioinformatics - Theory	231BO5M03	6	5	50+50
12a	Major Core	Techniques in Biology and Instrumentation; Cell Biology, Genetics & Molecular Biology and Biotechnology and Bioinformatics - Practical	231BO5M04	8	5	50+50
Part IV						
[b]	Skill Based	General Elective - Plantscaping [Refer Page]		4	3	50+50
[b]	Skill Based	Computers for Documentation		4	2	50+50
Part V						
	Extension Activities	NCC / NSS				
			Core	25	20	
			Elective			
			Sub Total	25	20	

STRUCTURE OF CBCS FOR UG - 2021 ONWARDS

SEMESTER VI

Component		Course	Code	Hours	Credit	Marks ICA+ESE
PART III						
13a	Major Core	Horticulture – Theory	211BO6M01	5	5	50+50
14a	Major Core	Plant Ecology and conservation Biology - Theory	211BO6M02	6	5	50+50
15a	Major Core	Plant Physiology and Biochemistry – Theory	211BO6M03	6	5	50+50
16a	Major Core	Combined Practicals: Horticulture, Plant Ecology and conservation Biology & Plant Physiology and Biochemistry - Practical	211BO6M04	2 4 4	5	50+50
3b	Major Elective	Traditional Knowledge and Intellectual Property Rights or Pharmacognosy – Theory	211BO6M05	3	3	50+50
Part V						

	Extension Activities	NCC or NSS				
			Core	27	20	
			Elective	3	3	
			Sub Total	30	23	

B.Sc.va
PLANT BIOLOGY AND PLANT BIOTECHNOLOGY
PART III- a. Core papers (Theory and Practical)
b. Special Papers (Theory)

SEMESTERS	Part – III [a- CORE, b-ELECTIVE]						
	SEMESTERS	I	II	III	IV	Y	VI	TOTAL
	HOURS	10	10	10	10	24	30	94
	CREDITS	8	8	8	8	20	23	75
	CORE CREDITS (10 Theory + 6 Practical = 16 papers) : 8+5+8+5+20+20 = 66 credits							
	ELECTIVE CREDITS (3 Theory) : 0+3+0+3+0+3 = 9 credits							
	Total Number of credits = 75 credits							

Programme Specific Outcomes of B.Sc. (va) - Plant Biology and Plant Biotechnology		
PSO No:	Programme Specific Outcomes Students of B.Sc. Plant Biology and Plant Biotechnology will be able to.	POs Addressed
PSO – 1	Interpret the morphology, anatomy, development, life cycle and classification of selected Algae, Fungi and Non-Vascular and Vascular Plants.	PO2
PSO – 2	Compare the ecological principles with various ecosystems and apply remote sensing in the conservation of natural resources.	PO2
PSO – 3	Assess the physiological responses of plants to environmental factors and evaluate the role of water, nutrients, and plant hormones in Plant Growth and Development.	PO2
PSO – 4	Determine the basic structure, property and functions of hereditary materials and to elucidate their role in molecular biology and biotechnology.	PO2
PSO – 5	Demonstrate mass production of clonal plants through tissue culture, apply biotechnological tools for the production of transgenic plants and use of computers in biology.	PO2,PO5

Syllabus Revision Details

Subject Code	Subject Name	Type of Change	Percentage of change
231BO1M01	Algology and Mycology	Revised	30
231BO1M02	Practicals Algology and Mycology	Revised	20
231BO1A01	Allied Botany – I	Revised	25
231BO2M01	Bryology, Pteridology and Gymnospermology	Revised	70
231BO2M03	Fungal Biotechnology (Optional)	New	100
231BO2A02	Practicals Allied Botany	Revised	45
231BO2M02	Practicals Bryology, Pteridology and Gymnospermology	Revised	75
231BO2A01	Allied Botany – II	Revised	30
231ZO3A01	Allied Biochemistry I	Revised	55
231CH3A02	Allied Chemistry I (For Botany And Zoology)	Revised	40
231BO3A01	Basic Biochemistry – I	Revised	55
231BO3I01	Plant - Animal Interaction	Revised	10
231BO3M01	Plant Anatomy, Embryology And Pollination Biology	Revised	30
231CH3A03	Practicals Allied Chemistry	Revised	70
231BO3M02	Practicals Plant Anatomy, Embryology And Pollination Biology	Revised	45
231BO4A01	Basic Biochemistry - II	Revised	40
231BO4M03	Basic and applied palynology (Optional)	Revised	15
231BO4M04	Biosocial Genetics (Optional)	New	100
231BO4M01	Morphology and Taxonomy of Angiosperms	Revised	30
231BO4A02	Practicals Basic Biochemistry	Revised	70
231BO4M02	Practicals Morphology and Taxonomy of Angiosperms	Revised	45
231BO5M01	Techniques in Biology and Instrumentation	New	100
231BO5M02	Cell Biology, Genetics and Molecular Biology	Revised	10
231BO5M03	Plant Biotechnology and Bioinfomatics	Revised	20
231BO5M04	Practicals Techniques In Biology and Instrumentation, Cell Biology, Genetics & Molecular Biology and Biotechnology and Bioinformatics	Revised	60
231BO5M05	Practicals Computers for Documentation	Revised	40

231BO5L01	Plant Scaping	Revised	15
211BO6M01	Horticulture	New	100
211BO6M06	Pharmacognosy		
211BO6M02	Plant Ecology and Conservation Biology	Revised	35
211BO6M03	Plant Physiology and Biochemistry	Revised	20
211BO6M05	Traditional Knowledge and Intellectual Property Rights	New	100
211BO6M04	Practicals Horticulture, Plant Ecology and Conservation Biology & Plant Physiology and Biochemistry	Revised	50

Paper 1a Core Theory: ALGOLOGY AND MYCOLOGY

Course Code	211BO1M01		
Credits	5		
Hours / Cycle	90		
Category	Part	Core	Theory
Semester	I		
Year of Implementation	2021-2022 onwards		
Course Objectives	To gain knowledge on distinguishing Algae & fungi based on various characters and its inevitable role in mankind.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	list the level of diversity of algae in India	PSO-1	**K1**
CO 2	classify algae based on the morphological structures	PSO-1	**K2**
CO 3	identify various divisions of algae and different types of life cycles in algae.	PSO-1	**K3**
CO 4	distinguish the characteristic features of fungi and classify them, the symbiotic relationships and its benefits.	PSO-1	**K4**
CO 5	evaluate the economic importance of algae and fungi	PSO1	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to Algae: Definition, Distribution ecology of Algae; Classification of Algae (Robert Edward Lee,2008); Major criteria for algal classification and distinguishing features of the classes of Algae: Cyanophyceae, Chlorophyceae, Phaeophyceae, Bacillariophyceae and Rhodophyceae. Thallus organization: Unicellular (*Chlorella*, *Closterium* and *Chlamydomonas*), colonial (*Volvox* and *Pediastrum*), filamentous (*Oedogonium*,*Hincksia*), siphonous (*Caulerpa*) and parenchymatous (*Dictyota*, *Sargassum*, *Gracilaria*)thallus organization.	**18**	**CO1-5**	**K1-K5**
II	Vegetative reproduction (Bulbils, tubers, propagules, hormogone, fragmentation and adventitious branches) and Asexual reproduction (exospores, endospores, zoospores, aplanospores, hypnospores, azygospores) in algae.Sexual reproduction in algae (Isogamous, anisogamous and oogamous); Life cycles in algae: Zygotic (*Oedogonium*, *Chara*), gametic (*Sargassum*), sporic (Biphasic*Dictyota*), (triphasic-*Gracilaria*) and somatic (*Batrachospermum*) life cycles.	**18**	**CO1-5**	**K1-K5**
III	Distribution and position of fungi in Whittaker's classific*ation, characteristic features* of Zygomycotina, Ascomycotina, Basidomycotina a*nd Deuteromycotinaeach with an* example. Bread fungi (Mucor), Peziza, Polyporus and Cercospora	**18**	**CO1-5**	**K1-K5**
IV	Biology of lichen: Structure, function and symbiosis of mycobiont and phycobiont. Local examples and case study in *Parmelia*. Role of Lichens in environment and others. Mycorrhizae: endomycorrhizae and ectomycorrhizae.Use of mycorrhizae in agriculture.	**18**	**CO1-5**	**K1-K5**
V	Economic importance of algae: Algae - source of single cell protein, pigments and biofertilizers; Diatomite; Source of agar-agar, carrageenan and alginic acid; Toxic algae Economic importance of Fungi: nutrient recycling, antibiotic production, fermentation technology (Yeast). Fungi as pathogens of plant plants - brown rust of wheat, red rot of sugarcane, white rust of crucifers.	**18**	**CO1-5**	**K1-K5**

Text Books

1. BARSANTI, LAURA AND PAOLO GUALTIERI. 2005. *Algae-Anatomy, Biochemistry and Biotechnology*. Taylor & Francis, London, New York.
2. DINABANDHUSAHOOANDJOSEPHSECKBACH.2016.*The algae World.* Springer, London.
3. FRITSCH, F.E. 1935 *Structure and Reproduction of Algae,* Vol. I, Cambridge University Press, Cambridge.
4. FRITSCH, F.E. 1945 *Structure and Reproduction of Algae,* Vol. II, Cambridge University Press, Cambridge.
5. SOUTH, G.R. AND A. WHITTICK 1987*Introduction to Phycology*. Blackwell Scientific Publications, Oxford.
6. JOHN WEBESTER and ROLAND W.S. WEBER. 2007. Introduction to Fungi. Cambridge University Press.
7. MEHROTRA, R.S. 1980. Plant Pathology. Tata McGraw Hill Publishing Company Ltd, New Delhi.
8. SHARMA P. D. 2005. Fungi and Allied Organisms. Narosa Publishing House Pvt. Ltd.
9. SHARMA OP. 2006. Text book of fungi. Tata McGraw – Hill publishing company ltd, New Delhi.
10. SINGH, R.S. 2006. Principles of Plant Pathology. Oxford & IBH Publishing co. Pvt. Ltd.

Suggested Reading

1. BELLINGERE.G.ANDD.C.SIGEE. 2010. Freshwater algae : identification and use as bioindicators. John Wiley & Sons, Ltd, Chichester, UK.
2. Gupta, R. K. and D. P. Vidya. 2007. Advances in Applied Phycology. Daya Publishing House, Delhi, India.
3. BURNETT, J.H. 1976. Fundamentals of mycology. Edward Arnold Publishers, London. Commonwealth Mycological Institute, Kew. U.K.
4. MARGULIS, L., AND K.V. SCHWARTZ. 1988. Five Kingdoms. W.H. Freeman and Co. New York.
5. SINGH. R.S. 1980. Introduction to Principles of Plant Pathology. III - Edition. Oxford. IBM. Publishing Co. Pvt. Ltd, New Delhi.

Reference

1. LOBBAN, C.S. AND M.J. WYNNE (Eds.) *The Biology of Seaweeds*. Blackwell Scientific Publications, Oxford.
2. LEE, R. E. 2008.*Phycology*. Cambridge University Press, Cambridge.
3. AINSWORTH, G.C. 1971. Ainsworth and Bibsy's dictionary of fungi. 6th Edition.
4. AINSWORTH, G.C., F.K. SPARROW, AND A.S. SUSSMAN (Eds.). 1965 - 1975. The fungi and advanced treatise. Vol. I - IV. G.L. Academic press, New York and London.
5. ALEXOPOLOUS, C.J and C.W. MISRA. 1972. Introductory mycology. John Wiley and Sons, New York.

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3								3					K1
CO 2		3								3					K2
CO 3		3								3					K3
CO 4		3								3					K4
CO 5		3								3					K5
Wt. Avg.		3								3					
Overall Mapping of the Course														3	

Paper 2a Core Practical: ALGOLOGY AND MYCOLOGY

Course Code	211BO1M02		
Credits	3		
Hours / Cycle	60		
Category	Part	Core	Practical
Semester	I		
Year of Implementation	2021-2022 onwards		
Course Objectives	The students will learn about components and mechanisms of various microscopes. Hands on training to prepare semi permanent slides to observe morphological characters of Algae and Fungi.		

CO No.	Course Outcomes *Upon the completion of this course, students will be able to*	PSO addressed	Bloom's Taxonomy Levels (K1 to K5)

CO-1	choose the algal specimen for microscopic observation and iIllustrate cellular and morphological drawings of algae	PSO-1	K1
CO-2	explain the vegetative and reproductive structures of various groups of algae and their uses	PSO-1	K2
CO-3	identify the vegetative and reproductive structures of various groups of fungi	PSO-1	K3
CO-4	examine different diseases in plants and causes for them	PSO-1	K3
CO-5	explain the techniques in culturing various fungi	PSO-1	K4

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Examination of algae mentioned in the theory to observe different types of thallus organization as given below: *Closterium* – Unicellular thallus; *Volvox*, *Pediastrum* – Colonial thallus; *Spirogyra*, *Hincksia* – Filamentous thalli; *Caulerpa* – Siphonous thallus; *Dictyota*, *Sargassum*, *Gracilaria* - Parenchymatous thallus. Examination of the following algae to observe the structures listed against them: *Oscillatoria* – Hormogones, *Planococcus*; *Sphacelaria*, *Hypnea* - Propagules; *Dictyota*, *Grateloupia* – adventitious branches; *Oedogonium*, *Hincksia* – zoospores; *Chlorella* – autospores; *Dermocarpa* – Endospore; *Chamaesiphon* – Exospore. Examination of different stages of the following algae to study their life cycle: *Caulerpa* – Isogamous, monophasic, diplontic/gametic life cycle *Hincksia* – Anisogamous, biphasic, diplohaplontic/sporic life cycle *Chara* – Oogamous, monophasic, haplontic/zygotic life cycle *Batrachospermum*-Oogamous, triphasic, haplobiontic/somatic life cycle. *Gracilaria* – Oogamous, triphasic, diplobiontic/sporic life cycle	**12**	**CO1-5**	**K1-K5**
II	Observation of spotters prepared with photographs/photomicrographs of algae to show the ultrastructural features, thallus organization, algal habitats, asexual and sexual reproductive structures.	**12**	**CO1-5**	**K1-K5**
III	Observation of agarophytes, carragenophytes and alginophytes, their products and uses	**12**	**CO1 -5**	**K1-K5**
IV	Examination of various thallus and reproductive structures of fungi and lichens. Detailed study of structure of *Mucor*, *Polyporus*, *Peziza*, *Cercospora* and *Parmelia*. Collection and observation of infected sugarcane plant by *Colletotrichum*and wheat plant by *Puccinia*	**12**	**CO1-5**	**K1-K5**
V	Culture and observation fungi: Media Preparation, slants and plating techniques, isolation of fungal culture. Cultivation of Mushrooms using isolated fungal cultures	**12**	**CO1-5**	**K1-K5**

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3								3					
CO 2		3								3					
CO 3		3								3					

CO 4		3								3					
CO 5		3								3					
Wt. Avg.		3								3					
													Overall Mapping of the Course	3	

Paper 1c ALLIED COURSE : ANC. BOT. I – INT. TO PLANT DIVERSITY

Course Code	211BO1A01		
Credits	3		
Hours / Cycle	60		
Category	Part	Allied	Theory
Semester	1		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	The students will develop understanding about the diversity of lower plants to higher plants, identification of organisms, their classification, structure, growth, reproduction and know about the utility of micro to macro organism resources.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	outline the important concepts in 7 kingdom classification, prokaryotes, eukaryotes, virus and their economic importance.	**PSO1**	**K1**
CO 2	explain the general characters and economic importance of fungi and bryophytes.	**PSO1**	**K2**
CO 3	build the importance of morphology, anatomy, reproduction and economic importance of selected representatives from pteridophytes and gymnosperms.	**PSO1**	**K3**
CO 4	compare the general outline of Bentham and Hooker's classification with the morphology, development and reproductive methods of angiosperms and its economic importance	**PSO1**	**K4**
CO 5	appraise the study of range of selected angiosperms families and its economic importance	**PSO1**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Origin of life: Prokaryotes and eukaryotes. Cavalier smith (1981) Seven Kingdom Classification of organisms. General characteristics of virus, bacteria and algae. Structure and life history of *Nostoc* and *Turbinaria*. Economic importance of bacteria and viruses and algae.	**10**	**CO 1-5**	**K1-K5**
II	General characters of fungi. Structure and life history of *Mucor* and *Polyporus.* Economic importance of Fungi. Origin of land plants. General characters of bryophytes. Structure and life history of *Riccia*. Economic importance of bryophytes.	**11**	**CO 1-5**	**K1-K5**
III	General characters of pteridophytes. Structure and life history of *Lycopodium*. Economic importance of pteridophytes. General characters of gymnosperms. Structure and life history of *Cycas*. Economic importance of gymnosperms.	**11**	**CO 1-5**	**K1-K5**
IV	General characters of angiosperms. Morphology and modifications of root (Storage roots, breathing roots, Velamen roots, prop roots), stem (rhizome, tuber, bulb, stolon) & leaves (Sacculent, Spines, Tendril, pitcher). Male and female gametophyte development.General outline of Bentham and Hooker's system of classification.	**14**	**CO 1-5**	**K1-K5**
V	Study of the range of characters and economic importance of Annonaceae, Fabaceae, Asteraceae, Apocynaceae and Poaceae.	**14**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

1. GANGULEE, H.C., K.S. DASS, AND C. DATTA (1988). College Botany. Vol. I & II. New Central Book Agency. Calcutta.
2. KAUFMAN, P.B, (Ed.) (1989). Plants: Their Biology and Importance. Harper and Row. New York.
3. PANDEY, S.N., P.S. TRIVEDI, AND S.P. MISRA (1992). A Text Book of Botany. Vol. I & II. 2nd Edition. Vikas Publishing House. New Delhi.
4. PANDEY B.P. (1st December 2010). College Botany - Volume II: Pteridophyta,Gymnosperms and Palaeobotany. Publisher : Schand, New Delhi, India.
5. MUKHERJI, H. 1982. Plant Groups. 9th Edition. New Central Book Agency. Calcutta.

References

1. DOBSON, A.P. (Ed.). 1996. Conservation and Biodiversity. Scientific American Library, New York.
2. KAUFMAN, P.B, (Ed.). 1989. Plants: Their Biology and Importance. Harper and Row. New York. 3. MARGULIS, L., AND V.S. KARLENE. 1988. Five Kingdoms - An Illustrated Guide to the Phyla of Life on Earth. 2nd Edition. W.H. Freeman and Company. New York.
4. PANDEY, S.N., P.S. TRIVEDI, AND S.P. MISRA. 1992. A Text Book of Botany. Vol. I & II. 2nd Edition. Vikas Publishing House. New Delhi.
5. SALISBURY, F.B., AND C.W. ROSS. 1992. Plant Physiology. 4th Edition. Wadsworth Pub. Co. California.

Suggested Reading

1. RAVEN, H.P (1992). Biology of Plants. 5th Edition. Worth Publisher. New York.
2. DUTTA, A.C (1996). Botany for Degree Students. 6th Edition. Oxford University Press. Calcutta.
3. PANDEY B.P. (20 August 2005). College Botany - Volume I: Algae Fungi and Bryophyta. Publisher : Schand, New Delhi, India. ISBN-13-8121905930.
4. PANDEY B.P. (January 2018). Botany for Degree students, Semester-II – Ecology, origin of angiosperms, their phylogeny and classification using various metheod. Publisher : Schand, New Delhi, India.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1		3							3					K1
CO 2		3							3					K2
CO 3		3							3					K3
CO 4		3							3					K4
CO 5		3							3					K5
Wt. Avg.		3							3					
Overall Mapping of the Course												3		

GENERAL COURSE: PLANTS AND PEOPLE

Course Code	211BO1G01		
Credits	2		
Hours / Cycle	60		
Category	Part IV A3	GC	Theory / Practical
Semester	1&2		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	To teach students the theoretical aspects of evolution and human plant coexistence.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			

CO 1	outline the Geological Time Scale, origin of life, plant groups and its evolution and its relationship with human culture	**PSO1**	**K1**
CO 2	relate the process of domestication of crop plants and introduction of crop plants from different region[s].	**PSO1**	**K2**
CO 3	discover the importance of medicinal plants and their relevance both locally and globally.	**PSO1**	**K3**
CO 4	analyse the myths, taboos and beliefs associated with plants and the development of culture, also with relevance to literature.	**PSO1**	**K4**
CO 5	judge the global outreach of plants that are used in medicines, food, garden and landscaping via political and trade.	**PSO1**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Origin of plants: Geological time scale and origin of plant groups (Supercontinent, Pangea, Laurasia, Gondwana, Continental Drift Theory). Evolution of human beings. Pre-historic plants. Origin of agriculture and civilizations (Oasis theory, Hilly-Flanktheory, Marginal theory and Population theory)	**12**	**CO 1-5**	**K1-K5**
II	Food Plants and People: Domestication of different crops (Rice, Tomato, Potato). Introduction of food plants from different regions [Vavilov].	**12**	**CO 1-5**	**K1-K5**
III	Medicinal Plants: A brief history of medicinal plants and their usage (Siddha or Tamil medicine, and other alternative medicines that use plant). Medicinal plants of global and local importance - (Ginger, Piper, Garlic, Ocimum, Cinchona, Turmeric, Trachyspermum, Piper,)	**12**	**CO 1-5**	**K1-K5**
IV	Plants and Human Cultures: Landscape (Thinai as explained in Sangam Literature), plants and people in Tamil culture . Myths, beliefs and taboos (Turmeric, Kumkumam, Vibuthi/Ash, Thali kaiyru, Thoran, Garland, Cacti, Thrusti Poosani, Thristi kayiru ( ) , associated with plants. Plants and Human Aesthetics: Ornamental plants. Gardening and landscaping for beauty, food, timber,temperature, air and environment.	**12**	**CO 1-5**	**K1-K5**
V	Globalization and Plants: Plants as National/Global resources. Exploitation of plant resources and knowledge linked with them [Commercial Crops:- Sugarcane,Tapioca, Tobacco., Patenting and issues :- Basmati, Turmeric, Neem., GM Crops, pros and cons:- Brinjal, Corn and Cotton]	**12**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

1. HEISER, C.B. 1985. Of Plants and People. University of Oklahoma Press. Oklahoma.
2. JOSHI, S.G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
3. KOCHHAR, S.L. 1981. Economic Botany in Tropics. Published by S.G. Wasani.
4. Macmillan India Ltd. Madras
5. SINGH, U., A.M. WADHWANI, AND B.M. JOSHI. 1965. Dictionary of Economic Plants of India. ICAR. New Delhi.

References

1. THIMANN, K.V., AND J.H. LANGENHEIM. 1982. Botany : Plant Biology and its Relation to Human Affairs. John Wiley & Sons. New York.
2. U.S. DEPARTMENT OF AGRICULTURE. 1992. New Crops, New Uses, New Markets.
3. Industrial and Commercial Products From Agriculture. Year Book of Agriculture, Office of Publishing and Visual Communication.

Suggested Reading

1. GORER, R. 1978. The Growth of Gardens. Faber and Faber Ltd. London.
2. HEISER, C.B. 1981. Seed to Civilization. The story of Food. 2nd Edition. W.H. Freeman. San Francisco.
3. KIRK, D AND E.K.ELIASON.1982. Food and People. Boyd & Fraser. San Francisco.
4. LEWIS, W.H., AND M.P.F. ELVIN LEWIS. 1976. Medical Botany. Plants Affecting Man's Health. A Wiley Interscience Publication. John Wiley and Sons. New York.
5. NAMBEESAN,K.M.P. 1992. Design elements of Landscaping. Oxford &IBH. New Delhi.
6. SIMMONDS, N.W. 1976. Evolution of Crop Plants. Long man Group. London.
7. SIMPSON, B.B., AND M.C. OGORZALY. 1986. Economic Botany. Plants in Our World. McGraw Hill Company. New York.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1		3							3					K1
CO 2		3							3					K2
CO 3		3							3					K3
CO 4		3							3					K4
CO 5		3							3					K5
Wt. Avg.		3							3					
Overall Mapping of th Course												3		

Paper 2a Core Theory: BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMOLOGY

Course Code	211BO2M01		
Credits	3		
Hours / Cycle	60		
Category	Part	Core	Theory
Semester	2		
Year of Implementation	From the academic year 2021-2022 onwards		
Course Objectives	To enable students to develop a deep understanding of the diversity of Bryophytes, Pteridophytes, Gymnosperms and fossils. To facilitate the understanding of the external, internal and reproductive characters of Bryophytes, Pteridophytes and Gymnosperms.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall the fossil types, characteristic features and economic importance of Bryophytes, Pteridophytes and Gymnosperms.	**PSO 1**	**K1**
CO 2	compare the various lifeforms of Bryophytes, Pteridophytes and Gymnosperms.	**PSO 1**	**K2**
CO 3	identify the various classes of Bryophytes, Pteridophytes and Gymnosperms based on the morphological, anatomical and reproductive features of extant and extinct forms.	**PSO 1**	**K3**
CO 4	analyse the distribution and threats to bryophytes, Pteridophytes and Gymnosperms.	**PSO 1**	**K4**

CO 5	assess the ecological significance of Bryophytes, Pteridophytes and Gymnosperms.	**PSO 1**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Origin, Evolution and Characteristics of Land plants; Geological Time scale; Characteristics, Evolutionary significance as seen in Enation theory and Telome theory.	**8**	**CO 1-5**	**K1-K5**
II	Characteristic features and classification of Bryophytes. Vegetative structure, Reproductive structure and Life History of *Riccia, Marchantia, Anthoceros* and *Polytrichum*. Biodiversity, Ecology, Conservation and Economic importance of Bryophytes.	**12**	**CO 1-5**	**K1-K5**
III	General characters of Pteridophytes. Homospory and Heterospory, Apospory and Apogamy. Eusporangium and leptosporangium. Classification of Pteridophytes (Reimer, 1954). Characteristic features of classes. Stelar evolution in Pteridophytes. Life cycle of homosporous and heterosporous Pteridophytes. A detailed study on the morphology, anatomy and reproduction in *Psilotum, Lycopodium, Equisetum* and*Marsilea.* Economic importance of Pteridophytes. Indian contribution to Pteridology.	**15**	**CO 1-5**	**K1-K5**
IV	General characters of Gymnosperms. Distribution of Gymnosperms. Classification of Gymnosperms. (Bierhorst, 1971) Characteristic features of classes. Differences with other major vascular plant groups. A Detailed Study of the Plant Body, Anatomy and Reproduction of the following of *Cycas*, *Pinus* and *Gnetum*. Economic importance of Gymnosperms. Indian contribution to Gymnosperms.	**15**	**CO 1-5**	**K1-K5**
V	Introduction to fossils and fossilization. Theories of fossilization. Types of Fossilization: Altered and unaltered : Compression, Petrifaction, Impression, mould, cast, coal and embedded fossils. Techniques used to study fossilization.	**10**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

1. BHATNAGAR, S.P., AND A. MOITRA. 1996. Gymnosperms. New Age International Publishers. New Delhi.
2. BIERHORST, D.W. 1971. Morphology of Vascular Plants. Macmillan Publishing Company. New York.
3. PANDEY,S.N.,MISRA,S.PANDTRIVEDI,P.S. 1970. A Text book of Botany (Vol II).Vikas Publishing House Pvt. Ltd. Delhi.
4. PARIHAR, N.S. 1967. Introduction Embryophyta: BryophytaVol. Central Book Depot., Allahabad.
5. SMITH, G. M. 1955. Cryptogamic Botany. Vol. III. McGraw Hill.
6. VASHISTA, P.C. 1971. Botany for degree students: Pteridophyta. S. Chand Publications.

References

1. ARNOLD CHESTER A. 1947. An Introduction to Paleobotany. Mc Graw-Hill Book Company. Inc. USA.
2. SPORNE, K. R. 1976. The Morphology of Pteridophytes. B.I. Publications. New Delhi.
3. SPORNE, K.R. 1967. The morphology of gymnosperms.Hutchinson& Co. London.
4. PANDEY, B.P. 1998. College Botany Vol II S. Chand and Company Ltd. New Delhi.
5. VASHISHTA, P.C. 1999. Pteridophytes. S. Chand and Company Ltd.New Delhi.
6. VASHISHTA,P.C. 1999. Gymnosperms. S. Chand and Company Ltd. New Delhi.

Suggested Reading

1. EAMES. J.A. 1964. Morphology of vascular plants (Lower groups). Mc Graw-Hill Book Company, New York.
2. JONES,D.L. 1993. Cycads of the World - Ancient Plants in Today's Landscape. Smithsonian Institution Press. Washington. D.C.
3. KAUFMAN, P.B., T.F. CARLSON, P. DAYANANDAN, M.L. EVANS, J.B. FISHER, C. PARKS, AND J. WELLS. 1989. Plants : Their Biology and Importance. Harper & Row, Publishers. Inc., New York.
4. MANICKAM, V.S. AND V. IRUDAYARAJ. 1992. Pteridophyte Flora of the Western Ghats, South India. B.I. Publications. New Delhi.
5. MEYEN, S.V. 1987. Fundamentals of Palaeobotany. Chapman and Hall. London.
6. MOORE,R., W.D. CLARK, K.R. STERN, AND D. VODOPICH. 1995. Botany : Plant Diversity. Wm.C.Brown Publishers. Dubuque. IA.
7. RAVEN, P.H., R.F. EVERT, AND S.E. EICHHORN. 1992. Biology of Plants. Fifth Edition. Worth Publishers. New York.

Web Resources

https://www.conifers.org/zz/gymnosperms.php https://www.cycadlist.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	

CO 1		3								3					K1
CO 2		3								3					K2
CO 3		3								3					K3
CO 4		3								3					K4
CO 5		3								3					K5
Wt. Avg.		2.8								3					
Overall Mapping of the Course															3

Paper 2a Core Practical: BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMOLOGY

Course Code	211BO2M02		
Credits	2		
Hours / Cycle	45		
Category	Part	Core	Practical
Semester	2		
Year of Implementation	From the academic year 2021-2022 onwards		
Course Objectives	To facilitate the students to observe, analyse and illustrate the morphological, anatomical and reproductive characters of Bryophytes, Pteridophytes and Gymnosperms.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall the morphological and reproductive structures of Bryophytes.	**PSO 1**	**K1**
CO 2	compare and illustrate the morphological and reproductive structures of Pteridophytes.	**PSO 1**	**K2**
CO 3	identify the anatomical features with special reference to variations in the stele.	**PSO 1**	**K3**
CO 4	analyse the morphological and reproductive structures of Gymnosperms.	**PSO 1**	**K4**
CO 5	explain the economic importance and anatomical characters with special emphasis on wood anatomy.	**PSO 1**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Comparative study of morphology and anatomy of *Riccia, Marchantia, Anthoceros* and *Polytrichum.*	**10**	**CO 1-5**	**K1-K5**
II	Comparative study of morphology and anatomy of *Psilotum,Lycopodium,Equisetum* and *Marsilea*.	**10**	**CO 1-5**	**K1-K5**
III	Morphological and anatomical studies of *Cycas, Pinus* and *Gnetum.*	**10**	**CO 1-5**	**K1-K5**
IV	Comparative study of wood anatomy of *Cycas, Pinus* and *Gnetum*.	**10**	**CO 1-5**	**K1-K5**
V	Study of economically important Pteridophytes and Gymnosperms and their products	**5**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

1. BHATNAGAR, S.P., AND A. MOITRA. 1996. Gymnosperms. New Age International Publishers. New Delhi.
2. BIERHORST, D.W. 1971. Morphology of Vascular Plants. Macmillan Publishing Company. New York.
3. PANDEY,S.N.,MISRA,S.PANDTRIVEDI,P.S. 1970. A Text book of Botany (Vol II).Vikas Publishing House Pvt. Ltd. Delhi.
4. PARIHAR, N.S. 1967. Introduction Embryophyta: BryophytaVol. Central Book Depot., Allahabad.
5. SMITH, G. M. 1955. Cryptogamic Botany. Vol. III. McGraw Hill.
6. VASHISTA, P.C. 1971. Botany for degree students: Pteridophyta. S. Chand Publications.

References

1. ARNOLD CHESTER A. 1947. An Introduction to Paleobotany. Mc Graw-Hill Book Company. Inc. USA.
2. SPORNE, K. R. 1976. The Morphology of Pteridophytes. B.I. Publications. New Delhi.
3. SPORNE, K.R. 1967. The morphology of gymnosperms.Hutchinson& Co. London.
4. PANDEY, B.P. 1998. College Botany Vol II S. Chand and Company Ltd. New Delhi.
5. VASHISHTA, P.C. 1999. Pteridophytes. S. Chand and Company Ltd.New Delhi.
6. VASHISHTA,P.C. 1999. Gymnosperms. S. Chand and Company Ltd. New Delhi.

Suggested Reading

1. EAMES. J.A. 1964. Morphology of vascular plants (Lower groups). Mc Graw-Hill Book Company, New York.
2. JONES,D.L. 1993. Cycads of the World - Ancient Plants in Today's Landscape. Smithsonian Institution Press. Washington. D.C.
3. KAUFMAN, P.B., T.F. CARLSON, P. DAYANANDAN, M.L. EVANS, J.B. FISHER, C. PARKS, AND J. WELLS. 1989. Plants : Their Biology and Importance. Harper & Row, Publishers. Inc., New York.
4. MANICKAM, V.S. AND V. IRUDAYARAJ. 1992. Pteridophyte Flora of the Western Ghats, South India. B.I. Publications. New Delhi.
5. MEYEN, S.V. 1987. Fundamentals of Palaeobotany. Chapman and Hall. London.
6. MOORE,R., W.D. CLARK, K.R. STERN, AND D. VODOPICH. 1995. Botany : Plant Diversity. Wm.C.Brown Publishers. Dubuque. IA.
7. RAVEN, P.H., R.F. EVERT, AND S.E. EICHHORN. 1992. Biology of Plants. Fifth Edition. Worth Publishers. New York.

Web Resources

https://www.conifers.org/zz/gymnosperms.php https://www.cycadlist.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3								3					K1
CO 2		3								2					K2
CO 3		3								3					K3
CO 4		3								3					K4
CO 5		3								3					K5
Wt. Avg.		3								3					
Overall Mapping of the Course														3	

Paper 1b CORE ELECTIVE THEORY: ALGAL BIOTECHNOLOGY

Course Code	211BO2M03		
Credits	3		
Hours / Cycle	211BO2M03		
Category	Part	Elective	Theory
Semester	2		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	Know about the Cultivation techniques & Biochemical composition of algae and its significance roles in environment and humans.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	find the overall importance of algae in the field of Biotechnology and algal resources in India	**PSO5**	**K1**
CO 2	summarize on the isolation of algae and various methods involved in indoor and outdoor cultures of Algae.	**PSO3**	**K2**
CO 3	build the importance of biochemical composition of marine and freshwater algae and its application in various industries.	**PSO3**	**K3**
CO 4	categorize the impact of algae in the fields of Agriculture, Green energy, waste water management and Green nanotechnology.	**PSO3**	**K4**
CO 5	develop solution on various toxin producing algae and control measures on the bloom forming algae in the ecosystem.	**PSO5**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Introduction to algal biotechnology: Resource potential of algae; commercial utility of algae. Algae as a source of food and feed; Algae as a source of pigments, fine chemicals, fuel and bio-fertilizers. Distribution of economically important algae in India.	**9**	**CO 1-5**	**K1-K5**
II	Uses of the following algae: S*pirulina, Dunaliella, Haematococcus, Botryococcus, Hypnea. Gracilaria, Kappaphycus, Sargassum.* Algal production systems; Strain selection; Algal growth curve; Culture media; indoor cultivation methods and scaling up. Measurement of algal growth. Large-scale cultivation of algae. Evaporation and uniform dispersal of nutrients; Harvesting and drying of algae.	**9**	**CO 1-5**	**K1-K5**
III	Chemical composition of selected algae: protein, amino acids, lipids, waxes, glycerol, vitamins, pigments, chlorophyll, carotenoids and phycobiliproteins. Algal immobilization technique and its applications; Blue-green algal bio-fertilizer: Method of preparation, application and its advantages over inorganic fertilizers.	**9**	**CO 1-5**	**K1-K5**
IV	Liquid seaweed fertilizer: Method of preparation and application. Biodiesel from algae; Advantages over other sources of biodiesel; Cultivation and extraction methods. Phycoremediation. Role of algae in nanobiotechnology.	**9**	**CO 1-5**	**K1-K5**
V	Algal control: Methods of control of algae; Algicides-preparation and Application; ultrasonic sound producing devices to control algae. Algal culture collection centers in India and abroad and their importance; Centres pursuing algal research in India and their field of interest.	**9**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

1. ANDERSON, R. A. 2005. Algal culturing Techniques. Phycological Society of America, Elsevier's Academic Press.
2. BARSANTI, LAURA AND PAOLO GUALTIERI. 2005. Algae-Anatomy, Biochemistry and Biotechnology. Taylor & Francis, London, New York.
3. BECKER, E.W. 1994. Microalgae-Biotechnology and microbiology. Cambridge University Press.
4. BOROWITZKA, M.A. and L.J. BOROWITZKA (eds.) 1988 Microalgal Biotechnology. Cambridge University Press, Cambridge.
5. RICHMOND, A. AND HU, Q. 2013. Handbook of microalgal culture : applied phycology and biotechnology. Wiley-Blackwell, UK.

References

1. CHANDRAMOHAN, D. 2007. Prospects of Biodiesel from marine microorganisms. Proceedings of the National Workshop on BIODIESEL, Organised by School of Energy, Environment & Natural Resources, Madurai Kamaraj University, Madurai and Ahimsa Agri division, Chennai, 17th and 18th October, 2007.
2. DEMIRBAS, A.·AND M. F. DEMIRBAS. 2010. *Algae Energy: Algae as a New Source of Biodiesel.* Springer-Verlag London.
3. TRIVEDI, P.C. 2001. Algal Biotechnology. Pointer publishers, Jaipur, India.

Suggested Reading

1. GUPTA, R. K. AND D. P. VIDYA. 2007. Advances in Applied Phycology. Daya Publishing House, Delhi, India.
2. KIM, S. 2012.Handbook of Marine Macroalgae: Biotechnology and Applied Phycology. Wiley- Blackwell, UK.
3. VENKATARAMAN, L.V. AND E.W. BECKER 1985. Biotechnology and Utilization of Algae – The Indian Experience. Dept. Science and Technology, New Delhi and Central Food Research Institute, Mysore, India.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1		3		3									3	K1
CO 2		3									3			K2
CO 3		3									3			K3
CO 4		3									3			K4
CO 5		3		3									3	K5
Wt. Avg.		3		3							3		3	
Overall Mapping of the Course												3		

Paper 1b CORE ELECTIVE THEORY: FUNGAL BIOTECHNOLOGY

Course Code	211BO2M04		
Credits	3		
Hours / Cycle	45		
Category	Part	Elective	Theory
Semester	2		

Year of Implementation	From the academic year 2021-22 onwards
Course Objectives	Know about the Cultivation techniques & Biochemical composition of algae and its significance roles in environment and humans.

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	know about the industries working with microbes in India and other parts of the world	PSO-1	**K1**
CO 2	understand the role of fungi in food and its nutritional value and method of cultivation of various mushrooms	PSO-4	**K2**
CO 3	develop an insight to the fermentation using fungi and the products obtained used in wine beer, cheese, yoghurt etc.,	PSO-4	**K3**
CO 4	distinguish the various useful products obtained from fungi such as enzymes, antibiotics, organic acids, drugs, etc.,	PSO-5	**K4**
CO 5	perceive the detailed information about fungi and its role in in environmental issues such as recreation of heavy metal polluted sites, degradation of xenobiotics	PSO-5	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Introduction to fungal biotechnology, Principles and recent developments in industries, medicine and others. Scope of fungal biotechnology in India and job opportunities in biotech and pharmaceutical industries.	**7**	**CO 1-5**	**K1-K5**
II	Fungi in food industry: Mycoproteins in the form of *Candida* spp., and others. Mushroom as food, its cultivation and nutritional importance: special emphasis on the cultivation of oyster and milky mushroom	**10**	**CO 1-5**	**K1-K5**
III	Fungi in fermentation: large scale production of fermented products from fungi such as brewing and baking products; cheese, yeast cake, Tempeh making. Alcoholic fermentation of wine and beer from industrially important fungi.	**10**	**CO 1-5**	**K1-K5**
IV	Industrial enzymes: cellulase, protease, peroxidase, lipase production from fungi. Commercial production of organic acids - lactic acid, citric acid etc. from fungi. Production of antibiotic like penicillin, griseofulvin and metabolite production taxol, ganoderic acid.	**9**	**CO 1-5**	**K1-K5**
V	Fungi and environment: recreation of heavy metal contaminated sites with case studies. Application of fungi in degradation of Xenobiotics PCB's, PAH's, PUFA's. Fungal biofertilizers and biopesticides, myconematicides	**9**	**CO 1-5**	**K1-K5**

Text Books

1. Wainwright M.1993. An Introduction to Fungal Biotechnology. Wiley, John & Sons Inc.
2. Ganguli B. N., Sunil K. Deshmukh. 2007. Fungi: multifaceted microbes. CRC Press.
3. Sharma P.D., 2005. Fungi & allied organisms. Narosa Publishing House, Delhi
4. Patel A. H. 2001. Industrial Microbiology. Macmillan India
5. Jogdand S.D., 2006. Environmental Biotechnology, Himalaya Publishing House
6. Dubey R.C. 2001. A text book of Biotechnology.

References

1. Dilip K. Arora, P. D. Bridge, Deepak Bhatnagar. 2004. Handbook of Fungal Biotechnology. Marcel Dekker Inc.
2. Jan S. Tkacz, Lene Lange. 2004. Advances in Fungal Biotechnology for Industry, Agriculture, and Medicine. Kluwer academic publishers, New York.
3. Richard P. Oliver, Michael Schweizer. 1999. Molecular Fungal Biology. Cambridge University Press. Cambridge.

Suggested Reading

1. PELCZAR Jr. M.J., E.C.S. CHAN AND N.R. KRIEG. 1986. Microbiology. 5th Edition. McGraw Hill Book Company. New York.
2. PRESCOT, L.M., J.P. HARLEY AND B.A. KLEIN. 2005. Microbiology. 6th Edition. Mc Graw Hill Book Company, New York.
3. PUROHIT. 2005. Microbiology Fundamentals and Applications 6th edition. International book distributors, Dehradun.
4. RAJA, K. 2005. Microbial Biotechnology for sustainable development and productivity. IBD Publishers, New Delhi

Web Resources:
https://www.indexfungorum.org/https://eol.org/
https://www.catalogueoflife.org/https://www.gbif.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3								3					
CO 2		3											3		
CO 3		3											3		
CO 4		3			3									3	
CO 5		3			3									3	

Wt. Avg.		3			3					3				3	
													Overall Mapping of the Course	3	

Paper 2c Allied Botany – II PLANT ANATOMY, EMBRYOLOGY, PHYSIOLOGY, MEDICINAL BOTANY AND BIOTECHNOLOGY

Course Code	081BO2A01		
Credits	3		
Hours / Cycle	60		
Category	Part	Allied	Theory
Semester	2		
Year of Implementation	From the academic year 2021-2022 onwards		
Course Objectives	The students will be able to understand the importance of the plant ecology, cell structure, mechanisms, the metabolic changes and physiological activities of plants with design solutions from medicinal plants for human ailments. Understand the scope and importance of plant tissue culture in crop cultivation.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
	On completing the course successfully, the student will be able to		
CO 1	recall the important concepts of Plant Anatomy, Physiology, Biotechnology and Conservation Biology.	PSO-1, PSO3	**K1**
CO 2	understand different physiological processes in plants	PSO-3	**K5**
CO 3	identify the role of plant growth regulators on the growth and development of plants	PSO-3	**K3**
CO 4	organize the concepts of plant biotechnology with its significance in human welfare	PSO-3	**K4**
CO 5	evaluate the forest types of South India and the conservation methods adopted to protect biodiversity	PSO1 & PSO-2	**K2**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Plant Anatomy: Simple Tissues - Parenchyma, Collenchyma, Sclerenchyma, Chlorenchyma, Aerenchyma. Complex tissues - Phloem	12	**CO 1-5**	**K1-K5**
	and Xylem. Primary structure of root and stem of dicots and monocots. Leaf anatomy: monocot and dicot. Types of stomata. Ultrastructure of plant cell wall and chloroplast.			
II	Embryology: Structure and function of flower, Structure and development of microsporangium: Tapetum female gametophyte: megasporangium development. Double fertilization, Seed – structure and function.	14	**CO 1-5**	**K1-K5**
III	Physiology: Transpiration and factors affecting it. Photosynthesis - light and dark reactions. Respiration – Glycolysis, Kreb's cycle and electron transport chain. Physiological effects of Auxins, cytokinins, gibberellins, ethylene and ABA.	12	**CO 1-5**	**K1-K5**
IV	Medicinal Botany: Phytochemicals – types and their medicinal properties. Plants in health care: Common medicinal plants - *Ocimum sanctum, Piper longum, Terminalia chebula, Aloe vera* and *Curcuma longa*. Traditional medicine vs Modern medicine. Study of selected plant examples used in traditional medicine as resource (active principles, structure, usage and pharmacological action) of modern medicine: Ashwagandha (*Withania somnifera*), Sarpagandha (*Rauvolfia serpentina*), Amla (*Phyllanthus emblica*) and Brahmi (*Bacopa monnieri*). Role of AYUSH, NMPB, CIMAP and CDRI.	12	**CO 1-5**	**K1-K5**

V	Biotechnology: Plant tissue culture - Sterilization procedure and in vitro culture methods. Callus regeneration, direct and indirect morphogenesis. Application of DNA technology in plant crop improvements.	10	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

1. BHATTACHARYA SUKANYA (2006). Anticancer Botanicals. Daya Publishing House, New Delhi. ISBN-9788170353836.
2. PANDEY B.P. (December 2010). College Botany - Volume III: Plant Anatomy, Reproduction in Flowering Plants, BioChemistry, Plant Physiology, Biotechnology, Ecology, Economic Botany, Cell Biology, and Genetics. Publisher: Schand, New Delhi, India.
3. GUPTA, V K et al., (2012). Bioactive Phytochemicals: Perspectives for Modern Medicine Vol. 1. Publisher: Daya Publishing House, New Delhi. ISBN-10: 9788170357797.
4. PANDEY B.P. (January 2018). Botany for Degree students, Semester-II – Ecology, origin of angiosperms, their phylogeny and classification using various method. Publisher: Schand, New Delhi, India.
5. ANIL KUMAR DHIMAN (2021). Ayurvedic Drug Plants. Daya Publishing House, New Delhi. ISBN-9788170358879.

References

1. DOBSON, A.P. (Ed.). 1996. Conservation and Biodiversity. Scientific American Library, New York.
2. JOSHI, S. G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
3. KAUFMAN, P.B, (Ed.). 1989. Plants: Their Biology and Importance. Harper and Row. New York.
4. NARAYANASWAMY, S. 1994. Plant Cell and Tissue Culture. Tata Mc Graw – Hill Publishing Company Limited. New Delhi.
5. MUKHERJI, H. 1982. Plant Groups. 9th Edition. New Central Book Agency. Calcutta.
6. SALISBURY, F.B., AND C.W. ROSS. 1992. Plant Physiology. 4th Edition. Wadsworth Pub. Co. California.

Suggested Reading

1. GANGULEE, H.C., K.S. DASS, AND C. DATTA (1988). College Botany. Vol. I & II. New Central Book Agency. Calcutta.
2. RAVEN, H.P (1992). Biology of Plants. 5th Edition. Worth Publisher. New York.
3. DUTTA, A.C (1996). Botany for Degree Students. 6th Edition. Oxford University Press. Calcutta.
4. JOSHI, S. G (2000). Medicinal Plants. Oxford and IBH, New Delhi.
5. PANDEY B.P. (January 2018). Botany for Degree students, Semester-II – Ecology, origin of angiosperms, their phylogeny and classification using various methods. Publisher : Schand, New Delhi, India.

Web Resources

1. https://Powo.science.kew.org
2. https://wfoplantlist.org/plant-list
3. https://pharmacognosy.pharmacy.uic.edu/napralert/

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3								3		3			**K1**
CO 2		3										3			**K5**
CO 3		3										3			**K3**
CO 4		3										3			**K4**
CO 5		3								3	3				**K2**
Wt. Avg.		3								**3**	**3**	**3**			-
												Overall Mapping of the Course		**3**	

Paper 3C COMBINED PRACTICAL (SEM I & II) - INTRODUCTION TO PLANT DIVERSITY & PLANT ANATOMY, PHYSIOLOGY, MEDICINAL BOTANY AND BIOTECHNOLOGY

Course Code	211BO2A02		
Credits	2		
Hours / Cycle	30		
Category	Part	Allied	Practical

Semester	II
Year of Implementation	From the academic year 2021-2022 onwards
Course Objectives	To provide the students with hands-on experience in studying the basic morphological,anatomical details of lower organisms as well as the flowering plants, and to develop a betterunderstanding on various techniques used in molecular biology and plant tissue culture.

SYLLABUS

SEM	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Parts mentioned in theory Study and identification of plants belonging to the families mentioned in theory and construction of floral diagrams. Microslide preparation and observation of forms studied in Unit I, II and III (Turbineria, Polyporus and Riccia). Study of morphology of plant.	30	**CO 1-5**	**K1-K5**
II	Anatomical structure of root and stem of dicots and monocots. Leaf anatomy. Types of stomata. Photographs of Structure of anther, pollen, ovule. Dissection of Embryo from Tridax flower. Demonstration of physiological experiments included in theory and spotters relating to physiological effects of hormones. Identification of medicinal plants and their uses mentioned in theory. Demonstration of plant tissue culture methods and spotters relating to plant biotechnology.	30	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- BHATTACHARYA SUKANYA (2006). Anticancer Botanicals. Daya Publishing House, New Delhi. ISBN- 9788170353836.
- PANDEY B.P. (December 2010). College Botany - Volume III: Plant Anatomy, Reproduction in Flowering Plants, BioChemistry, Plant Physiology, Biotechnology, Ecology, Economic Botany, Cell Biology, and Genetics. Publisher: Schand, New Delhi, India.
- GUPTA, V K et al., (2012). Bioactive Phytochemicals: Perspectives for Modern Medicine Vol. 1. Publisher: Daya Publishing House, New Delhi. ISBN-10: 9788170357797.
- PANDEY B.P. (January 2018). Botany for Degree students, Semester-II – Ecology, origin of angiosperms, their phylogeny and classification using various method. Publisher: Schand, New Delhi, India.
- ANIL KUMAR DHIMAN (2021). Ayurvedic Drug Plants. Daya Publishing House, New Delhi. ISBN-9788170358879.

References (3 – 5)

- DOBSON, A.P. (Ed.). 1996. Conservation and Biodiversity. Scientific American Library, New York.
- JOSHI, S. G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
- KAUFMAN, P.B, (Ed.). 1989. Plants: Their Biology and Importance. Harper and Row. New York.
- NARAYANASWAMY, S. 1994. Plant Cell and Tissue Culture. Tata Mc Graw – Hill Publishing Company Limited. New Delhi.
- MUKHERJI, H. 1982. Plant Groups. 9th Edition. New Central Book Agency. Calcutta.
- SALISBURY, F.B., AND C.W. ROSS. 1992. Plant Physiology. 4th Edition. Wadsworth Pub. Co. California.

Suggested Reading (2 -5)

- GANGULEE, H.C., K.S. DASS, AND C. DATTA (1988). College Botany. Vol. I & II. New Central Book Agency. Calcutta.
- RAVEN, H.P (1992). Biology of Plants. 5th Edition. Worth Publisher. New York.
- DUTTA, A.C (1996). Botany for Degree Students. 6th Edition. Oxford University Press. Calcutta.
- JOSHI, S. G (2000). Medicinal Plants. Oxford and IBH, New Delhi.
- PANDEY B.P. (January 2018). Botany for Degree students, Semester-II – Ecology, origin of angiosperms, their phylogeny and classification using various methods. Publisher : Schand, New Delhi, India.

Web Resources (3-5)

- https://Powo.science.kew.org
- https://wfoplantlist.org/plant-list
- https://pharmacognosy.pharmacy.uic.edu/napralert/

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
	On completing the course successfully, the student will be able to		
CO 1	understand the morphological and anatomical details of selected forms of algae, fungi, bryophytes, Pteridophytes and gymnosperms.	PSO-1	**K1**
CO 2	demonstrate importance of the morphology of flowering plants.	PSO-1	**K2**

CO 3	evaluate the morphological characters on angiosperm families and its world wide importance.	PSO-1	**K3**
CO 4	identify the anatomical features of stems, roots and leaves of Angiosperms concepts of plant physiology.	PSO-1, PSO-3	**K4**
CO 5	understand the concepts of plant tissue culture.	PSO-5	**K5**

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	-	3	-	-	-	-	-	-	-	3	-	-	-	-	**K1**
CO 2	-	3	-	-	-	-	-	-	-	3	-	-	-	-	**K2**
CO 3	-	3	-	-	-	-	-	-	-	3	-	-	-	-	**K3**
CO 4	-	3	-	-	-	-	-	-	-	3	-	3	-	-	**K4**
CO 5	-	3		3	-	-	-	-	-	-	-	-	-	3	**K5**
Wt. Avg.	-	3		-3	-	-	-	-	-	**3**	-	**3**	-	3	-
Overall Mapping of the Course													**3**		

Paper 5a PLANT ANATOMY, EMBRYOLOGY AND POLLINATION BIOLOGY

Course Code	**211BO3M01**		
Credits	**5**		
Hours / Cycle	**90**		
Category	**Part**	**Core**	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2021 onwards**		
Course Objectives	**This will enable the students to understand the basic cell types, internal plant cellular organisation, reproductive structures and various pollination mechanisms.**		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	understand the plant growth mechanism of with respect to cellular structures and types.	**PSO1**	**K1**
CO 2	explain the internal structure of plant and various plant tissues and study the primary secondary structure of plant.	**PSO1**	**K2**
CO 3	identify the abnormal anatomical characters in the plants; study the ontogeny and structures of various types of leaf.	**PSO1**	**K3**
CO 4	analyze the developmental aspects of different tissues, reproductive organs and its significance in the plant Reproduction.	**PSO1**	**K4**
CO 5	interpret various theories in meristems, plant reproductive structures and its pollinators for the process of pollination.	**PSO1**	**K5**
SYLLABUS			

UNIT	CONTENT	HOURS	Cos	BLOOM'S TAXONOMY LEVEL
I	Cell Wall: Structure and function of Primary, Secondary wall and Plasmodesmata; Meristems: Apical, Lateral, Intercalary, Axillary and Basal; Organization and theories of shoot and root apex. Simple Tissues -Structure, ontogeny and functions of Parenchyma, Collenchyma and Sclerenchyma.	**16**	**CO 1-5**	**K1-K5**
II	Complex tissues: Xylem and Phloem structure, ontogeny and functions; Vascular cambium: Origin, cell types, seasonal activity and function. Primary and Secondary structure in Dicot stem and root; Primary structure in Monocot stem and root.	**19**	**CO 1-5**	**K1-K5**
III	Anomalous secondary structure in the stem of *Pseudocalyma*, *Dracaena* and the root of *Achyranthes*. Leaf: Structure and Development; variation based on symmetryDorsiventral, Isobilateral and Centric; environment and photosynthetic process; Stomata: structure and types; Secretary Structures; Leaf abscission.	**19**	**CO 1-5**	**K1-K5**
IV	Microsporangium: Structure and development of Microsporangium; Tapetum: Structure and function; Male gametophyte: Structure and development; Megasporangium: Structure and Types; Female gametophyte: structure and development; Types of female gametophyte (Monosporic and Bisporic only).	**18**	**CO 1-5**	**K1-K5**
V	Pollination: Self-pollination, Cross-pollination; contrivances for cross Pollination; Primary and secondary attractants. Nectaries: Floral and extrafloral. Co-evolution; Pollination mechanism in *Ficus*, *Yucca*, *Ophrys* and *Dendrophylaxlindenii*. Fertilization; Endosperm- Types; Embryo structure and development.	**18**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- BHOJWANI, S.S. AND BHATNAGAR, S.P. 1974. The Embryology of Angiosperms. Vikas Publishing House (P) Ltd, New Delhi.
- ESAU, K. 1977 Anatomy of Seed plants. John Wiley & Sons. U.S.A.
- FAHN, A 1982. Plant Anatomy. Pergamon Press U.K.
- JOHRI, B.M. 1984. Embryology of angiosperm. Springler-Verleg, Berlin.

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3								3					K5
CO 2		3								3					K4
CO 3		3								3					K4
CO 4		3								3					K5
CO 5		3								3					K5
Wt. Avg.		3								3					
													Overall Mapping of the Course		3

- PANDEY, B.P. 2001. Plant Anatomy: For Degree, Honours and Post Graduates, S.Chand& Company Ltd, India.

References (3 – 5)

- BATYGINA T. B. 2009. Embryology of Flowering Plants Terminology and Concepts.Vol. 3. Reproductive System. Science Publishers, USA, 526pp.
- BECK, C. B. 2010. An Introduction to Plant Structure and Development Plant Anatomy for the Twenty-First Century. Cambridge University Press, UK, 465pp.
- MAUSETH, J.D. 1988. Plant Anatomy. Benjamin/Cumming Pub. U.S.A.
- RUDALL, P. J. 2007. Anatomy of Flowering Plants - An Introduction to Structure and Development. Cambridge University Press, UK, 159pp.

Suggested Reading (2 -5)

- SHIVANNA, K. R. 2003. Pollen Biology-Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

Web Resources (3-5)

Paper 6a - PLANT ANATOMY, EMBRYOLOGY AND POLLINATION BIOLOGY

Course Code	**211BO3M02**		
Credits	3		
Hours / Cycle	60		
Category	Part	Core	Practical
Semester			
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	To teach the students to improve their technical skills in free hand sectioning, staining and observing various plant anatomical structures.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall the basic cellular structures and their types.	PSO-1	K1
CO 2	explain the various plant tissues, their organisation and the primary secondary structure of plants.	PSO-1	K2
CO 3	identify the abnormal anatomical characters in plants; study the structures of various types of leaf.	PSO-1	K3
CO 4	compare the various developmental stages of male and female reproductive organs in plants.	PSO-1	K4
CO 5	evaluate the various pollinator-attracting mechanisms and pollination syndromes.	PSO-1	K5

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	**PLANT ANATOMY**	**30**	**CO 1-5**	**K1-K5**
	Simple and complex tissues from Cucurbita stem. Shoot and root apical organization. Dicot Stem - Primary structure (Cucurbita and Tridax); Secondary structure (Moringa); Anomalous secondary structure (Pseudocalyma). Dicot Root - Primary structure; Anomalous secondary structure (Achyranthes).Monocot Stem - Grass (Stenotaphrum); Anomalous secondary structure -Dracaena. photographs). Monocot Root – Dieffenbachia. Vascular cambium- Stratified (Dalbergia); Non-stratified (Lannea). Leaf nodal anatomy and symmetry- Dorsiventral (Polyalthia, Nerium); Isobilateral (Callistemon); C4 (Chloris); Isolateral and CAM (Kalanchoe). Stomata- Anomocytic (Bougainvillea); Anisocytic (Aralia); Paracytic (Pentas); Diacytic (Asystasia) and Grass type (Stenotaphrum).			
II	**PLANT EMBRYOLOGY** Cross section of Anther (free hand section) - Datura and Ipomea. Permanent slides and photomicrographs of pollen types. Permanent slides and photomicrographs of young ovule, embryo development and embryo sac. Dissection of embryo from Tridax flowers**.**	**15**	**CO 1-5**	**K1-K5**
III	**POLLINATION BIOLOGY** Photographs depicting various Pollination syndromes and coevolution. Nectaries – Floral (Atalantia monophylla, Catharanthus roseus), Extra-floral (Cassia occidentalis, Ricinus communis).	**15**	**CO 1-5**	**K1-K5**

Course Articulation Matrix

Course Outcomes	**Programme Outcomes**									**Programme Specific Outcomes**					**Cognitive Level**
	PO 1	**PO 2**	**PO 3**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	
CO 1		3								3					K1
CO 2		3								3					K2
CO 3		3								3					K3

CO 4		3								3					K4
CO 5		3								3					K5
Wt. Avg.		3								3					
Overall Mapping of the Course													3		

Allied Paper BASIC BIOCHEMISTRY - I

Course Code	**211BO3A01**		
Credits	**3**		
Hours / Cycle	**4**		
Category	**Part**	**Allied**	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2021-2022 onwards**		
Course Objectives	To impart knowledge on the classification, properties and significance of biomolecules. To enable students to get a deep understanding of the biochemical processes.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall the structure and characteristics of carbohydrates.	**PSO 3**	**K1**
CO 2	summarise the classification and properties of amino acids and proteins.	**PSO 3**	**K2**
CO 3	interpret the factors affecting the activity of Enzymes.	**PSO 3**	**K3**
CO 4	analyze the biological functions of lipids & vitamins.	**PSO 3**	**K4**
CO 5	assess the biological roles of secondary metabolites.	**PSO 3**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Carbohydrates - Structure, properties, classification and biological functions of Monosaccharides, Disaccharides, Oligosaccharides and Polysaccharides.	**12**	**CO 1-5**	**K1-K5**
II	Amino acids - Structure, properties, classification, and biological functions. Proteins - General Characteristics, Classification, Synthesis and Structural levels of organization**.**	**14**	**CO 1-5**	**K1-K5**
III	Enzymes - Classification and biological functions. Michaelis-Menten equation. Enzyme inhibition. Coenzymes. Factors affecting enzyme activity.	**12**	**CO 1-5**	**K1-K5**
IV	Lipids - Classification and Biological functions. Saturated and unsaturated fatty acids. β-oxidation. Vitamins - Occurrence, classification, biological functions and deficiency symptoms.	**12**	**CO 1-5**	**K1-K5**
V	Secondary Metabolites - Biochemistry, classification and biological roles of Alkaloids, Terpenoids and Phenolics. Shikimic acid Pathway and Mevalonic acid Pathway.	**12**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

- DAVID HAMES AND NIGEL HOOPER.2005. Instant Notes Biochemistry. 3rd Edition. Taylor and Francis group.
- JAIN, J.L., S. JAIN AND N. JAIN. 2005. Fundamentals of Biochemistry. S. Chand & Company Ltd., New Delhi.
- RASTOGI. S.C. 2010. Biochemistry. Tata McGraw-Hill Education Pvt. Ltd., New Delhi.
- SADASIVAM, S. AND A. MANICKAM. 2008. Biochemical Methods. Third Edition. New Age International Publishers, New Delhi.
- SATYANARAYANA, U.2006. Essentials of Biochemistry. Books and Allied Private Limited, Kolkata.
- SAWHNEY, S.K. AND RANDHIR SINGH. 2009. Introductory Practical Biochemistry. Second Edition. Narosa Publishing House, New Delhi

References

- CONN, E.E., P.K. STUMPF, G. BRUENING AND R.H.DOI. 1987. Outlines of Biochemistry. John Wiley and Sons, New York.
- KEITH WILSON AND JOHN M. WALKER. 2000. Principles and Techniques of Practical Biochemistry. Cambridge University Press.
- NELSON, D.L. AND M. M. COX. 2005. Lehninger Principles of Biochemistry, Fourth Edition, W.H. Freeman and Company, New York.

Suggested Reading

- HANS-WALTER HELDT AND BIRGIT PIECHULLA. 2010. Plant Biochemistry. 4th edition. Academic Press.
- STRYER, L. 1999. Biochemistry. Fourth Edition, W.H. Freeman and Company, New York.
- VOET D. AND G.T. VOET. 1994. Biochemistry, Second Edition, John Wile and Sons, New York

Web Resources

www.masterorganicchemistry.comhttps://openlearning.mit
.edu

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	-	3	-	-	-	-	-	-	-	-	-	3	-	-	K1
CO 2	-	3	-	-	-	-	-	-	-	-	-	3	-	-	K2
CO 3	-	3	-	-	-	-	-	-	-	-	-	3	-	-	K3
CO 4	-	3	-	-	-	-	-	-	-	-	-	3	-	-	K4
CO 5	-	3	-	-	-	-	-	-	-	-	-	3	-	-	K5
Wt. Avg.		3	-	-	-	-	-	-	-	-	-	3	-	-	
Overall Mapping of the Course													3		

PART IVb INTERDISCIPLINARY ELECTIVE: PLANT - ANIMAL INTERACTION

Course Code	211BO3I01		
Credits	3		
Hours / Cycle	60		
Category	Part IV b	ID - ELECTIVE	Theory
Semester	3		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	To make the students more aware about the interdependence of various organisms and their role in the sustenance of life on earth		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)

On completing the course successfully, the student will be able to

CO 1	recall the various types of interactions between plants and animals	**PSO2**	**K1**
CO 2	explain the concept of co-evolution and its significance in the context of plant-animal interactions	**PSO2**	**K2**
CO 3	identify the mechanisms and significance of plant-animal interactions in pollination.	**PSO2**	**K3**
CO 4	explain the adaptations and strategies involved in seed dispersal by animals	**PSO2**	**K4**
CO 5	analyze various other interactions between plants and animals	**PSO2**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Plant- animal interaction an evolutionary approach- An introduction to types of interactions (positive and negative) between plants and animals, Concept of evolution and co-evolution. Co-evolution of plantanimal interaction through the ages; Brief account on the following interactions: Madagascar star orchid and Darwin's Hawk moth interaction, Leaf cutter ant and fungus interaction.	**12**	**CO 1-5**	**K1-K5**
II	Plant- animal interaction in pollination- Flower: structure and types; Pollination: Self and cross pollination; Barriers that prevent selfpollination in bisexual flowers; A brief account on various types of biotic pollination- Floral modification or blossom types for biotic pollination.; Plant reward for pollinators; Primary attractants: Pollen – source and composition, Nectar – source (Nectary) and Chemical composition, floral sap, Oil, and wax; Secondary attractants: Odour/scent as means of attracting pollinators, Visual attractant – colour of flower. Pollination syndrome in Ficus, Yucca, and Ophrys.	**13**	**CO 1-5**	**K1-K5**
III	Interactions in seed dispersal- Adaptations/ modifications in seed/fruit for dispersal. Epi and endozoochory-Wild fleshy fruit/ seed as source of food; Frugivores, seed dispersers; Fruit/ Seed dispersal; Seed dispersal through faeces, stickiness of fruits/seeds, Seed dispersal by mimicry	**10**	**CO 1-5**	**K1-K5**
IV	Other interactions- Plants as shelter for animals in different ecosystems;	**13**	**CO 1-5**	**K1-K5**
	Plant Galls – Gall producing insects; Acacia-ant interaction. Insectivorous plants, different mechanisms to trap insects; Insects mimicking plant parts (Camouflage) and plants mimicking insects.Parasitic interactions- Cuscuta, Sandal wood and Loranthus.			
V	Antagonistic interactions and Plant Defense mechanisms: Allelopathy	**12**	**CO 1-5**	**K1-K5**
	and HerbivoryMechanical defense – thorns, prickles, spines etc.; Chemical defense –The role of secondary metabolites for defense mechanism against herbivores; Plant volatiles as defense against insect herbivores; Host-derived chemical defense.			

Prescribed Books/Textbooks

1. DEL CLARO, KLEBER, TOREZAN-SILINGARDI, HELENA MAURA (Eds.) 2021; PlantAnimal Interactions ISBN 9783-030-66877-8, Springer International Publishing WARREN G.
2. ABRAHAMSON (Editor) 1988; Plant Animal Interactions, McGraw-Hill Inc.,US **References**
   1. Barlt. F.G. 1985. Insect and Flowers. The Biology of a Partnership. George. Allen. Lunwin, London.
   2. Bentley, B., and T. Elias. 1983. The Biology of Nectaries. Columbia University Press, London.
   3. Faegri, K., and V. L. Piji. 1980. The principles of pollination ecology. Pergamon Press, USA.
   4. Levey, D. J.; Silva, W. R. and Galetti, M. (eds.) 2002. Seed Dispersal and Frugivory: Ecology, Evolution, and Conservation.
   Wallingford: CABI Publishing. 511pp.
   5. Slack, A. 2000. Carnivorous Plants (3rd Revised edition edition). Marston House, Publishers, 240pp.
   6. Walter, D. 2010. Plant Defense: Warding off attack by pathogens, herbivores and parasitic plants. Wiley-Blackwell, 248pp.**Suggested Reading**
1. PETER W. PRICE (Editor) 1991. Plant-Animal Interactions: Evolutionary Ecology in Tropical and Temperate Regions, 047150937X (ISBN 13: 9780471509370), Wiley Interscience
2. PALATTY ALLESH SINU AND KR SHIVANNA 2016; Mutualistic Interactions between Flowering Plants and Animals, Manipal University Press

Course Articulation Matrix

	Programme Outcomes								**Programme Specific Outcomes**					**Cognitive**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	Level
CO 1		3								3				K1
CO 2		3								3				K2
CO 3		3								3				K3
CO 4		3								3				K4
CO 5		3								3				K5
Wt. Avg.		3								3				

Overall Mapping of the Course 3

Paper 7a. MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Course Code	**211BO4M01**		
Credits	**3**		
Hours / Cycle	**60**		
Category	**Part**	**Major**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To educate students with a wide range of morphology, basic nomenclature, classifications, method of herbarium preparation and diagnosis of selected families of flowering plants.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	define the morphology of flowering plants using taxonomic technical terms.	**PSO 1**	**K1**
CO 2	classify flowering plants based on Bentham and Hooker's and Angiosperm Phylogeny Group classifications.	**PSO 1**	**K2**
CO 3	apply basic ICN rules essential to describe a new taxon and recognize correct scientific names.	**PSO 1**	**K3**
CO 4	compare the herbarium specimens.	**PSO 1**	**K4**
CO 5	evaluate the diagnostic characters and identify the members of selected flowering plant families.	**PSO 1**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	Cos	BLOOM'S TAXONOMY LEVEL
I	Morphology and modifications of roots, stems and leaves. Types of inflorescence, flowers and fruits.	**12**	**CO 1-5**	**K1-K5**
II	A brief history of Angiosperm Classifications: Phenetic (Benthem and Hooker's) and Phylogenetic (Angiosperms Phylogeny Group IV) systems of classifications.	**5**	**CO 1-5**	**K1-K5**
III	Nomenclature: Taxonomic hierarchy. Binomial and Polynomial. Synonyms and homonyms. Author Citation. Principle of Priority. Holotype, Isotypes, Lectotype and Neotype.	**5**	**CO 1-5**	**K1-K5**
IV	Field and Herbarium Methods: Collection, Numbering, Poisoning, Pressing, Drying, Mounting and Preservation of herbarium specimens. Brief introduction on Botanical Survey of India (Kolkata) and Royal Botanic Gardens (Kew). Floras and Taxonomic Keys.	**8**	**CO 1-5**	**K1-K5**

V	Systematic study of the following families (as per APG IV) and their economic importance: Nymphaeceae,Annonaceae, Araceae, Orchidaceae, Poaceae, Euphorbiaceae, Fabaceae, Cucurbitaceae, Rutaceae, Malvaceae, Rubiaceae, Apocynaceae, Lamiaceae, Solanaceae and Asteraceae	**30**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- HENRY, A.N., M. CHANDRABOSE. 1980. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.
- JAIN, S.K. and R.R. RAO. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.
- KOCHHAR, S.L. 2016. Economic Botany – A Comprehensive Study. Cambridge University Press, New Delhi. LAWRENCE, G. H. M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.
- NAIK, V. N. 2000. Taxonomy of Angiosperms. Tata McGraw – Hill Publishing Company Limited. New Delhi.

References (3 – 5)

- TURLAND, N.J. 2019. The Code Decoded – A user's guide to the International code of Nomenclature for algae, fungi and plants. Pensoft Publishers, Russia.
- TURLAND, N.J., WIERSEMA, J.H., BARRIE, F.R., GREUTER, W., HAWKSWORTH, D.L., HERENDEEN, P.S., KNAPP, S., KUSBER, W.H., LI, D-Z., MARHOLD, K., MAY, T.W., MCNEILL, J., MONRO, A.M., PRODO, J., PRICE, M.J. & SMITH, G.F. (2018) International Code of Nomenclature for algae, fungi and plants (Shenzhen Code). Regnum Vegetabile 159. Koeltz Scientific Books, Koenigstein.
- SINGH, P. & AL. 2015. Endemic Vascular Plants of India. Botanical Survey of India, Kolkata.
- STEARN, W.T. (1992). Botanical Latin. David & Charles, Abbott.

Suggested Reading (2 -5)

- DAVIS, P.H. AND V.H. HEYWOOD. 1965. Principles of Angiosperm Taxonomy. Oliver & Boyd. Edinburgh.
- GAMBLE, J.S, AND C.E.C. Fischer. 1967. Flora of the Presidency of Madras. Vols. I - III. Botanical Survey of India. Calcutta.
- MABBERLEY, D.J. 2017. Mabberley's Plant–Book: A portable dictionary of plants, their Classification and uses. Fourth Edition. Cambridge University Press, Cambridge.
- SIMPSON, M. G. 2006. Plant Systematics. Elsevier Academic Press, California, USA.
- SINGH, G. 2008. Plant Systematics – Theory and Practice. Oxford & IBH, New Delhi.

Web Resources (3-5)

http://www.mobot.org/MOBOT/research/APweb/https:/
/www.ipni.org/http://www.efloras.org/
https://www.iapt-taxon.org/nomen/main.phphttps://www.ars-grin.gov/
http://www.plantsoftheworldonline.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1		3							3					
CO 2		3							3					
CO 3		3							3					
CO 4		3							3					
CO 5		3							3					
Wt. Avg.		3							3					
Overall Mapping of the Course												3		

PAPER 2b BASIC AND APPLIED PALYNOLOGY

Course Code	**211BO4M03**		
Credits	**3**		
Hours / Cycle	**45**		
Category	**Part**	**Core Elective**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2021 onwards**		

Course Objectives	This will enable the students to learn the basics of Palynology and its importance in various other applied fields of Biological sciences.

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall the history, basics and important terms of Palynology.	**PSO1**	**K1**
CO 2	explain the pollen morphological characters, apertures and the various techniques in processing the pollen.	**PSO1**	**K2**
CO 3	apply the role of palynology in bee keeping and aerobiology; various methods, techniques and importance.	**PSO1**	**K3**
CO 4	discover the role of pollen in plant taxonomy, paleopalynology and archaeology; techniques and significance.	**PSO1**	**K4**
CO 5	assess the importance of pollen in allergy, medicine, and forensic science.	**PSO1**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	History and advancement of palynology; Terminologies used in spore and pollen description; Difference between pollen and spores; Sporoderm: Characters, Composition and importance.	**9**	**CO 1-5**	**K1-K5**
II	Pollen dispersal unit; Shape and size; Aperture; Pollen wall ornamentation, LO Analysis; Pollen wall stratification; NPC classification; polliniferous sample collection, Acetolysis method and reference slide preparation; Sample preparation techniques for Scanning and Transmission Electron Microscopic observation.	**9**	**CO 1-5**	**K1-K5**
III	Melittopalynology/ Melissopalynology: Bees that are commonly domesticated in India; Bee colony, Pollen nectar source (plant), pollen collection; Role of Melissopalynology in Bee keeping; Season of honey production, Origin of honey and evaluation; Extraction of pollen from honey, slide preparation and identification. Aeropalynology: Methods of collecting air borne particles; Identification, preparation of pollen calendar; Aerobiological studies in relation to allergy - Extraction of allergens, Testing patients and treatment.	**9**	**CO 1-5**	**K1-K5**
IV	Palynotaxonomy: Use of pollen in plant classification; Pollen flora; Pollen Atlas and pollen database; Geo/paleopalynology: pollen diagram construction and interpretation of data in relation to Paleoenvironment, vegetation and climate; Copropalynology: Uses of coprolite in Archeology and ancient human settlement.	**9**	**CO 1-5**	**K1-K5**
V	Forensic Palynology: Recent development in Forensic palynology with significant case studies. Iatropalynology: Pollen in pharmaceuticals; Pollen in cosmetics and dietary supplements.	**9**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- ERDTMAN, G. 1952. Pollen morphology and plant taxonomy/ Angiosperm. Stockholm.
- FAEGRI, K IVERSON, J. 1989. Text book of Pollen analysis. John Wiley and Sons, New York.
- HESLOP-HARRISON. 1973. Pollen Development and Physiology. London, Butterworth.
- MOORE, P.D, WEBB, J.A. 1978. An Illustrated guide to pollen analysis. Hodder and Stoughton, London.
- SHIVANNA, KR, RANGASWAMY, N.S. 1992.Pollen Biology, A laboratory manual. Narosa Pub. House, New Delhi.
- WODEHOUSE, R.P. 1935. Pollen grain - their structure, identification and significance in Science and Medicine.Hafner Publishing Co. New York.

References (3 – 5)

- DOROTHY HODGES. 1974. The Pollen loads honey bees. Bee Research Association. London.
- KEDVES, M. 1986. Introduction to the palynology of Pre-Quaternary Deposits. Part I & II Pub.House of the Hungarian Academy of Sciences, Budapest.
- HESSE, M.; HALBRITTER, H.; ZETTER, R.; WEBER, M.; BUCHNER, R.; FROSCH-RADIVO, A. and ULRICH, S.(Eds.) (2009). Pollen Terminology: An illustrated handbook. SpringerVerlag, Vienna New York, pp. 264.
- SINGH. S. 1962. Beekeeping in India. ICAR, New Delhi.
- TILAK, S.T. 1982. Aerobiology.VijayantiPrakashan, Aurangabad.
- TSCHUDY, RH, SCOTT, AR 1969 Aspects of Palynology. Wiley Interscience, New York.

Suggested Reading (2 -5)

- EVA CRANE. 1970. Honey - A Comparative Survey. John Wiley and Sons, Heinemann, London.
- MISHRA, RC. 1995. Honey Bees and their management in India ICAR. New Delhi.
- PUNT, W; HOEN, P.P.; BLACKMORE, S.; NILSSON, S. and Le THOMAS, A. 2007. Glossary of pollen and spore terminology.Review of Palaeobotany and Palynology,143(1–2): 1–81.
- TILAK, S.T. 1989. Air borne pollen and fungal spores. Vijayanti Prakashan, Aurangabad.
- TIWARI, RS. 1995.Coaliferous fuel resource of India. Parameters of Studies in Palynology and Biopetrology.
- TRAVERSE, A 1988. PALAEOPALYNOLOGY. UNWIN HYMAN, LONDON.

Web Resources (3-5)

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3								3					K1
CO 2		3								3					K2
CO 3		3								3					K3
CO 4		3								3					K4
CO 5		3								3					K5
Wt. Avg.		3								3					
Overall Mapping of the Course													3		

Paper 2b BIOSOCIAL GENETICS

Course Code	211BO4M0		
Credits	3		
Hours / Cycle	45		
Category	Part 2b	SPECIAL PAPER - ELECTIVE	Theory
Semester	4		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	To provide students with the knowledge of social implications of genetic technology		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	relate GMOs and its social impacts	**PSO4**	**K1**
CO 2	explain the implications of monoclonal antibodies and GMOs for human welfare.	**PSO4**	**K2**
CO 3	identify the varrious complexities in human in vitro fertilization.	**PSO4**	**K3**

CO 4	analyze the importance on the causes and effects of mutation	**PSO4**	**K4**
CO 5	evaluate the ethical, social, and economic implications of mutation, use of GMOs, MAbs and reproductive technologies and their impact on society and individuals.	**PSO4&PSO5**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Introduction to biosocial genetics. UV induced mutation and its repair mechanism. Mismatch DNA repair mechanism. Mutation typesframeshift Mutation, addition, deletion,substitution, transition and transversion.	**8**	**CO 1-5**	**K1-K5**
II	Genetically modified foods (Rice, Tomato and Corn), Edible vaccines.Potential human health impact, environmental impact, ethics and society – Benefits and controversies.	**10**	**CO 1-5**	**K1-K5**
III	Monoclonal Antibody Technology : Production of antibodies - Monoclonal and Polyclonal antibodies and its applications in the medical field- Diagnosis and treatment.	**9**	**CO 1-5**	**K1-K5**
IV	Amniocentesis: Its use in detecting defective foetuses and misuse in female foeticide. Surrogacy, Surrogate mother, social and economic problems. Reproductive Engineering: Sperm bank, its prospects and problems.	**13**	**CO 1-5**	**K1-K5**
V	Recombinant DNA Technology : Applications of recombinant DNA technology in the production of medically useful recombinant molecules - Diagnostic and therapeutic- Impact and safety, moral, social, regulatory & ethical issues associated with recombinant DNA.	**12**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

3. BOURGAIZE, D. 2001. Biotechnology: Demystifying the concepts. Pearson Publications. JOHN WHISSON , JANET BAINBRIDGE , BASAMA ELLAHI , GRAEME SMITH. 2000 Genetically Modified Foods .Chadwick House Group Ltd. FRANCE WINDDANCE TWINE .2011. Outsourcing the Womb: Race, Class and Gestational Surrogacy in a Global Market (Framing 21st Century Social Issues).Routledge Publishers.

References

7. GOEFRY M.COOPER et al.2016. The Cell – A Molecular approach.Seventh Edition.Sinauer Associates Inc.
8. LEWIN, B. 2003. Genes VIII. Oxford University Press. JEREMY W. DALE. 2011. From Genes to Genomes- Concept and Applications of DNA Technology. Third Edition. Wiley-Black Well Publishers.
9. WATSON,J.D. et al. 2003. Molecular Biology of the Gene. Fourth Edition. The Benjamin Cummings Pub. Co.

Suggested Reading

3. BURTON E. TROPP, 2014. Genes to proteins. Fourth Edition. Jones & Bartlett Publishers.
4. GERALD KARP.2002.Cell and Molecular Biology, John Wiley & Sons, New York.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1		3										3		K1
CO 2		3										3		K2
CO 3		3										3		K3
CO 4		3										3		K4
CO 5		3		3								3	2	K5
Wt. Avg.		3		3								3	2	
											Overall Mapping of the Course		2.75	

Course title: BASIC BIOCHEMISTRY - II

Course Code	**211BO4A01**				
Credits	**3**				
Hours / Cycle	**4**				
Category	**Part**	**Allied**	**Theory**		
Semester IV	I				
Year of Implementation	**From the academic year 2021-2022 onwards**				
Course Objectives	To impart knowledge on the techniques and instrumentation used in Biochemistry. To enable students to get a deep understanding of the biochemical reactions.				
CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**		
On completing the course successfully, the student will be able to					
CO 1	recall the laws of thermodynamics and dynamics of bioenergetics.	**PSO 3**	**K1**		
CO 2	summarise the process of photosynthesis.	**PSO 3**	**K2**		
CO 3	identify the biochemical reactions involved in respiration.	**PSO 3**	**K3**		
CO 4	analyze the components of a balanced diet and the nutritional content of fruits & vegetables.	**PSO 3**	**K4**		
CO 5	assess the significance of instruments used in Biochemistry.	**PSO 3&5**	**K5**		
SYLLABUS					
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**	
I	Laws of Thermodynamics and Energy changes in Biological reactions, Concept of Enthalpy, Entropy and Gibbs free energy. Exothermic and Endothermic reactions. Redox reactions. Role of ATP, GTP and UTP.	**10**	**CO 1-5**	**K1-K5**	
II	Photosynthesis – Ultrastructure and function of Chloroplast and its Photosynthetic pigments composition. Light reaction - Hill reaction, Cyclic and Non-Cyclic Photophosphorylation. Dark reaction - Calvin cycle.	**14**	**CO 1-5**	**K1-K5**	
III	Respiration – Ultrastructure and function of Mitochondria. Glycolysis, Krebs cycle. Electron transport chain and Oxidative phosphorylation. ATP synthase (CF1–CFo) complex. Microbial fermentation.	**14**	**CO 1-5**	**K1-K5**	

IV	Biochemical composition and food value of various food grains (cereals, pulses, oil seeds), fruits and vegetables. Fundamentals of nutrition and concept of balanced diet.	10	CO 1-5	K1-K5
V	Techniques in Biochemistry - Principle and applications of Centrifuge, Chromatography, Spectrophotometer, pH meter and Electrophoresis.	12	CO 1-5	K1-K5

Prescribed Books/Textbooks

- DAVID HAMES AND NIGEL HOOPER.2005. Instant Notes Biochemistry. 3rd Edition. Taylor and Francis group.
- JAIN, J.L., S. JAIN AND N. JAIN. 2005. Fundamentals of Biochemistry. S. Chand & Company Ltd., New Delhi.
- RASTOGI. S.C. 2010. Biochemistry. Tata McGraw-Hill Education Pvt. Ltd., New Delhi.
- SADASIVAM, S. AND A. MANICKAM. 2008. Biochemical Methods. Third Edition. New Age International Publishers, New Delhi.
- SATYANARAYANA, U.2006. Essentials of Biochemistry. Books and Allied Private Limited, Kolkata.
- SAWHNEY, S.K. AND RANDHIR SINGH. 2009. Introductory Practical Biochemistry. Second Edition. Narosa Publishing House, New Delhi

References

- CONN, E.E., P.K. STUMPF, G. BRUENING AND R.H.DOI. 1987. Outlines of Biochemistry. John Wiley and Sons, New York.
- KEITH WILSON AND JOHN M. WALKER. 2000. Principles and Techniques of Practical Biochemistry. Cambridge University Press.
- NELSON, D.L. AND M. M. COX. 2005. Lehninger Principles of Biochemistry, Fourth Edition, W.H. Freeman and Company, New York.

Suggested Reading

- HANS-WALTER HELDT AND BIRGIT PIECHULLA. 2010. Plant Biochemistry. 4th edition. Academic Press.
- STRYER, L. 1999. Biochemistry. Fourth Edition, W.H. Freeman and Company, New York.
- VOET D. AND G.T. VOET. 1994. Biochemistry, Second Edition, John Wile and Sons, New York

Web Resources

www.masterorganicchemistry.com
https://openlearning.mit.edu

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3										3			K1
CO 2		3										3			K2
CO 3		3										3			K3
CO 4		2										3			K4
CO 5		3			3							3		3	K5
Wt. Avg.		2.8			3							3		3	
												Overall Mapping of the Course		2.95	

Course title: Paper 6c Allied - II BASIC BIOCHEMISTRY – I & II

Course Code	211BO4A02		
Credits	**4**		
Hours / Cycle	**60**		
Category	**Part**	**Allied**	**Practical**
Semester			
Year of Implementation	**From the academic year 2021-2022 onwards**		

Course Objectives	To enable the students to experimentally analyze and quantify the presence of biomolecules. To impart knowledge on concepts of concentration, enzymatics and bioseparation.

CO No.	Course Outcome Upon the completion of this course, students will be able to	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
CO - 1	find the presence of carbohydrates, amino acids, lipids,alkaloids and flavonoids in the samples.	PSO-3	K1
CO - 2	demonstrate an understanding of estimation of ascorbic acid, acid number of oil, glycine and proteins.	PSO-3	K2
CO - 3	experiment with the separation of amino acids and photosynthetic pigments by chromatography.	PSO-3	K3
CO - 4	compare the concepts of molarity, molality and normality.	PSO-3	K4
CO - 5	evaluate seed viability and enzyme amylase in plants.	PSO-3	K5

SYLLABUS

UNIT	CONTENT	COs	BLOOM'S TAXONOMY LEVEL
I	Qualitative identification tests for carbohydrates-reducing and non-reducing sugars (Fehling's test, Benedict's test) and amino acids (Ninhydrin test, Xanthoproteic test). Estimation of total carbohydrates (Anthrone reagent method/Phenol sulphuric acid method) by spectrophotometric method. Qualitative Identification Test for Lipids - Sudan III Test. Phytochemical tests for alkaloids and flavonoids.	CO 1-5	K1-K5
II	Estimation of Glycine (amino acid) by Sorenson's formol titration method. Estimation of acid number of edible oil by titration method. Estimation of ascorbic acid (Vitamin C) by titration method. Estimation of protein (Bradford method) by spectrophotometric method.	CO 1-5	K1-K5
III	Separation of photosynthetic pigments using paper chromatography. Quantification of photosynthetic pigments by spectrophotometric method.	CO 1-5	K1-K5
IV	Preparation of percent, normal, molal and molar solutions.	CO 1-5	K1-K5
V	Testing of seed viability by TTC method. To study the effect of temperature and substrate concentration on the activity of amylase.Demonstration of Centrifuge, Spectrophotometer, pH meter and Electrophoresis.pH analysis of lemon juice, tamarind juice and detergent powder and Preparation of Phosphate buffer.	CO 1-5	K1-K5

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	
CO 1		3									3			K1
CO 2		3									3			K2
CO 3		3									3			K3
CO 4		2									3			K4
CO 5		3									3			K5
Wt. Avg.		2.8									3			

Overall Mapping of the Course	2.9

Course Code	**211BO5M01**		
Credits	**5**		
Hours / Cycle	**75**		
Category	**Part**	**Core**	**Theory**
Semester	**V**		
Year of Implementation	**From the academic year 2023-2024 onwards**		
Course Objectives	This will equip the students with adequate knowledge about the microscopes, various microtechniques and instruments.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
	On completing the course successfully, the student will be able to		
CO 1	recall the principle, working mechanism, types and application of light microscopes	PSO1	**K1**
CO 2	understand the principle, components and working mechanisms of electron microscopes	PSO1	**K2**
CO 3	choose various methods and techniques used in extraction and separation of bio-components.	PSO3	**K3**
CO 4	compare the principle, working mechanism, handling and maintenance of various analytical instruments.	PSO3	**K4**
CO 5	recommend various stains, dyes and staining procedures involved in micro-technique.	PSO3	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Techniques in Microscopy: Light Microscopy- optical principle, magnification, resolution and care of microscope. Bright-field and Dark-field microscopy.	15	**CO 1-5**	**K1-K5**
II	Principles of Transmission and scanning electron microscope. Major steps involved in the preparation and processing of specimens for electron microscopy.	15	**CO 1-5**	**K1-K5**
III	Separation procedure: Paper and thin-layer chromatography, Gas chromatography, HPLC and Ion-exchange chromatography. Gel electrophoresis and Immunoelectrophoresis.	15	**CO 1-5**	**K1-K5**
IV	Instrumentation: pH metry, Colorimetry, Spectrophotometry and Centrifugation.	15	**CO 1-5**	**K1-K5**
V	Microtechniques: Bright field stains; Preparation of whole mounts, free-hand sectioning and microtome sectioning. Fixation, dehydration, infiltration and permanent slide preparation.	15	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- KRISHNAMURTHY, K.V. 1988. Methods in Plant Histochemistry. S. Viswanathan (Printers & Publishers) Pvt. Ltd. Madras.
- CHANDAK, T., CHAUDHARY, M. AND CHANDAK, V. 2012. Microtomy: Microtome and its applications. Lambert Academic Publishing.
- LACEY, A.J. 1989. Light microscopy in biology - a practical approach. IRL Press. Oxford University Press. U.K.

References (3 – 5)

- CONN, H.J. 1991. Biological stains. Ninth Edition. Sigma Chemical Company, St. Louis. USA.
- CLARK, G. 1981. Staining Procedures. Fourth Edition. Williams & Wilkins Co. MD. U.S.A.
- GARTNER, H. AND SCHWEINGRUBER, F.H. 2013. Microscopic preparation techniques for plant stem analysis. Swiss federal Research Institute. Switzerland.
- ROBINSON, P.C. 1992 Qualitative polarized light microscopy. Royal Microscopical Society. Oxford University Press. U.K

Suggested Reading (2 -5)

- BERLYN, G.P. AND J.K. MIKSCHE. 1976. Botanical Microtechnique and cytochemistry. Iowa State University Press. Iowa. USA.

	Course Articulation Matrix														
Course Outcomes	**Programme Outcomes**										**Programme Specific Outcomes**				**Cognitive Level**
	PO 1	**PO 2**	**PO 3**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	
CO 1	-	3	-	-	-	-	-	-	-	3	-	-	-	-	**K1**
CO 2	-	3	-	-	-	-	-	-	-	3	-	-	-	-	**K2**
CO 3	-	3	-	-	-	-	-	-	-	-	-	3	-	-	**K3**
CO 4	-	3	-	-	-	-	-	-	-	-	-	3	-	-	**K4**
CO 5	-	3	-	-	-	-	-	-	-	-	-	3	-	-	**K5**
Wt. Avg.	-	**3**	-	-	-	-	-	-	-	**3**	-	3	-	-	-
	Overall Mapping of the Course													**3**	

- ENSEN, W.A. 1962. Botanical Histochemistry. W.H. Freeman and Company. San Francisco.
- KIERNAN, J.A. 1990. Histological and Photochemical Methods. Theory and Practice. Pergamon Press. U.K.
- LAWLOR, D. 2019. Introduction to Microscopy: Tips and tricks for beginners. Springer.

Paper 10a CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY

Course Code	211BO5M02		
Credits	5		
Hours / Cycle	90		
Category	Part 11a	Core	Theory
Semester	6		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	To enable the student to have an understanding of the basics of cell, cell organelles, DNA, gene and patterns of inheritance.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall the structure, organization and functions of Cell and Cell organelles.	**PSO4**	**K1**
CO 2	compare Mendelian and Non Mendelian pattern of Inheritance.	**PSO4**	**K2**
CO 3	identify cell cycle and cell division.	**PSO4**	**K3**
CO 4	analyse the basic structure and organization of DNA, Gene, Chromosome and the process of replication.	**PSO4**	**K4**
CO 5	Compare the mechanism of prokaryotic and eukaryotic Gene expression.	**PSO4**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**Cos**	**BLOOM'S TAXONOMY LEVEL**
I	Cell structure- Ultra-structure - Cell wall, Plasma membrane; Structure, functions and biosynthesis of organelles - Nucleus,	**20**	**CO 1-5**	**K1-K5**

	Endoplasmic			

	reticulum Golgi bodies, Lysosomes, Ribosomes, Peroxisomes, Mitochondria and Chloroplast. Chromosome - structure.			
II	The cell cycle - Mitosis; Meiosis- Linkage and crossing over. Construction of linkage maps. Mendel's law of inheritance - modifications (codominance, incomplete dominance, lethal genes), quantitative inheritance (Ear length in Maize, Colour of skin in Man), cytoplasmic inheritance (eg. Mirabilis, yeast, maize). Multiple alleles (ABO blood group in humans).	**15**	**CO 1-5**	**K1-K5**
III	Chromosomal mutations – Types – Structural and Numerical – Euploidy - monoploid, triploid, tetraploid, polyploid (autopolyploid and allopolyploid) and Aneuploidy- monosomy, disomy, trisomy, tetrasomy. Nondisjunction. Gene mutations - types – point mutation, silent mutation, insertion, deletion, frameshift mutation.	**15**	**CO 1-5**	**K1-K5**
IV	Organisation of DNA double helix - A, B and Z forms of DNA, RNA - mRNA, tRNA, rRNA. DNA replication in Prokaryotes and Eukaryotes. Protein Synthesis - Transcription, Post - transcriptional modification of hnRNA. Genetic code - Translation, Post translational modification. Gene Regulation with reference to lac Operon.	**20**	**CO 1-5**	**K1-K5**
V	Inheritance of Genetic diseases- Autosomal Recessive Disorders, Autosomal Dominant Disorders, X- linked Diseases and Genetic diagnosisprenatal, embryonic and adult. Genetic screening of Sickle Cell Anaemia (SCA). Stem cells and Germ line therapy. DNA fingerprinting, RFLP, RAPD, AFLP, PCR, Western, Southern and Northern blotting.		**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

- VERMA, P.S. 2014. Text Book of Cytology. S. Chand Publishing.
- BOURGAIZE, D. 2001. Biotechnology: Demystifying the concepts. Pearson Publications.
- FRIEFELDER, D. 2005. Molecular Biology. Second Edition. Narosa Pub. House.
- WINTER, P.C et.al., 2007. Instant Notes in Genetics. Taylor and Francis Group.
- PHIL TURNER et.al., 2006. BIOS Instant Notes in Molecular Biology. Taylor and Francis Group.

References

- GOEFRY M. COOPER et al. 2016. The Cell – A Molecular Approach. Seventh Edition. Sinauer Associates Inc.
- LEWIN, B. 2003. Genes VIII. Oxford University Press.
- WATSON, J.D. et al. 2003. Molecular Biology of the Gene. Fourth Edition. The Benjamin Cummings Pub. Co.
- ROBERT BROOKES, 2014. Genetics- Analysis and Principles. Fifth Edition. McGrawHill Education. Publishers,1998 LINDSEY, K. Plant Tissue Culture Manual. Kluwer Academic Publishers. 1992.

Suggested Reading

- BURTON E. TROPP, 2014. Genes to proteins. Fourth Edition. Jones & Bartlett Publishers.
- GERALD KARP. 2002. Cell and Molecular Biology, John Wiley & Sons, New York.
- GEOFFERY. H. COOPER et al., 2004. Cell-Molecular approach, ASM press, Washington.
- GUPTA, P.K. 2004. Cell and Molecular Biology. Third Edition. Rastogi Publications.
- SOBTI, R.C. and GOBE. 1991. Eukaryotic chromosomes. Narosa Publishing House.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1		3										3		K1
CO 2		3										3		K2
CO 3		3										3		K3
CO 4		3										3		K4

CO 5		3										3		K5
Wt. Avg.		3										3		
Overall Mapping of th Course												3		

Paper 11a PLANT BIOTECHNOLOGY AND BIOINFORMATICS

Course Code	211BO5M03		
Credits	5		
Hours / Cycle	90		
Category	Part 11a	Core	Theory
Semester	6		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	To provide students with an opportunity to apply basic biological concepts to the applied fields of biotechnology, specifically in r-DNA technology, plant tissue culture		

CO #	**Course Outcome(s)**	**PSO**	**Bloom's Taxonomy Levels Addressed (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall the role of r-DNA technology and gene manipulation in the production of Transgenic plants and plant tissue culture techniques.	**PSO4&5**	**K1**
CO 2	interpret the role of plant growth regulators and media formulations in plant tissue culture.	**PSO3&5**	**K2**
CO 3	make use of different culture systems in the production of secondary metabolites and elite clones.	**PSO5**	**K3**
CO 4	examine a Tissue Culture Lab for mass production of clonal plants through micropropagation.	**PSO5**	**K4**
CO 5	explain the principles and applications of rDNA technology, plant tissue culture and bioinformatics	**PSO5**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**Cos**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to Biotechnology: history and scope. Conventional and Modern Biotechnology. Introduction to r-DNA technology and its role in transgenics, tools and techniques used in r-DNA technologyenzymes (restriction enzymes and ligase), vectors-(Plasmids, phages and cosmids) and DNA delivery systems (direct and indirect).	**20**	**CO 1-5**	**K1-K5**
II	Introduction to transgenic organisms. Need of transgenic plants-methods employed in producing genetically modified organisms-Transgenesis, Overexpression, Gene silencing. CRISPR technology safety concerns and ethical issues in production and use of genetically modified organisms (GMOs).	**15**	**CO 1-5**	**K1-K5**
III	Plant Tissue culture: Introduction. Concepts of totipotency. Laboratory organization. Sterilisation Procedures: Mechanical, physical & chemical methods. Maintenance of aseptic condition and production of axenic cultures.Media and components media: Solid, liquid and prepacked media. Micro and macronutrients, vitamins, natural adjuvants like coconut milk and fruit juices. Auxin, cytokinin and other PGRs and other components of media.	**15**	**CO 1-5**	**K1-K5**

IV	In vitro cultures: Callus culture, shoot cultures and cell cultures. Micropropagation-direct and indirect morphogenesis, Organogenesis, somatic embryogenesis and synthetic seed production. Introduction to organ culture, Embryo culture and Anther culture.Isolation of protoplast, somatic cell hybridization, selection and regeneration of plants. Somaclonal variation.	**20**	**CO 1-5**	**K1-K5**
V	Bioinformatics: Introduction to bioinformatics. Biological Database– Protein and DNA sequence database, Structure database, literature database, (Pubmed, Medline). Sequence Alignment, Database similarity searching; FASTA; BLAST, Proteomics – protein structure prediction (primary, secondary & tertiary). Application of bioinformatics- biochips.	**20**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks

- SATYANARAYANA, U. Biotechnology, Allied Pvt. Ltd. Kolkata, 2007.
- DUBEY, R. C. 2001. A text Book of Biotechnology. S. Chand & Company Ltd. NewDelhi.

References

- PRIMROSE, S.B. AND TWYMAN, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006) 7th ed. ISBN 1-4051-3544-1
- ROBERTA H.SMITH, Plant Tissue culture- techniques and experiments, Third edition, Elsevier Publications, 2013
- RA DIXON, RA GONZALES, Plant Cell Culture a Practical Approach, 2 Edition, Oxford Uty Press, 2004
- HAMISH A COLLIN, SUE EDWARDS, Plant Tissue Culture, Bioscientific Publishers,1998 LINDSEY, K. Plant Tissue Culture Manual. Kluwer Academic Publishers. 1992.

Suggested Reading

- BHOJWANI S. S. AND RAZDAN M.K., Plant tissue culture :Theory & practice-a revised edition, Elsevier, Netherlands 1996
- CHAWLA H.S., Introduction to Plant Biotechnology, 2nd Edition, Oxford and IBH Press, 2003.
- WALKER, J. M. AND RAPLEY.(eds). Molecular Biology and Biotechnology. (4thEdition), Panima Publishing Corporation. New Delhi. 2003.
- ADRIAN SLATER, NIGEL SCOTT, AND MARK FOWLER, Plant Biotechnology, Oxford University Press, NewYork, 2008., New York.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1		3		3								3	3	K1
CO 2		3		3							3		3	K2
CO 3		3		3									3	K3
CO 4		3		3									3	K4
CO 5		3		3									3	K5
Wt. Avg.		3		3							3	3	3	
											Overall Mapping of the Course		3	

Paper 12a COMBINED PRACTICAL: TECHNIQUES IN BIOLOGY AND INSTRUMENTATION; CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY & BIOTECHNOLOGY, TISSUE CULTURE AND BIOINFORMATICS

Course Code	211BO5M04		
Credits	5		
Hours / Cycle	120		
Category	Part 12a	Core	Practical
Semester	VI		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	To provide the students with hands-on experience on various instruments that may be used in biology, developing skill in basic techniques used in molecular biology and plant tissue culture, solving problems related with genetics and familiarizing with some bioinformatics tools.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)

On completing the course successfully, the student will be able to			
CO 1	relate the basic components of LM, EMs & various Instruments; their maintenance and use Learn about stains and Dyes; Stainings mechanisms	**PSO3**	**K1**

CO 2	demonstrate squash preparation technique	**PSO4**	**K2**
CO 3	solve problems in Mendelian genetics	**PSO4**	**K3**
CO 4	distinguish various results obtained during the experiments	**PSO3,4&5**	**K4**
CO 5	judge the skills needed for plant tissue culture techniques & bioinformatics	**PSO5**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	Cos	BLOOM'S TAXONOMY LEVEL
I	TECHNIQUES IN BIOLOGY AND INSTRUMENTATION Acquaintance with light microscope. Measurement and drawing of plant cell and tissue. Exercises on interpretation and description of electron micrographs. Staining of starch, cell walls, lipids, proteins and nucleic acids using bright-field stains. Demonstration of permanent slides: free-hand section, whole mount or peel mount. Demonstration of Microtome sectioning, double staining and permanent slide preparation. Demonstration of electrophoretic separation of proteins. Demonstration of the following instruments: pH meter, colorimeter, spectrophotometer, centrifuge and chromatography.	**30**	**CO 1-5**	**K1-K5**
II	CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY HOURS 45 Photomicrographs of cell organelles. Acetocarmine and Hematoxylin staining procedure. Squash preparation of Allium cepa root tips and observation of stages of mitosis Squash preparation of Tradescantia flower buds and observation of stages of meiosis Preparation of squash of Polytene chromosome from Chironomus larva. DNA separation by Agarose gel electrophoresis. Solving problems in Lac Operon. Solving problems in multiple alleles inheritance, polygenic inheritance and gene regulation.	**45**	**CO 1-5**	**K1-K5**
III	BIOTECHNOLOGY, TISSUE CULTURE AND BIOINFORMATICS Sterilization Procedures: Fumigation, wet & dry sterilization, UV sterilization,Surface sterilization.Handling of glasswares. Medium preparation: Preparation of solid, semisolid and liquid media. (MS medium). Callus culture: Initiation, establishment and maintenance of callus from carrot cambial tissue. Organ culture: Culture of excised, leaves, axillary bud, cotyledon and shoot tip culture.	**30**	**CO 1-5**	**K1-K5**
IV	Demonstration of immobilization of plant cells. DNA isolation from plants. Demonstration of restriction enzyme lambda phage digestion and separation of DNA by gel electrophoresis.	**10**	**CO 1-5**	**K1-K5**
V	Bioinformatics: Similarity, Pairwise and multiple sequence analysis.	**5**	**CO 1-5**	**K1-K5**

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1		3									3			K1
CO 2		3										3		K2
CO 3		3										3		K3
CO 4		3		3							3	3	3	K4
CO 5		3		3									3	K5
Wt. Avg.		3		3							3	3	3	
												Overall Mapping of the Course		3

PART IVb SKILLED-BASED GENERAL ELECTIVE: PLANT SCAPING

Course Code	**211BO5L01**		
Credits	**3**		
Hours / Cycle	**60**		
Category	**Part**	**Elective Theory**	**Theory**
Semester			
Year of Implementation	**From the academic year 2021-'22 onwards**		
Course Objectives	**To teach students and make them understand the theoretical and practical skills and the nuances of growing plants for aesthetic and commercial purposes.**		

CO No.	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO - 1	list the use of plants, its habit and forms.	PSO-1	**K1**
CO - 2	Understand the mechanism for plant propagation.	PSO-3	**K2**
CO - 3	identify infrastructure and tools for controlled plant growth - fertilizers and land for floriculture production.	PSO-3	**K3**
CO - 4	compare the art of combining plants for visual appeal.	PSO-1	**K4**
CO - 5	select the type of plants, its form, color, structure to be used in landscaping.	PSO-1	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Plant Types- Perennials and Annuals, Lawn, Foliage and Flowering plants; Ferns, Palms, Xerophytic plants. Habit:- Herbs, Shrubs, Climbers and Trees; Habitat- Terrestrial, Aquatic plants.	**12**	**CO 1-5**	**K1-K5**
II	Asexual Propagation - Cuttings, Grafting, Layering, Bulbs and Tubers; Sexual Propagation- Fertilization, Seed setting, Hybridization, Seed germination; Culture - Embryo Culture and Micropropagation.	**12**	**CO 1-5**	**K1-K5**
III	Plant care Structures - Shade House, Green House, Poly Tunnel, Pro-tray; Media- Soil Mixture, Vermiculite, Soilrite, Perlite, Farm yard Manure; Irrigation- Watering methods, Integrated Irrigation, Automated Irrigation; Nutrient- Organic and Inorganic Fertilizers, Fertigation; Pest & Disease - Manual control, Chemical control.	**12**	**CO 1-5**	**K1-K5**
IV	Components: Land cover - Flower beds, Topiary, Arborsculpture; Boundary-Fencing, Pathway, Avenue and Pergolas; Miniature - Bonsai, Aquarium, Terrarium, Vivarium.	**12**	**CO 1-5**	**K1-K5**
V	Layout and Design: Aesthetics- Elements and Principle of design. Horizontal scape and Vertical scape; Environmental - Shade, noise, habitat, Building; Visualization-Growth and maintenance; Cost Plant, Space, Care.	**12**	**CO 1-5**	**K1-K5**

(As it is a Course with wide scope Students based on their current knowledge can give suitable examples)

Prescribed Books/Textbooks (1-5 books)

- KUMAR, N.1997. Introduction to Horticulture. 6th ed. Rajalakshmi Pub. Nagerkoil. S.India.
- LEILA DHANDA. 1984. Bonsai Culture. Oxford and IBH publishing Co. New Delhi.
- RANDHAWA AND A. MUKHOPADHYAY.1986. Floriculture in India. Allied Pub. Pvt. Ltd. New Delhi.
- TIWARI, G.N. and R.K. GOYAL. Green House Technology - Fundamentals, design, modeling and application. Narosa publishing house. New Delhi.

References (3 – 5)

- ADAMS 2005. Principles of Horticulture. 4th ed. Elsevier India Pvt. Ltd.
- ANITTA FANISH S. 2013. Organic Farming: Principles and Practices – LAP LAMBERT Academic Publishing.
- EDMOND J.B., T.L. SENN, F.S. ANDREWS AND R.G. HALFACRE. 1977. Fundamentals of Horticulture 4th ed. Tata McGraw-Hill. New Delhi.
- EDWARD F. DURNER. 2013. Principles of Horticultural Physiology Paperback – CABI
- ERLER, C. T. 2005. New Complete Home Landscaping: Designing * Constructing * Planting. Creative Home Owner Publishers.
- GRAF,A.B. 1981. Tropica, 2nd ed. Roehrs Co. USA.
- HARTMAN, H. T., D.E. KESTLER, F. T. DAVIES, Jr. AND R. L. GENRE, 1997. Plant Propagation: Principles and practices. 6th ed. Prentice & Hall of India. New Delhi.

Suggested Reading (2 -5)

- ANTJE RUGULLIS. 2008. 1001 Garden Plants and Flowers. Parragon Publishers.
- BARBARA L. COLLINS. 2002. Professional Interior Plant scaping, Stipes Pub Llc.
- BEVERLEY, D. AND B. PHILLIPS. 2002. Encyclopedia of Gardening. Parragon Publishers.
- BRIGGS, G. B. AND C. L. CALVIN, 1987. Indoor Plants. John Wiley & Sons. NY, USA.
- DAVID VAN FLEET, ELLA VAN FLEET, GEORGE J. SEPERICH. 2013. Agribusiness: Principles of Management Hardcover
- EARLY M P, ADAMS. C R. 2004. Principles of Horticulture; Butterworth-Heinemann; 4 edition.
- HUNTER, J. M. AND L. CARPENTER, 2003. Teach yourself Gardening. Hodd Publishers.
- INGELS. J. E. 2003. Landscaping principles and practices. 4th ed. Thomson Delmar Learning Publishers.
- JAMES M. DELPRINCE. 2012. Interior Plantscaping: Principles and Practices, Delmar Cengage Learning; 1 edition.
- JANICK JULES. 1979. Horticulture Science. 3rd ed. W.H. Freeman and CO. San Francisco. USA.
- KATHY FEDIW. 2011: Green Plant Care Tips for Techs, Johnson Fediw Associates; 1st edition.
- MOORE, R., AND W.D. CLARK. 1995. Botany: Plant Form and Function. Vol. I. W.M.C. Brown Publishers.
- STUART D. SNYDER. 1995. Environmental Interiorscapes: A Designer's Guide to Interior Plantscaping and Automated Irrigation Systems, Watson-Guptill Publications; First Edition edition.
- TIWARI, G.N. and R.K. GOYAL. Green House Technology - Fundamentals, design, modeling and application. Narosa publishing house. New Delhi.
- MOORE, R., W.D. CLARK, K.R. STERN, AND D. VODOPICH. 1995. Botany: Plant Diversity. Wm.C. Brown Publishers. Dubuque. IA.
- RAVEN, P.H., R.F. EVERT, AND S.E. EICHHORN. 1992. Biology of Plants. Fifth Edition. Worth Publishers. New York.

Web Resources (3-5)

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3								3					K1
CO 2		3										3			K2
CO 3		3										3			K3
CO 4		3								3					K4
CO 5		3								3					K5
Wt. Avg.		3								3		3			
Overall Mapping of the Course													3		

SKILL BASED COURSE: COMPUTER FOR DOCUMENTATION

Course Code	**211BO5C01**		
Credits	**3**		
Hours / Cycle	**30**		
Category	**Part**	**SKILL BASED COURSE**	**Practical**
Semester	**V**		
Year of Implementation	**From the academic year 2012-'22 onwards**		
Course Objectives	**To train students the practical skills of using Office and other internet tools for documentation and report generation.**		

CO No	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	select hardware / software's, licensing and use basic tools	PSO 5	K1
CO 2	Explain MS Office.	PSO 5	K2
CO 3	select Microsoft Word, Excel and PowerPoint to edit content [Text, Image, Audio & Video]	PSO 5	K3
CO 4	analyse content to be prepared.	PSO 5	K4
CO 5	evaluate content prepared using a computer.	PSO 5	K5

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Introduction to Hardware: Parts of the CPU- Cabinet, Motherboard, Processor, Ports, Sound Card and Graphics Card; Input devicesKeyboard, Mouse, Scanner, Mic, Camera; Output devices-Speaker, Monitor; Storage Devices-Hard Disc, CD, DVD, Blue ray etc. Introduction to software: Operating systems - Open Source, Proprietary and OEM (Software license); Device drivers - Printer, Camera etc.; Utilities–Disc Fragmentation, Anti Virus, Compression; Formats - File Type, Quality, Conversion and Compatibility.	**6**	**CO 1-5**	**K1-K5**
II	Office - MS-Office, Libre Office and Online Office (Zoho and Google); Word processor - Font, Paragraph, Page, Data (text, tables and box) and Import/Export of Data; Spreadsheet - Layout, Column & Row, Data, Mathematical functions and Chart/graph Insertion.	**6**	**CO 1-5**	**K1-K5**
III	Use Microsoft PowerPoint or other presentation options of Office software's and enable slideshow with animation and sound. Presentation - PowerPoint (using time, transition and animation); Database - Enter data using Forms and generate Report using Query.	**6**	**CO 1-5**	**K1-K5**
IV	Multimedia editing: Use and manipulation of image, sound and video files; Image- Cropping, rotating, resizing, adding text, Irfan view, MSPaint and Online Working with Layers using (Irfanview, pixlr.com/editor, http://www.photoshop.com/); Sound & Video - Clipping and adjusting Tempo (Movie maker, Audocity and Blender); Timeline - Mixing image, audio and video file in making movie, Titling, fade in/fadeout.	**6**	**CO 1-5**	**K1-K5**
V	Online: Cloud computing for data creation, modification and storage; Search - Internet search - Browser and browser settings; E-mail - Account creation, settings and sharing files; Web - Online Web Page Creation & Edition (yolasite.com, weebly.com) (Wiki).	**6**	**CO 1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

References (3 – 5)

Online support and youtube support for learning MS Office, Libre Office, Zoho, Irfanview, Adobe-Photoshop, Audocity, Blender, wiki and google search engines.

(This is required to keep updated with the changes, updates and upgrades).

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	**PO 2**	**PO 3**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	
CO 1		3			3									3	K1
CO 2		3			3									3	K2

CO 3		3			3									3	K3
CO 4		3			3									3	K4
CO 5		3			3									3	K5
Wt. Avg.		3			3									3	
Overall Mapping of the Course														3	

Paper 13a HORTICULTURE

Course Code	**211BO6M01**		
Credits	**5**		
Hours / Cycle	**75**		
Category	**Part**	**Core**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2012-'22 onwards**		
Course Objectives	**To enable students to understand the theoretical and practical skills and the nuances of growing plants for aesthetic and commercial purposes.**		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	relate horticulture and its relevance to societal and market.	PSO-3, PSO-5	**K1**
CO 2	understand plant needs and providing Infrastructure to have controlled and intensive yield.	PSO-3, PSO-5	**K2**
CO 3	identify plant propagation techniques.	PSO-1, PSO-5	**K3**
CO 4	Analyse landscape principles and elements with value addition.	PSO-3, PSO-5	**K4**
CO 5	Compare the origin of Plants and its economic significance.	PSO-1	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to the importance of Horticulture. Market potential for horticultural products. Home garden to meet household demands. Nutritional and economic benefits of home gardens.	**15**	**CO1-5**	**K1-K5**
II	Infrastructure for large scale production. Greenhouse:- Concepts of Humidity, Light, Temperature and weather and its control. Irrigation:- Water and nutrient management Inorganic and Organic (Vermicompost, Panchakavya). Soil and other media, Soilless culture - Hydroponics. Forcing:- Induction of flowering through Physical / Chemical control. Structures:- Seed germination box, Pro tray and Poly tunnel.	**15**	**CO1-5**	**K1-K5**
III	Plant Propagation:- Selection of elite plants based on specific feature(s). Asexual Propagation: Cuttings, Grafting, Layering, Bulbs, Rhizomes and Tubers, Micropropagation and Root induction. Sexual Propagation:- Seed setting, Methods to control and enhance seed germination, Seed germination and Embryo culture. Concept and scope of plant breeding.	**15**	**CO1-5**	**K1-K5**
IV	Components of Design. Layout and Design of garden for growing Vegetable, Flower and Mixed garden. Raised Bed Garden, Container	**15**	**CO1-CO5**	**K1-K5**

	Garden. Nutritional value of common Vegetables and Fruits. Value addition for ornamental and horticultural products.			
V	Vegetables, Flowers and Fruits: Classification, Source of origin ,Cultivation and Trade (Moringa, Amaranth, Tomato, Rose, Jasmine, Gerbera, Mango, Banana and Jackfruit). Hybrid seeds: Crossing. Seedless variants: Commercial Importance. GM crops: Environmental impact.	**15**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- KUMAR, N.1997. Introduction to Horticulture. 6th ed. Rajalakshmi Pub. Nagerkoil. South India.
- RANDHAWA AND A. MUKHOPADYAY. 1986. Floriculture in India. Allied Pub. Pvt. Ltd. New Delhi.
- RANJIT, S. 1992. Fruits. 2nd ed. National Book Trust. New Delhi.
- RAO,K.M. 1991. Text book of Horticulture. MacMillan India Ltd. New Delhi.
- TIWARI, G.N. and R.K. GOYAL. Green House Technology - Fundamentals, design, modeling and application. Narosa publishing house. New Delhi. **References (3 – 5)**
- GEORGE E.F., AND P.D.SHERINGTON. 1984. Plant Propagation by Tissue Culture. Exegectics Ltd. England.
- GORER, R. 1978. The growth of gardens, Faber and Faber. London.
- GRAF,A.B. 1981. Tropica, 2nd ed. Roehrs Co. USA.
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- TORRES, C.K. 1989. Tissue Culture Techniques for Horticultural Crops. Van Nostrand Reinhold. New York.

Suggested Reading (2 -5)

- ADAMS,C.R., K.M.BANFORD AND M.P.EARLY. 1993. Principles of Horticulture. Butternorth Heineman Ltd. London.
- AGRAWAL, P.K. 1993. Handbook of seed testing. Dept. of agriculture and cooperation. National Seed Corporation. Ltd. New Delhi.
- CAROL, C. BASKIN and JERRY, M. BASKIN. 1998. Seeds - Ecology, biogeography and evolution of dormancy and germination. Academic press.
- EDMOND, J.B., T.L. SENN, F.S. ANDREWS and R.G. HALFACRE. 1977. Fundamentals of Horticulture Fourth Edition. Tata McGraw-Hill. New Delhi.
- HARTMAN,H.T., AND D.E. KESTLER. 1976. Plant Propagation: Principles and practices. Prentice & Hall of India. New Delhi.
- JANICK JULES. 1979. Horticulture Science. 3rd ed. W.H. Freeman and CO. San Francisco. USA.
- LEILA DHANDA. 1984. Bonsai Culture. Oxford and IBH publishing Co. New Delhi.
- MARCEL DEKKAR. 1999. Handbook of Agriculture. Idea books. New York.
- MAYER, A.M., AND A. POLJAKOFF. MAYBER. 1975. The germination of seeds. 2nd ed. Pergamon press. Ltd. U.K.
- PRUTHI, J.S. 1976. Spices and condiments. National Book Trust. New Delhi.
- TUNWAR,N.S. AND S.V. SINGH. 1988. Indian minimum seed certification standards. The Central Seed Certification Board. Govt. of India. New Delhi.

Web Resources (3-5)

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1		3		3							3		3	K1
CO 2		3		3							3		3	K2
CO 3		3		3					3				3	K3
CO 4		3		3							3		3	K4
CO 5		3							3					K5
Wt. Avg.		3		3					3		3		3	
											Overall Mapping of the Course			3

Paper 14a PLANT ECOLOGY AND CONSERVATION BIOLOGY

Course Code	**211BO6M02**		
Credits	**5**		
Hours / Cycle	**90**		
Category	**Part**	**Core**	**Theory**

Semester	VI
Year of Implementation	From the academic year 2021 onwards (this is required as some of the courses may not be revised during particular revision)
Course Objectives	To enable students to gain knowledge about forest conservation and uses of remote sensing

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall about the ecosystem.	**PSO2**	**K1**
CO 2	compare different energy cycles and phenology Patterns.	**PSO2**	**K2**
CO 3	identify the major forest types and their management principles.	**PSO2**	**K3**
CO 4	examine the importance of biodiversity and its conservation	**PSO2**	**K4**
CO 5	explain current advances in remote sensing technology and its applications.	**PSO2**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Ecosystem concept. Structure and function. Abiotic and biotic components; Autotrophs and heterotrophs. Energy flow models, Food chain, Food web, Ecological Pyramids-types. Ecological succession (primary and secondary succession). Cycling of carbon, nitrogen and phosphorous in an ecosystem.	**16**	**CO1-5**	**K1-K5**
II	Habitat specialists and habitat generalists. Grasslands, Mangroves and Deep Sea Communities. Soil ecology: Definition, climatic factors - light, temperature and precipitation. Edaphic factors: soil profile, soil formation, soil classification, soil erosion and soil conservation.	**17**	**CO1-5**	**K1-K5**
III	Plant-herbivore relationship: Co-evolution, Keystone species-competition, predation, parasitism, commensalism and mutualism. Phenology - Flowering and Fruiting episodes. Pollination and dispersal. Pollinator guilds. Forests and their importance. Forest types of India with special reference to Tamil Nadu. Bioprospecting and Biopiracy.	**17**	**CO1-5**	**K1-K5**
IV	Biological conservation: Principles of conservation, In situ and ex situ conservations. World heritage sites, Biosphere reserves, National Parks, Sanctuaries and Sacred Groves. Conservation of biodiversity with special reference to India. Major and minor forest products. Afforestation and Agroforestry. Silviculture of Teak. Quadrant techniques. Brief account of the following: UNEP, IUCN, WWF, CBD, BGCI, NBF.	**20**	**CO1-5**	**K1-K5**
V	Remote Sensing: Principles of remote sensing. The electromagnetic spectrum. Data acquisition platforms. Sensors-types - Geographical Information System (GIS) and Ground truth. Data input and output in GIS. False Colour Composites (FCC). Applications of Remote sensing.	**20**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

- EUGENE P. ODUM and GRAY W. BARRETT. 2009. Fundamentals of Ecology. Fifth Edition.
- MICHAEL P. 1984. Ecological Methods for Field and Manual Laboratory Investigations.

Course Articulation Matrix

Course Outcome	Programme Outcomes	Programme Specific Outcomes	Cognitive Level

s	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1		3									3				K1
CO 2		3									3				K2
CO 3		3									3				K3
CO 4		3									3				K4
CO 5		3									3				K5
Wt. Avg.		3									3				
													Overall Mapping of the Course	3	

Tata McGraw Hill Publishing Company Limited, New Delhi.

References

- AULAY MACKENZIE, ANDY S. BALL and SONIA R. VIRDEE. 2002. Ecology – Instant Notes. Second Edition. Viva Books Pvt Ltd, New Delhi.
- GEORGE JOSEPH. 2005. Fundamentals of Remote Sensing by jGeorge Joseph Edition II. University Press private limited.

Suggested Reading

- SHARMA. P.D. 2003. Environmental Biology and Toxicology. Second Edition. Rakesh KUMAR Rastogi for Rastogi Publications, Gangotri Shivaji Road, Meerut.
- RICHARD T. WRIGHT and DOROTHY F. BOORSE. 2010. Environmental Science Toward a Sustainable Future. 11th Edition. PHI Learning Private Limited, New Delhi.
- KUTTY, R., and KOTHARI, A. 2001. Protected areas in India – A profile. KalpavrikshMoEF. New Delhi, India.
- YANNEY, E. 1985. Elements of Ecology. ELBS Publication. Heinemann Educational Books**.**

Web Resources (3-5)

Paper 15a PLANT PHYSIOLOGY AND BIOCHEMISTRY

Course Code	**211BO6M03**		
Credits	**5**		
Hours / Cycle	**90**		
Category	**Part**	**Core**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2021 onwards (this is required as some of the courses may not be revised during particular revision)**		
Course Objectives	**To study the transport of water and inorganic nutrients in plants.** **To get acquainted with the role of Plant hormones in growth and development.** **To understand the reactions of metabolic pathways and functional role of enzymes.**		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	find the main themes of Plant Physiology and Biochemistry. Determine the structure and functional relationships in water and nutrient uptake by plants.	**PSO1&3**	**K1**
CO 2	demonstrate an understanding of plant hormones in regulation of growth and development. Understand the function of biomolecules.	**PSO3**	**K2**
CO 3	identify the role of enzymes in biochemical reaction process.	**PSO3**	**K3**
CO 4	analyse metabolic pathways and the regulation of biochemical process.	**PSO3**	**K4**

CO 5	evaluate the biochemical reactions involved in the formation of ATP and assimilation of Nitrogen in plants.	**PSO3**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Definition and Scope of Plant Physiology. Water relations in plants, Significance of Water in plants, Water potential, imbibition, Diffusion and Osmotic relations. Absorption of water and Ascent of sap. Transpiration, Significance of transpiration. Distribution of stomata, structure, opening and closing of stomata with reference to physiological factors. Factors affecting transpiration. Specific functions of macro elements and micro elements and their deficiency symptoms. Mechanism of mineral salt absorption.	**16**	**CO1-5**	**K1-K5**
II	Biosynthesis and Physiological effects of auxins, gibberellins, cytokinins, ethylene and ABA. Photoperiodism and flowering, vernalization and seed dormancy. Plant movements.	**17**	**CO1-5**	**K1-K5**
III	Nomenclature, classification and biological functions of enzymes. Michaelis-Menten equation. Enzyme inhibition. Factors affecting enzyme activity. Structure and Classification of carbohydrates, protein and lipids.	**17**	**CO1-5**	**K1-K5**
IV	Electromagnetic spectrum, interaction of light waves and excitation of pigment molecules. Ultrastructure of chloroplast. Pigments involved in photosynthesis. Absorption spectrum, Emerson enhancement effect and the involvement of PSI andPS II. Photophosphorylation reactions. CO2 assimilation pathways: C3, C4 and CAM pathways. Factors affecting photosynthesis.	**20**	**CO1-5**	**K1-K5**
V	Aerobic and anaerobic respiration. Respiration quotient. Glycolysis, Kreb's cycle and oxidative phosphorylation reactions. Chemiosmotic ATP synthesis. Factors affecting respiration. Sources of nitrogen, nitrate and nitrite reduction. N2 and ammonia assimilation in higher plants.	**20**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

- BALA MANJU, GUPTA SUNTA, N.K. GUPTA AND M.K. SANGA. 2013. Practical's in Plant Physiology and Biochemistry. Scientific Publishers, Jodhpur.
- DAVID HAMES AND NIGEL HOOPER. 2005. Instant Notes Biochemistry. 3rd Edition. Taylor and Francis group.
- DEVLIN, R.M. AND F.H. WITHAM. 1983. Plant Physiology. Willard Grant Press. U.S.A.
- JAIN, V.K. Fundamentals of Plant Physiology. 2012 (Revised). S. Chand Group Company.
- KUMAR, A., S.S. PUROHIT AND S.S. PUROHIT. 2002. Fundamentals and applications of Plant Physiology. 2nd edition. Agrobios India Ltd.

References

- BUCHANAN, B. B., W. REUISSEM AND R. L. JONES. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologist, Rockwell, Maryland, USA.
- ELLIOT, W, H. AND D. C. ELLIOT. 1997. Biochemistry and Molecular Biology. Oxford University Press, New York. USA.
- HANS-WALTER HELDT AND BIRGIT PIECHULLA. 2010. Plant Biochemistry. 4th edition. Academic Press.
- NELSON, D.L. AND M. M. COX. 2005. Lehninger Principles of Biochemistry, Fourth Edition, W.H. Freeman and Company, New York.

Suggested Reading

- HOPKINS, W.G. and P.A. HUNER. 2008. Introduction to Plant Physiology. John Wiley and Sons.
- LINCOLN TAIZ AND EDUARDO ZEIGER. 2010. Plant Physiology. Fourth Edition. Sinauer Associates Inc.
- RASHID, A. 2009. Molecular Physiology and Biotechnology of flowering plants. Narosa Publishing House.
- SALISBURY, F.B. AND C. ROSS. 1991. Plant Physiology. Wadsworth Publishing Company. Belmont.

Web Resources (3-5)

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1			3							3		3			K1
CO 2			3									3			K2

CO 3			3									3			K3
CO 4			3									3			K4
CO 5			3									3			K5
Wt. Avg.			3							3		3			
												Overall Mapping of the Course		3	

Paper 16a COMBINED PRACTICAL: HORTICULTURE, PLANT ECOLOGY AND CONSERVATION BIOLOGY & PLANT PHYSIOLOGY AND BIOCHEMISTRY

Course Code	211BO6M04		
Credits	5		
Hours / Cycle	160		
Category	Part 12a	Core	Practical
Semester	VI		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	**To facilitate the practice and learning of small garden to make students understand the nuances of caring for plants.** **To make students do a sample field with vegetable and ornamental plant garden.** **To gain practical learning of the environmental factors like pH, relative humidity, soil temperature, etc.** **To facilitate the practical learning of the Physiological and Biochemical process in plants through simple experiments and demonstration.**		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	define relative humidity.	**PSO2**	**K1**
CO 2	demonstrate phenological spectrum.	**PSO1**	**K2**
CO 3	experiment with phenological spectrum.	**PSO2**	**K3**
CO 4	analyse biomolecules using chromatography techniques.	**PSO3**	**K4**
CO 5	evaluate biomolecules using chromatography techniques.	**PSO3**	**K5**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**Cos**	**BLOOM'S TAXONOMY LEVEL**
I	HORTICULTURE: Development of a small composite garden in the department premises (5-8-member group). Important aspects of garden with observation and inference (weekly submission). Garden implements and tools. Soil (sand, clay, farm yard manure, peat etc.). Layout (drainage, light, aeration, aesthetics etc.). Propagation (seed, cutting, bulbs, corms etc.). Garden (vegetable, flower, foliage etc.). Irrigation (Concepts). Maintenance (Fertilizer, pest & weed	**30**	**CO1-5**	**K1-K5**
	management -Organic and physical). Yield analysis (input cost, space, duration, weight/volume). Enhancement (Pruning, mowing, thinning, Bonsai etc.). Product outlet - Raw/ processed material- Packing, Transportation and Marketing. Survey and report on. (Examples): Fruit, Vegetables, Flowers, Seeds, Ferns, Irrigation, Lawn, Weeds, Tools, Pests, Diseases, Floral decoration and Preservation			

II	PLANT PHYSIOLOGY AND BIOCHEMISTRY Determination of water potential by Plasmolytic method. Determination of the permeability of cell membrane. Effect of environmental factors on the rate of transpiration by Ganong's Potometer/Simple Potometer. Qualitative measurement of transpiration by cobalt chloride method. Effect of quality and intensity of light on photosynthesis.Determination of respiration by Ganong's respiroscope. Effect of light and dark conditions on seed germination. Spotters on the physiological effects of plant growth regulators (PGR). Qualitative tests for reducing sugars, starch and amino acids. Separation of photosynthetic leaf pigments by paper chromatography. Determination of the activity of enzyme amylase on starch	**60**	**CO1-5**	**K1-K5**
III	PLANT ECOLOGY AND CONSERVATION BIOLOGY Ecological adaptations in morphology and anatomy of hydrophytes and xerophytes.Identification and study of local selected species as examples. Construction of Ombrothermic diagrams and identification of bioclimates using meteorological data. Construction of Raunkier's frequency diagram using the provided sample vegetation data. Determination of Primary productivity of forest biomass. Determination of relative humidity using wet and dry bulb thermometer. Determination of soil characteristics like soil temperature, pH, colour, texture, soil moisture, etc. Determination of water characteristics like water temperature, pH, Total Dissolved Solids (TDS), etc. Mapping of forest types, biosphere reserves and important National parks of India. Diagrammatic representation of Terrestrial and Aquatic food chain. Photographs of Remote sensing.	**60**	**CO1-5**	**K1-K5**

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO 1			3							3				K1
CO 2			3						3					K2
CO 3			3							3				K3
CO4			3								3			K4
CO5			3								3			K5
Wt. Avg.			3						3	3	3			
Overall Mapping of the Course												3		

TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY RIGHTS

Course Code	211BO6MO5		
Credits	**3**		
Hours / Cycle	**45**		
Category	**Part**	**Elective**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2021-2022 onwards**		
Course Objectives	To introduce the students with basic concepts of Traditional Knowledge (TK) and Intellectual Property Rights, commercial applications and the legal approaches to protect the TK.		

CO #	**Course Outcome(s) Upon the completion of this course, students will be able to**	**PSO Addressed**	**Bloom's Taxonomy Levels**
			(K1 to K5)
On completing the course successfully, the student will be able to			

CO 1	recall the concepts and terminology of traditional knowledge and intellectual property rights.	PSO1	**K1**
CO 2	explain the commercial use of traditional knowledge in various industrial products.	PSO1	**K2**
CO 3	make use of various case studies of the misappropriation of Traditional Knowledge.	PSO1	**K3**
CO 4	analyze the legal mechanism to protect traditional knowledge.	PSO1	**K4**
CO 5	Assess the significance of traditional knowledge and the method of protection systems.	PSO1	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Terminology: Traditional Medicinal Knowledge (TMK), Traditional Ecological Knowledge (TEK), Indigenous Traditional Knowledge (ITK), Indigenous Agricultural Knowledge (IAK), Indigenous Botanical Knowledge (IBK). Understanding terms such as Tradition and Indigenous and their implications. Traditional Knowledge Digital Library (TKDL).	5	**CO1-5**	**K1-K5**
II	Commercial Uses of Traditional Knowledge in Pharmaceuticals, Agriculture, Cosmetics, and Industrial Products. Access of Bioresources and Associated knowledge and Benefit Sharing.	10	**CO1-5**	**K1-K5**
III	Case studies of misappropriation of Traditional Knowledge: Turmeric, Basmati, Hoodia, Zinger.	10	**CO1-5**	**K1-K5**
IV	Intellectual Property Protection Systems. Copy Rights, Industrial Designs, Trade Marks, Patents and Geographical Indication and their application.	10	**CO1-5**	**K1-K5**
V	Legal Mechanisms and Traditional Knowledge. CBD, NBA, PPvFR, Indian Patent Act and Amendments. Bioethics.	10	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- APTE, T. 2006. Intellectual Property Rights, Biodiversity and Traditional Knowledge. Kalpavriksh, Grain & IIED, Pune / New Delhi.
- JAIN, S.K. AND V. MUDGAL. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, DehraDun.
- JAIN, S.K. 1989. Methods and Approaches in Ethnobotany. Society of Ethnobotanists. Lucknow.

References (3 – 5)

- DUTHFIELD, G. 2004. Intellectual Property, Biogenetic Resources and Traditional Knowledge. Earthscan, London, UK.
- HEYWOOD, V.H. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U.K.
- KATE, K. T., S. A. LAIRD. 2000. Commercial Use of Biodiversity. Earth Scan, London, UK.

Suggested Reading (2 -5)

- AKERELE, O., V. HEYWOOD, AND H. SYNGE. 1991. The conservation of Medicinal Plants. (Ed.) Cambridge University Press. Cambridge.
- CUNNINGHAM, A.B. 1993. Ethics, Ethnobiological Research, and Biodiversity. WWF. International Publication. Switzerland.
- LAIRD, S.A. 2002. Biodiversity and Traditional knowledge equitable partnerships in Practice. EarthScan Publications Ltd., London.
- MINISTRY OF ENVIRONMENT AND FORESTS. 1994. Ethnobiology in India. A Status Report. All India Coordinated Research Project on Ethnobiology. Ministry of Environment and Forests. New Delhi.

	Course Articulation Matrix															
Course Outcomes	**Programme Outcomes**									**Programme Specific Outcomes**						**Cognitive Level**
	PO 1	**PO 2**	**PO 3**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	
CO 1	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	**K1**
CO 2	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	**K2**
CO 3	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	**K3**

CO 4	-	3	-	-	-	-	-	-		3	-	-	-	-	-	**K4**
CO 5	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	**K5**
Wt. Avg.	-	**3**	-	-	-	-	-	-	-	**3**	-	-	-	-	-	-
	Overall Mapping of the Course													3		

Paper 3b PHARMACOGNOSY

Course Code	211BO6M06		
Credits	**3**		
Hours / Cycle	**45**		
Category	**Part**	**Elective**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2021-2022 onwards**		
Course Objectives	To introduce the concepts and importance of Pharmacognosy. To get acquainted with plant drug evaluation and adulteration. To identify the phytochemicals, present in various parts of the plants. The course intends to provide students with information about applications of secondary metabolites in modern medicine.		

CO #	Course Outcome(s) Upon the completion of this course, students will be able to	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
	On completing the course successfully, the student will be able to		
CO 1	outline the concept and scope of Pharmacognosy.	PSO1	**K1**
CO 2	understand the classification of Crude drugs.	PSO1	**K2**
CO 3	learn about the sources and therapeutics of plant based crude drugs.	PSO1	**K3**
CO 4	classify the different types of Secondary Metabolites.	PSO1	**K4**
CO 5	discuss on the application of Secondary Metabolites in modern medicine.	PSO1	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Definition, inter-disciplinary nature and scope of pharmacognosy. A general account on Ayurveda, Siddha, Homeopathy and Unani systems of medicine.	5	**CO1-5**	**K1-K5**
II	Organized and unorganized crude plant drugs. Classification of plant drugs - morphological, taxonomical and chemical methods. Plant drug evaluation and adulteration - organoleptic, microscopical, physical, chemical and biological methods.	10	**CO1-5**	**K1-K5**
III	Study of the following plant drugs with special reference to botanical description, active principles and therapeutic uses: Rauwolfia serpentina (root), Curcuma longa(rhizome), Cinnamomum zeylanicum (bark), Santalum album (wood), Senna auriculata(flowers), Coriander sativum, (seeds) and Moringa pterigosperma (leaves). Unorganized drugs - Acacia nilotica (Gum Arabic), Syncarpia glomulifera (Turpentine) and Ricinus communis (Castor oil).	10	**CO1-5**	**K1-K5**

IV	Introduction, definition, classification, identification test and distribution of phytochemicals: alkaloids, glycosides, tannins, flavonoids, terpenoids, volatile oils, steroids, resins, gums, mucilage and latex.	10	**CO1-5**	**K1-K5**
V	Study of plant metabolites used in modern medicine, nutraceuticals and cosmetics. Plant sources mentioned in Unit IV.	10	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- APTE, T. 2006. Intellectual Property Rights, Biodiversity and Traditional Knowledge. Kalpavriksh, Grain & IIED, Pune / New Delhi.
- JAIN, S.K. AND V. MUDGAL. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, DehraDun.
- JAIN, S.K. 1989. Methods and Approaches in Ethnobotany. Society of Ethnobotanists. Lucknow.

References (3 – 5)

- DUTHFIELD, G. 2004. Intellectual Property, Biogenetic Resources and Traditional Knowledge. Earthscan, London, UK.
- HEYWOOD, V.H. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U.K.
- KATE, K. T., S. A. LAIRD. 2000. Commercial Use of Biodiversity. Earth Scan, London, UK.

Suggested Reading (2 -5)

- AKERELE, O., V. HEYWOOD, AND H. SYNGE. 1991. The conservation of Medicinal Plants. (Ed.) Cambridge University Press. Cambridge.
- CUNNINGHAM, A.B. 1993. Ethics, Ethnobiological Research, and Biodiversity. WWF. International Publication. Switzerland.
- LAIRD, S.A. 2002. Biodiversity and Traditional knowledge equitable partnerships in Practice. EarthScan Publications Ltd., London.
- MINISTRY OF ENVIRONMENT AND FORESTS. 1994. Ethnobiology in India. A Status Report. All India Coordinated Research Project on Ethnobiology. Ministry of Environment and Forests. New Delhi.

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes						Cognitive Level
	PO 1	**PO 2**	**PO 3**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	
CO 1	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	**K1**
CO 2	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	**K2**
CO 3	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	**K3**
CO 4	-	3	-	-	-	-	-	-		3	-	-	-	-	-	**K4**
CO 5	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	**K5**
Wt. Avg.	-	**3**	-	-	-	-	-	-	-	**3**	-	-	-	-	-	-
	Overall Mapping of the Course													**3**		

M.Sc.(va)
PLANT BIOLOGY AND PLANT BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS)
LOCF SYLLABUS (2023-2025)

DEPARTMENT OF BOTANY

Madras Christian College (Autonomous)
B.Sc.(va) Plant Biology and Plant Biotechnology
Curriculum 2021-2022 – CBCS

STRUCTURE OF CBCS FOR PG - 2021 ONWARDS						
SEMESTER I						
Component		**Course**	**Code**	**Hours**	**Credit**	**Marks** ICA+ESE
A. MAJOR – CORE						
1a	Major Core	Mycology and Plant Pathology - Theory	232BO1M01	5	4	50+50
2a	Major Core	Bryology, Pteridology and Gymnospermology - Theory	232BO1M02	5	4	50+50
3a	Major Core	Research Methodology, Instrumentation and Biostatistics – Theory	232BO1M03	5	4	50+50
4a	Major Core	Mycology and Plant Pathology, Bryology, Pteridology, Gymnospermology & Research Methodology, Instrumentation and Biostatistics – Practical	232BO1M04	4 4 3	5	50+50
1b	Major Elective	Ethnobotany / Pharmacognosy – Theory	232BO1E01/ 232BO1E02	4	5	50+50
			Core	15	212BO1E02	
			Elective	4	5	
			Sub Total	26	22	

STRUCTURE OF CBCS FOR PG - 2021 ONWARDS						
SEMESTER II						
Component		**Course**	**Code**	**Hours**	**Credit**	**Marks** ICA+ESE
A. MAJOR – CORE						
5a	Major Core	Biodiversity and Conservation Biology – Theory	212BO2M01	6	5	50+50
6a	Major Core	Algal Biology and Biotechnology – Theory	232BO2M02	5	4	
7a	Major Core	Genetics and Molecular Biology - Theory	232BO2M03	5	4	
8a	Major Core	Algal Biology and Biotechnology & Genetics and Molecular Biology - Practical	232BO2M04	4 4	4	
2b	Major Elective	Microbial Technology / Phycotechnology – Theory	232BO2E01	4	5	50+50
			Core	16	17	
			Elective	4	5	
			Sub Total	24	22	

STRUCTURE OF CBCS FOR PG - 2021 ONWARDS						
SEMESTER III						
						Marks

M.Sc. - PLANT BIOLOGY AND PLANT BIOTECHNOLOGY

Component		Course	Code	Hours	Credit	ICA+ESE
MAJOR – CORE						
9a	Major Core	Angiosperms Systematics – Theory	232BO3M01	5	5	50+50
10a	Major Core	Plant Physiology and Biochemistry - Theory	232BO3M02	5	5	50+50
11a	Major Core	Ecology, Forestry and Remote Sensing - Theory	232BO3M03	5	4	50+50
12a	Major Core	Angiosperms Systematics, Plant Physiology and Biochemistry & Ecology, Forestry and Remote Sensing - Practical	232BO3M04	2 4 3	4	50+50
3b	Major Elective	Bioinformatics / Nanobiotechnology – Theory	232BO3E01	4	5	50+50
SOFT SKILL						
	Soft Skill	Personality Development			8	
			Core	15	18	
			Elective	4	5	
			Sub Total	24	23	

STRUCTURE OF CBCS FOR PG - 2021 ONWARDS

SEMESTER IV

Component		Course	Code	Hours	Credit	Marks ICA+ESE
A. MAJOR – CORE						
13a	Major Core	Biotechnology, Plant Tissue Culture and Crop Improvement – Theory	232BO4M01	5	5	50+50
14a	Major Core	Plant anatomy, Embryology and Palynology - Theory	232BO4M02	5	4	50+50
15a	Major Core	Biotechnology, Plant Tissue Culture and Crop Improvement & Plant anatomy, Embryology and Palynology - Practical	232BO4M03	4 4	4	50+50
16a	Major Core	Project (Dissertation)	232BO4M04	8	5	50+50
4b	Major Elective	(i) Application of plant tissue culture in Biotechnology (ii) Bioprospecting of Algae (iii) Ecology and Environment (iv) Fungal Biology and Biotechnology (v) Genetics (vi) Palynology (vii) Phytochemistry (viii) Plant Histochemistry (ix) Plant Taxonomy	232BO4E01 232BO4E02 232BO4E03 232BO4E04 232BO4E05 232BO4E06 232BO4E07 232BO4E08 232BO4E09	4	5	50+50
			Core	15	18	
			Elective	4	5	
			Sub Total	31	23	

a- Core, b-Elective

SEMESTERS	I	II	III	IV	TOTAL
CREDITS	17	17	18	18	70

Number of credits

Core = 70 Credits
Elective = 20 Credits
Soft Skill = 8 Credits
Internship = 2 Credits
Total = 100 Credits

Programme Specific Outcomes of M.Sc. (va) - Plant Biology and Plant Biotechnology		
PSO No:	Programme Specific Outcomes Students of M.Sc. Plant Biology and Plant Biotechnology will be able to.	POs addressed
PSO – 1	Comprehend the morphology, anatomy, development, life cycle, classification and economic & ecological significance of different Algae, Fungi and Non - Flowering Plants.	PO1
PSO – 2	Describe, identify, name and classify flowering plants based on Morphology, Anatomy & Molecular Phylogeny and list the Ethno-botanical & Economic importance of different families.	PO1
PSO – 3	Discuss on various ecosystems and forest types and the role of GIS and remote sensing in management and conservation of natural resources.	PO1, PO6
PSO – 4	Evaluate the process of transport, growth and development in plants from biochemical, biotechnological and environmental perspectives.	PO1
PSO – 5	Perceive the structure, property and functions of nucleic acids and proteins and their applications in molecular biology, biotechnology and in silico studies.	PO1, PO2, PO5
PSO – 6	Formulate and carry out independent research projects acquiring laboratory and field expertise both in the classical and applied areas of Plant Sciences.	PO1, PO2, PO3, PO4, PO5

Syllabus Revision Details

Subject Code	Subject Name	Type of Change	Percentage of change
232BO1E01	Ethnobotany	Revised	20
232BO1E02	Pharmacognosy	New	100
232BO1M02	Bryology, Pteridology and Gymnospermology	Revised	45
232BO1M01	Mycology and Plant Pathology	Revised	15
232BO1M03	Research Methodology, Instrumentation and Biostatistics	Revised	60
232BO1M04	Practicals Mycology and Plant Pathology, Bryology, Pteridology, Gymnospermology and Research Methodology, Instrumentation and Biostatistics	Revised	20
232BO2M02	Algal Biology and Biotechnology	Revised	40
232BO2M01	Biodiversity and Conservation Biology	Revised	20
232BO2M03	Genetics and Molecular Biology	Revised	20
232BO2E01	Microbial Technology (Optional)	Revised	15
232BO2E02	Phycotechnology (Optional)	New	100
232BO2M04	Practicals Algal Biology and Biotechnology & Genetics and Molecular Biology	Revised	25
232BO3E01	Bioinformatics	Revised	15

232BO3E02	Nanobiotechnology	New	100
232BO3M01	Angiosperms Systematics	Revised	30
232BO3M03	Ecology, Environment, Forestry And Remote Sensing	Revised	35
232BO3M02	Plant Physiology And Biochemistry	Revised	20
232BO3M04	Practicals Angiosperms Systematics, Plant Physiology And Biochemistry & Ecology, Forestry And Remote Sensing	Revised	45
232BO4E01	Application of Plant Tissue Culture in Biotechnology	Revised	25
232BO4E02	Bioprospecting of Algae	Revised	35
232BO4E03	Ecology and Environment	Revised	35
232BO4E04	Fungal Biology and Biotechnology	New	100
232BO4E05	Genetics	Revised	50
232BO4E06	Palynology	Revised	29
232BO4E07	Phytochemistry	New	100
232BO4E08	Plant Histochemistry	Revised	30
232BO4E09	Plant Taxonomy	Revised	20
232BO4M01	Biotechnology, Plant Tissue Culture and Crop Improvement	Revised	30
232BO4M02	Plant Anatomy, Embryology and Palynology	Revised	30
232BO4M03	Practical Biotechnology, Plant Tissue Culture And Crop Improvement &Plant Anatomy, Embryology And Palynology	Revised	30
232BO4M04	Project		

Paper 1a Core Theory: MYCOLOGY AND PLANT PATHOLOGY

Course Code	212BO1M01		
Credits	4		
Hours / Cycle	75		
Category	Part	Core	Theory
Semester	I		
Year of Implementation	2021-2022 onwards		
Course Objectives	To equip the students to distinguish various fungal forms, recognize its role and potential. Gain knowledge on plant disease, effects and its management.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	define the position of fungi in the classification of life forms, how it has evolved and to Distinguish different group of fungi to genus level	PSO-1	**K1**
CO 2	understand the distinguishing characteristic feature with reference to its structure, development, reproduction of Fungi	PSO-1	**K2**
CO 3	identify the different associations in fungi and to recognize the importance of fungi in day today life and its commercial potential.	PSO-1	**K3**
CO 4	analyse the disease, its types, agents and management, mechanism of infection, interactions and effect during disease	PSO-1	**K4**

CO 5	explain the inbuilt mechanism of defense in plants and role of environment in disease development	PSO-1	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	A general account of fungi, their nature, distribution, structural variation, development, modes of reproduction, patterns of life cycle. A general knowledge of heterothallism and hormonal mechanism of sexual reproduction. A critical reference to the position of fungi in recent classification of the plant and other kingdoms. Classification of fungi as given by Alexopoulous and Higher level phylogenetic classification (Hibbett).	**17**	**CO1-5**	**K1-K5**
II	Occurrence, distribution, somatic structure, reproduction and life cycle of Myxomycota (*Physarum*), Plasmodiophoromycota (*Plasmodiophora*), Oomycota (*Pythium*), Chytridiomycota (*Synchytrium*), Zygomycota (*Rhizopus, Pilobolus*), Ascomycota (*Peziza*), Basidiomycota (*Polyporus Puccinia*) and Deuteromycota (*Colletotrichum*) *Aspergillus.*	**15**	**CO1-5**	**K1-K5**
III	Lichen: Diversity, types, classification & its use in environment. *Parmelia* &*Usnea*Mycorrhizae: Types, occurrence & its use in agriculture and bioremediation, *Pisolithus, Glomus.* Importance of fungi in academy and industries. Cultivation of Mushrooms.	**13**	**CO1-5**	**K1-K5**
IV	A General account of plant diseases caused by mycoplasma, bacteria, viruses & fungi. Causes of plant diseases, Mechanism of infection; inoculum potential, penetration, infection, factors governing infection. Symptoms and identification of plant diseases. Host – parasite interaction: Effect of infection on the physiology of the host, role of toxins in pathogenesis. Effect of environment on pathogenesis.	**17**	**CO1-5**	**K1-K5**
V	Defense mechanism in plants. Principles of plant disease management. Control of plant diseases through cultural practices, biological control, genetic methods, fungicides including systemic fungicides and other protectants.	**13**	**CO1-5**	**K1-K5**

Text Books

1. Sharma, P.D. 2005. Fungi & allied organisms. Narosa Publishing House, Delhi
2. Sharma OP. 2006. Text book of fungi. Tata McGraw – hill publishing company ltd, New Delhi. 3. Annie R and Kumerasan V. 2002. Fungi Plant Pathology. Saras publishing Nagerkoil, India
4. GEETHA SUMBALI. 2010. The Fungi. Narosa publishing House pvt ltd.
5. Mehrotra R.S., &Aneja KR.2006. An Introduction to mycology. New age international Pvt. Ltd.
6. MEHROTRA, R.S. 1980. Plant pathology. Tata McGraw Hill Publishing Company Ltd,
7. SINGH. R.S. 1980. Introduction to Principles of Plant Pathology. III - Edition. Oxford. Sons, New York.

Suggested Reading

1. AINSWORTH, G.C., F.K. SPARROW, AND A.S. SUSSMAN (Eds.). 1965 - 1975. The Fungi and advanced treatise. Vol. I - IV. G.L. Academic press, New York and London.
2. ALEXOPOLOUS, C.J and C.W. MISRA. 1972. Introductory mycology. John Wiley and
3. Bisby's Dictionary of the Fungi. 7th Edition. Commonwealth Mycological Institute. Kew. England.
4. BURNETT, J.H. 1976. Fundamentals of mycology. Edward Arnold Publishers, London.
5. Commonwealth Mycological Institute, Kew. U.K.
6. COOKE, W.B. 1979. The ecology of fungi. C.R.C. Press. Inc., Florida.
7. KIRK PM. CANNON PF, MINTER DW AND STALPERS JA.2011. Ainsworth and Bibsy'sDictionary of fungi. 10thEdition. CPI group International U.K.
8. MORRE - LANDECKER. 1972. Fundamentals of the fungi. Prince Hall Inc, New Jersey.
9. New Delhi.
10. SUBRAMANIAN, C.V. 1983. Hyphomycetes, taxonomy and biology. Academic press,
11. TALBOT, P.H.B. 1971. Principles of fungal taxonomy. Macmillan Press Ltd, London.
12. WEBSTER, J and WEBER, R.W.S. 2007. Introduction to Fungi. Cambridge University Press, UK

Web Resources:

1. https://www.indexfungorum.org/
2. https://eol.org/
3. https://www.catalogueoflife.org/
4. https://www.gbif.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	3									3					K1
CO 2	3									3					K2
CO 3	3									3					K3
CO 4	3									3					K4
CO 5	3									3					K5
Wt. Avg.	3									3					
Overall Mapping of the Course														3	

Paper 2a Core Theory: BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMOLOGY

Course Code	212BO1M02		
Credits	4		
Hours / Cycle	75		
Category	Part	Core	Theory
Semester	1		
Year of Implementation	From the academic year 2021-2022 onwards		
Course Objectives	The students will have an overview and understanding of the structure and interrelationship within and between various forms of cryptogams. Students learn the evolutionary trends in non vascular plants. The students will develop an understanding of diversity, distinctive characteristics and significance of gymnosperms		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall the characteristic features of Bryophytes, Pteridophytes and Gymnosperms.	**PSO 1**	**K1**
CO 2	classify the various lifeforms of Bryophytes, Pteridophytes and Gymnosperms.	**PSO 1**	**K2**
CO 3	identify the various classes of Bryophytes, Pteridophytes and Gymnosperms based on the morphological, anatomical and reproductive characters of extant and extinct forms.	**PSO 1**	**K3**
CO 4	analyse the evolutionary significance, distribution and threats of bryophytes, Pteridophytes and Gymnosperms.	**PSO 1**	**K4**
CO 5	assess the ecological significance of Bryophytes, Pteridophytes and Gymnosperms.	**PSO 1**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	General account of habit, habitat, ecology and distribution of bryophytes. Characteristics of bryophytes as true plants. Classification of bryophytes - Goffinet and Shaw (2009). Distinguishing features of Marchantiophyta, Anthocerotophyta and Bryophyta. Adaptations for land habit. Fossil bryophytes. Phylogeny of bryophytes. Culture of bryophytes. Economic importance.	**15**	**CO1-5**	**K1-K5**
II	Range of vegetative and reproductive structures, modes of reproduction in liverworts (Haplomitriopsida – Calobryales; Marchantiopsida - Sphaerocarpales, Marchantiales; Jungermanniopsida – Fossombroniales, Porellales; Jungermanniales) hornworts (Anthocerotales, Notothyladales); and mosses (Takakiales, Sphagnales, Polytrichalesand Bryales).	**15**	**CO1-5**	**K1-K5**
III	. Features of Seedless Vascular Plants : Organisation of sporophyte, stele, microphylls and megaphylls, homospory, heterospory, gametophytes and embryos. Classification of fossil and living pteridophytes – Smith et al., 2008; Origin and evolution of early vascular plants; Telome Theory. Significance of extinct Divisions: Rhyniophyta (*Rhynia, Cooksonia*); Zosterophyllophyta (*Zosterophyllum*); Trimerophyta (*Trimerophyton*). Selected fossil lycopods (*Asteroxylon, Lepidodendron*), equisetophytes (*Sphenophyllum, Calamites*) and ferns (Coenopteridales).	**15**	**CO1-5**	**K1-K5**
IV	Survey of structure and reproduction in living pteridophytes. Psilotophyta (*Psilotum*); Lycopodiophyta (Lycopodiales, Selaginellales, Isoetales); Equisetophyta (*Equisetum*); Pterophyta (Ophioglossales, Filicales, Marsileales).	**15**	**CO1-5**	**K1-K5**
V	Characteristics of gymnosperms. Classification of gymnosperms (Christenhusz's classification – 2011) and their interrelationships. Distribution of Gymnosperms. Groups of fossil gymnosperms: progymnosperms (*Archaeopteris*), pteridosperms (*Lyginopteris*), glossopterids (*Glossopteris*), cycadeoids (*Williamsonia*), Pentoxylon. Distribution, reproduction and interrelationships of Cycadophyta (*Cycas*), Coniferophyta (*Pinus, Araucauria* and *Taxus*), Ginkgophyta (*Ginkgo*) and Gnetophyta (*Gnetum, Ephedra* and *Welwitchia*). Economic importance of Gymnosperms. Indian contributions to Gymnosperms..	**15**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. BHATNAGAR, S.P., AND A. MOITRA. 1996. Gymnosperms. New Age International Publishers. New Delhi.
2. BIERHORST, D.W. 1971. Morphology of Vascular Plants. Macmillan Publishing Company. New York.
3. BOLD, H.C., C.J. ALEXOPOULOS, T. DELEVORYAS. 1987. Morphology of Plants and Fungi. Harper & Row, Publishers. New York.
4. CHOPRA, R.N., AND P.K. KUMAR. 1988. Biology of Bryophytes. John Wiley. New York.
5. CHOPRA, R.S. 1975. Taxonomy of Indian Mosses. CSIR. New Delhi
6. GOFFINET, B. AND A. J. SHAW. 2009. Bryophyte Biology, 2nd edition. Cambridge University Press, Cambridge.
7. MEYEN, S.V. 1987. Fundamentals of Palaeobotany. Chapman and Hall. London.
8. PANDEY, S.N., P.S. TRIVEDI, AND S.P. MISRA. 1992. A Text Book of Botany. Vol. I & II. 2nd Edition. Vikas Publishing House. New Delhi.
9. PREM PURI. 1986. Bryophytes - Morphology, growth and differentiation. Atma Ram and Sons. Delhi.
10. SPORNE, K. R. 1974. The Morphology of Gymnosperms. B. I. Publications. New Delhi.
11. SPORNE, K. R. 1976. The Morphology of Pteridophytes. B.I. Publications. New Delhi.
12. SMITH, A.J.E. 1982. Bryophyte Ecology. Chapman and Hall. London.
13. SRIVASTAVA, H.N. 2004. *Gymnosperms*. Pradeep Publications, Jalandar, India.
14. VENKATACHALA, B.S., M. SHUKLA AND M. SHARMA. 1992. Plant Fossils - A Link with the Past. Pub. & Information Directorate. New Delhi.

References

1. BECK, C.B. (Ed.). 1988. Origin and Evolution of Gymnosperms. Columbia University Press. New York.
2. DYER, A.F., AND J.G. DUCKETT. 1984. The Experimental Biology of Bryophytes. Academic Press. London.
3. GANGULEE, H.C. 1985. Handbook of Indian Mosses. Amerind Pub. Co., New Delhi.
4. GENSEL, P.G., AND H.N. ANDREWS. 1984. Plant Life in the Devonian. Praeger Publishers. New York.
5. GRAHAM, L.E. 1993. Origin of Land Plants. John Wiley & Sons, Inc. New York.
6. GIFFORD, E.M. AND E.S. FOSTER. 1989. Morphology and Evolution of Vascular Plants. Third Edition. W.H. Freeman and Company. New York.
7. JOHRI, B.M. 1994. Botany in India - History and Progress Vol - I Oxford & IBH Pub. Co. Pvt. Ltd. New Delhi.
8. JONES,D.L. 1993. Cycads of the World - Ancient Plants in Today's Landscape. Smithsonian Institution Press. Washigton. D.C.
9. KAUFMAN, P.B., T.F. CARLSON, P. DAYANANDAN, M.L. EVANS, J.B. FISHER, C. PARKS, AND J. WELLS. 1989. Plants : Their Biology and Importance. Harper & Row, Publishers. Inc., New York.
10. KASHYAP, S.R. 1929. Liverworts of Western Himalayas. Part I and Part II(1932). University of Punjab, Lahore.
11. MANICKAM, V.S. AND V. IRUDAYARAJ. 1992. Pteridophyte Flora of the Western Ghats, South India. B.I. Publications. New Delhi.
12. MAUSETH, J.D. 1991. Botany - An Introduction to Plant Biology. Saunders College Pub., Philadelphia.
13. STEWART. W. N. 1983. Paleobotany and the Evolution of Plants. Cambridge University Press, California.
14. WATSON, E.V. 1971. The Structure and Life of Bryophytes. Hutchinson and Co., (Publishers) Ltd. London.

Suggested Reading

1. BANKS, H.P. 1970. Evolution and Plants of the Past. Wadsworth Publishing Co., Ic., Belmont.
2. California.
3. CHRISTENHUSZ, M. J. REVEAL, J.L, FARJON.A, GARDNER, M.F, MILL, R.R., CHASE,
4. M.W., 2011. A new classification and linear sequence of extant gymnosperms. *Phytotaxa* 19:55-70.
5. CONRAD, H.S., AND P.L. REDFEARN, Jr. 1979. How to Know the Mosses and Liverworts. Academic Press. New York.
6. DELEVORYAS, T. 1962. Morphology and Evolution of Fossil Plants. Holt, Rinehart and Winston. New York.
7. KUBITZKI, K., K.U. KRAMER AND P.S. GREEN (Eds.). 1990. The Families and Genera of Vascular Plants - I: Pteridophytes and Gymnosperms. Springer - Verlag. Berlin.
8. MOORE,R., W.D. CLARK, K.R. STERN, AND D. VODOPICH. 1995. Botany : Plant Diversity. Wm. C. Brown Publishers. Dubuque. IA.
9. RAVEN, P.H., R.F. EVERT, AND S.E. EICHHORN. 1992. Biology of Plants. Fifth Edition. Worth Publishers. New York.

Web Resources

1. https://www.conifers.org/zz/gymnosperms.php
2. https://www.cycadlist.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2									3					K1
CO 2	3									3					K2
CO 3	3									3					K3

CO 4	3									2					K4
CO 5	3									3					K5
Wt. Avg.	2.8									2.8					
													Overall Mapping of the Course	2.8	

Paper 3a Core Theory: RESEARCH METHODOLOGY, INSTRUMENTATION AND BIOSTATISTICS

Course Code	212BO1M03		
Credits	4		
Hours / Cycle	75		
Category	Part	Core	Theory
Semester	1		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	**To make students understand the basics of research, various biological techniques, instrumentation and interpretation of research findings and presentation of research work.**		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	choose various strategies and steps in carrying out a successful research.	**PSO6**	**K1**
CO 2	demonstrate the principle, working mechanism, types and application of microscopes; learn the various techniques pertaining to microscopy; Demonstrate the inevitable use of photographic techniques in biology.	**PSO6**	**K2**
CO 3	construct various methods and techniques used in extraction and separation of bio-components.	**PSO6**	**K3**
CO 4	compare the principle, working mechanism, handling and maintenance of various analytical instruments.	**PSO6**	**K4**
CO 5	evaluate the use of computers, different statistical methods, statistical packages/tools used in academics and scientific research.	**PSO6**	**K5**

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to research: Basic outline of research, Basic and Applied research and essential steps in research. Experimental design and analysis. Retrieval of abstracts and bibliographic data. Thesis and research writing. Ethics with respect to scientific research. Definition, introduction and importance. Scientific Misconduct of Publication Ethics. Falsification, Fabrication and Plagiarism (FFP). Selective Reporting and misrepresentation of data. Conflicts of interest, publication misconduct, complaints and appeals. Predatory publishers and journals.	**15**	**CO1-5**	**K1-K5**

II	Microscopy: Light microscopy, optical principles, magnification and resolution. Dark-field, phase contrast, polarized light, differential interference contrast (Nomarski-DIC) and fluorescence microscopy. Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM);Photomicrography and photomacrography; Microtomy and Micrometry: slide preparation,fixatives and staining technique. Preparation of whole mounts.Tissue Printing.	**15**	**CO1-5**	**K1-K5**
III	Extraction and separation procedure: Solvent extraction; Separation by centrifugation; Purification by dialysis, Sephadex gel filtration.; Thin Layer Chromatography (TLC); Column Chromatography; Gel electrophoresis (SDS-PAGE).	**15**	**CO1-5**	**K1-K5**
IV	Analytical Instruments: detailed study of the principle, construction and application of pH Meter, Centrifuge, Spectrophotometer, High Performance Thin Layer Chromatography (HPTLC), Gas Chromatography Mass Spectroscopy (GCMS), Nuclear Magnetic Resonance spectroscopy (NMR-spectroscopy), Atomic Absorption Spectroscopy (AAS), Flow cytometer.	**15**	**CO1-5**	**K1-K5**
V	Biostatistics: Frequency distribution, measure of central tendency, standard deviation, standard error, correlation and regression. Test of significance, analysis of variance (ANOVA) and Chi-square test. Packages used in statistical analysis, RSM, Graph pad prism, SPSS.	**15**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. WEBSTER, J. G. 2004. Bioinstrumentation, John Wiley & Sons, New York, 2004. John Wiley & Sons.
2. BAJPAI P.K.. 2010. Biological Instrumentation & Methodology. S Chand & Company.
3. ANANTA SWARGIARY. 2017. Biological Tools & Techniques (A textbook for UG/PG students of Life Sciences). Kalyani Publishers, New Delhi
4. TUAN VO-DINH. 2010. Protein Nanotechnology: Protocols, Instrumentation, and Applications. Edition II.Springer Science & Business Media, 2005
5. PALANICHAMY, S., AND M. MANOHARAN. 1990. Statistical Methods for Biologists. Palani Paramount Publisher. Palani. Tamil Nadu.

References

1. DELLY,J. 1988. Photography through the microscope. Ninth edition. Eastman Kodak Co. New York.
2. GOMEZ, K.A., AND A. GOMEZ. 1976. Statistical Procedures for Agricultural Research with Emphasis on Rice. IRRI. Philippines.
3. LACEY,A.J. 1989. Light microscopy in biology - a practical approach. IRL Press. Oxford University Press. U.K.
4. PRASAD, S. 1992. Fundamentals of Biostatistics (Biometry). Emkay Pub. Delhi.
5. REID, P.D., AND R.F. PONT-LEZICA (Eds.). 1992. Tissue Printing: tools for the study of anatomy, histochemistry, and gene expression. Academic Press. New York.
6. ROBINSON, P.C. 1992. Qualitative polarized light microscopy. Royal Microscopical Society. Oxford University Press. U.K.

Suggested Reading

1. BERLYN, G.P. AND J.K.MIKSCHE. 1976. Botanical Microtechnique and cytochemistry. Iowa State University Press. Iowa. USA.
2. CLARK, G. 1981. Staining Procedures. Fourth Edition. Williams & Wilkins Co. MD.U.S.A.
3. GAHAN, P.B. 1984. Plant Histochemistry and Cytochemistry - An Introduction. Academic Press. U.K.
4. HOROBIN, R.W. 1982. Histochemistry: An Explanatory Outline of Histochemistry and Biophysical Staining. Gustav Fischer Verlag. Stuttgart. Germany.
5. HOROBIN, R.W. 1988. Understanding Histochemistry: Selection, Evaluation and Design of Biological Stains. Ellis Horwood Ltd. U.K.

Web Resources (3-5)

1. https://www.researchgate.net/
2. https://pubmed.ncbi.nlm.nih.gov/
3. https://scholar.google.com/
4. https://www.elsevier.com/
5. https://www.springer.com/

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3	3	3	3	3									3	K1
CO 2	3	3	3	3	3									3	K2
CO 3	3	3	3	3	3									3	K3

CO 4	3	3	3	3	3									3	K4
CO 5	3	3	3	3	3									3	K5
Wt. Avg.	3	3	3	3	3									3	
												Overall Mapping of the Course		3	

Paper 4a COMBINED PRACTICAL: MYCOLOGY AND PLANT PATHOLOGY, BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMOLOGY & RESEARCH METHODOLOGY, INSTRUMENTATION AND BIOSTATISTICS

Course Code	212BO1M04		
Credits	5		
Hours / Cycle	165		
Category	Part	Core	Practical
Semester	1		
Year of Implementation	From the academic year 2021-2022 onwards		
Course Objectives	To enable the students to learn and culture the various lower plant groups; to have basic hands-on training towards the advanced microscopes, instruments and associated research techniques.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	choose the techniques in isolation and culturing different members of fungi	**PSO 1**	**K1**
CO 2	understand the morphological and physiological characters of various divisions of bryophytes; Understand the evolution and phylogeny of Bryophytes.	**PSO 1**	**K2**
CO 3	identify the various fossil and extent forms of primitive vascular land plants and their evolutionary importance.	**PSO 1**	**K3**
CO 4	compare the morphological and physiological characters of living and fossil gymnosperms.	**PSO 1**	**K4**
CO 5	assess the principle and working mechanism of various instruments used in extraction, separation and analysis of biocomponents, statistical methods and tools used in Scientific Research	**PSO 1, PSO 5**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**

I	Structure of various thallus and reproductive stages of fungi belonging to various classes. Laboratory techniques in mycology: Preparation of culture media. Preparation of culture slants and plates. Plate assay techniques. Isolation of soil fungi, aquatic fungi and coprophilous fungi. Growth of fungi using baits-Moisture chamber. Sporangial and spore discharge mechanism of fungi with particular reference to *Pilobolus.* Sectioning and observation of Zygomycotina (*Mucor* &*Rhizopus*), Ascomycotina (*Galiella*, *Xylaria*), Basidiomycotina (*Ganoderma*, *Lentinus*), Deuteromycotina (*Alternaria*). Sectioning of Lichen Thallus & Reproductive structure: *Parmelia* &*Usnea* Study of structures associated with the following diseases: **Fungal Disease (Sectioning and Observation):** Damping off of mustard (*Pythium)*, White rust of Cruciferae (*Albugo*), Club root of Cruciferae (*Plasmodiophora*), Brown rust of wheat (*Puccinia*), Red rot of sugarcane (*Colletotrichum*), Leaf spot of brinjal (*Alternaria*), Tikka disease of groundnut (*Cercospora*). **Bacterial Disease (Observation):**Blight of rice*(Xanthomonas oryzae*), Citrus canker (*Xanthomonas citrii*) **Viral Disease (Observation)**: Vein clearing of *Acalypha*, Mosaic of *Phaseolus* **Mycoplasma Disease (Observation)**: Little leaf of brinjal, Leaf curl disease	**33**	**CO1-5**	**K1-K5**
II	Study of habit, habitat distribution, external and internal structure of gametophytes of selected species; Sporophytes and reproductive structures of the following: *Riccia, Reboulia, Dumortiera, Marchantia, Blyttia (Pallavicinia), Anthoceros, Sphagnum,* and *Polytrichum.* Knowledge of some common bryophytes of Tambaram and neighbourhood.	**33**	**CO1-5**	**K1-K5**
III	Study of vegetative and reproductive structures of the following living members: *Psilotum, Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Gleichenia, Marsilea*, Slides or photographs of fossil Pteridophytes - *Rhynia, Zosterophyllum, Lepidodendron, Calamites*..	**33**	**CO1-5**	**K1-K5**
IV	Study of vegetative and reproductive structures of the following living gymnosperms: *Cycas, Ginkgo, Pinus, Araucaria* and *Gnetum.* Study and identification of fossil slides or photographs of *Lyginopteris, Medullosa, Williamsonia* and *Pentaxylon*.	**33**	**CO1-5**	**K1-K5**
V	Selected techniques in light microscopy Permanent slide preparation –Microtomy, pollen acetolysis method and micrometry Photomicrography and Photomacrography Photomicrographs of LM and EM Demonstration of tissue printing technique Demonstration of the following instruments: p^H meter, spectrophotometer, centrifuge, chromatography and electrophoresis. Observation of Analytical instruments from various laboratories of institutions in and around Chennai. Demonstration of SDS-PAGE, Column chromatography	**33**	**CO1-5**	**K1-K5**

	Solving Statistical problems - standard error, standard deviation, graphical representation of data and statistical software Open access Publishing, Publication Misconduct, Plagiarism tools, Indexing & citation databases (Web of Sciences, Scopus) and Research Metrics (h-index, G-index and i10 index)			

Prescribed Books/Textbooks

1. BIERHORST, D.W. 1971. Morphology of Vascular Plants. Macmillan Publishing
2. Company. New York.
3. BOLD, H.C., C.J. ALEXOPOULOS, T. DELEVORYAS. 1987. Morphology of Plants and Fungi.
4. Harper & Row, Publishers. New York.
5. CHOPRA, R.N., AND P.K. KUMAR. 1988. Biology of Bryophytes. John Wiley. New York.
6. CHOPRA, R.S. 1975. Taxonomy of Indian Mosses. CSIR. New Delhi.
7. GOFFINET, B. AND A. J. SHAW. 2009. Bryophyte Biology, 2nd edition. Cambridge
8. University Press, Cambridge.
9. MEYEN, S.V. 1987. Fundamentals of Palaeobotany. Chapman and Hall. London.
10. PANDEY, S.N., P.S. TRIVEDI, AND S.P. MISRA. 1992. A Text Book of Botany. Vol. I & II.
11. 2nd Edition. Vikas Publishing House. New Delhi.
12. SPORNE, K. R. 1974. The Morphology of Gymnosperms. B. I. Publications. New Delhi.
13. SPORNE, K. R. 1976. The Morphology of Pteridophytes. B.I. Publications. New Delhi.
14. SMITH, A.J.E. 1982. Bryophyte Ecology. Chapman and Hall. London.
15. VENKATACHALA, B.S., M. SHUKLA AND M. SHARMA. 1992. Plant Fossils - A Link with **16.**the Past. Pub. & Information Directorate. New Delhi**.**

References

1. BECK, C.B. 1988. Origin and Evolution of Gymnosperms. Columbia University Press.New York.
2. GANGULEE, H.C. 1985. Handbook of Indian Mosses. Amerind Pub. Co., New Delhi.
3. GENSEL, P.G., AND H.N. ANDREWS. 1984. Plant Life in the Devonian. Praeger Publishers. New York.
4. GRAHAM, L.E. 1993. Origin of Land Plants. John Wiley & Sons, Inc. New York.
5. GIFFORD, E.M. AND E.S. FOSTER. 1989. Morphology and Evolution of Vascular Plants.Third Edition. W.H. Freeman and Company. New York.
6. JOHRI, B.M. 1994. Botany in India - History and Progress Vol - I, Oxford & IBH Pub. Co.Pvt. Ltd. New Delhi.
7. JONES, D.L. 1993. Cycads of the World - Ancient Plants in Today's Landscape.Smithsonian Institution Press. Washington. D.C.
8. KAUFMAN, P.B., T.F. CARLSON, P. DAYANANDAN, M.L. EVANS, J.B. FISHER, C. PARKS,
9. AND J. WELLS. 1989. Plants: Their Biology and Importance. Harper & Row, Publishers.Inc., New York.
10. KASHYAP, S.R. 1929. Liverworts of Western Himalayas. Part I and Part II (1932). University of Punjab, Lahore.
11. MANICKAM, V.S. AND V. IRUDAYARAJ. 1992. Pteridophyte Flora of the Western Ghats, South India. B.I. Publications. New Delhi.
12. MAUSETH, J.D. 1991. Botany - An Introduction to Plant Biology. Saunders College Pub.,Philadelphia.
13. STEWART. W. N. 1983. Paleobotany and the Evolution of Plants. Cambridge University Press, California.
14. WATSON, E.V. 1971. The Structure and Life of Bryophytes. Hutchinson and Co.,(Publishers) Ltd. London.

Suggested Reading

1. BANKS, H.P. 1970. Evolution and Plants of the Past. Wadsworth Publishing Co., Ic.,Belmont. California.
2. CHRISTENHUSZ, M. J. REVEAL, J.L, FARJON.A, GARDNER, M.F, MILL, R.R., CHASE, M.W.,2011. A new classification and linear sequence of extant gymnosperms. Phytotaxa 19:55-70.
3. CONRAD, H.S., AND P.L. REDFEARN, Jr. 1979. How to Know the Mosses and Liverwort Academic Press. New York.
4. DELEVORYAS, T. 1962. Morphology and Evolution of Fossil Plants. Holt, Rinehart and Winston. New York.
5. KUBITZKI, K., K.U. KRAMER AND P.S. GREEN (Eds.). 1990. The Families and Genera of Vascular Plants - I: Pteridophytes and Gymnosperms. Springer - Verlag. Berlin.
6. MOORE, R., W.D. CLARK, K.R. STERN, AND D. VODOPICH. 1995. Botany: Plant Diversity. Wm. C. Brown Publishers. Dubuque. IA.
7. RAVEN, P.H., R.F. EVERT, AND S.E. EICHHORN. 1992. Biology of Plants. Fifth Edition.Worth Publishers. New York.
8. SMITH, A. R., PRYER, K.M., SCHUETTPELZ, E., KORALL, P., SCHNEIDER, H., AND WOLF, P.G. 2008. Fern Classification In - Biology and Evolution of Ferns and Lycophytes, (eds.)
9. T.A. Ranker and C.H. Haufler. Cambridge University Press.

Web Resources

https://www.conifers.org/zz/gymnosperms.php https://www.cycadlist.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	3									3	-	-	-	-	K1
CO 2	3									3	-	-	-	-	K2
CO 3	3									3	-	-	-	-	K3
CO 4	3									3	-	-	-	-	K4

CO 5	3	3			3					3	-	-	-	3	K5
Wt. Avg.	3	3			3					3	-	-	-	3	
Overall Mapping of the Course														3	

Paper 1b ELECTIVE THEORY: ETHNOBOTANY

Course Code	212BO1E01		
Credits	5		
Hours / Cycle	60		
Category	Part	Elective	Theory
Semester	I		
Year of Implementation	2021-2022 onwards		
Course Objectives	To educate students with basic concepts and terms, life of major tribes in Tamil Nadu, methods of ethnobotanical data collection and interpretation, role of plants in cultural and socio-religious activities, and protection systems for traditional knowledge.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	define the concepts, inter-disciplines, ethics, sociological and anthropological terms of Ethnobotany	**PSO 2**	**K1**
CO 2	explain the distribution of tribes in India especially on major tribes of Tamil Nadu	**PSO 2**	**K2**
CO 3	choose appropriate primary and secondary ethno-botanical data and methods to study a particular tribe	**PSO 2**	**K3**
CO 4	analyse the significance of traditional knowledge and perceive the know-how of protection of the same	**PSO 2**	**K4**
CO 5	Assess the role of plants in cultural and socio-religious activities and list various NTFPs that sustain the livelihood of forest dwellers of India	**PSO 2**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Ethnobotany: concepts, changes and definitions. Interdisciplinary approaches. Knowledge of following sociological and anthropological terms: culture, values and norms, institutions, culture diffusion and ethnocentrism. History of Ethnobotany: A brief history of ethnobotanical studies in the world and in India.	**10**	**CO1-5**	**K1-K5**
II	Distribution of Tribes in India. Basic knowledge of following Tribes of Tamil Nadu: Irulas, Kanis, Paliyars and Malayalis.	**15**	**CO1-5**	**K1-K5**
III	Sources of Ethnobotanical Data: Primary - Archeological sources and Inventories, Secondary - Travelogues, Folklore and Literary sources, Herbaria, Medicinal texts and Official records. Methods in Ethnobotanical Research. Prior Informed Consent, PRA Techniques, Interviews and Questionnaire methods, Choice of Resource persons.	**15**	**CO1-5**	**K1-K5**
IV	Ethnobotanical Knowledge and Communities: Folk Taxonomy. Non Timber Forest Produce (NTFP) and Livelihood Sustainable Harvest and Value addition.	**10**	**CO1-5**	**K1-K5**
V	Bioprospecting and commercial use of Traditional Knowledge. Developing Research Partnerships: Codes of Ethics and Research Guidelines, Equitable Research Relationships. Traditional Knowledge (TK) in relation to Intellectual Property Rights. Benefit sharing models of the world and Economic, Social and Political issues in Benefit Sharing.	**10**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. COTTON, C. M. 1997. Ethnobotany - Principles and Applications. John Wiley and Sons Limited. New York, USA
2. JAIN, S.K. 1989. Methods and Approaches in Ethnobotany. Society of Ethnobotanists. Lucknow.
3. JAIN, S.K. 1991. Dictionary of Indian folk medicine and Ethnobotany. Deep Publishers. New Delhi.
4. JAIN, S.K. AND V. MUDGAL. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, DehraDun.
5. MARTIN, G. 1994. Ethnobiology. Chapman & Hall. London.

References

1. APTE, T. 2006. Intellectual Property Rights, Biodiversity and Traditional Knowledge. Kalpavriksh, Grain & IIED, Pune / New Delhi.
2. DUTHFIELD, G. 2004. Intellectual Property, Biogenetic Resources and Traditional Knowledge. Earthscan, London, UK.
3. JAIN, S.K. 1991. Contributions to Indian Ethnobotany. Scientific Publishers. Jodhpur.
4. KATE, K. T., S. A. LAIRD. 2000. Commercial Use of Biodiversity. Earthscan, London, UK
5. LAIRD, S.A. 2002. Biodiversity and Traditional Knowledge Equitable partnerships in Practice. Earthscan Publications Ltd., London.

Suggested Reading

1. CUNNINGHAM, A.B. 1993. Ethics, Ethnobiological Research, and Biodiversity. WWF. International Publication. Switzerland.
2. DAVID, N AND C. KRAMER. 2001. Ethnoarchaeology in Action. Cambridge University Press, New York.
3. UNDP. 1994. Conserving Indigenous Knowledge. Integrating Two Systems of Innovation. Rural Advancement Foundation. Commissioned by UNDP.
4. RAMAKRISHNAN, P.S., R. BOOJH, K. G. SAXENA et al. 2005. One Sun Two World an Ecological Journey. Oxford & IBH. New Delhi, India.

Web Resources (3-5)

1. Ethnobotany Research and Applications (https://ethnobotanyjournal.org/index.php/era/about)
2. Journal of Traditional and Complementary Medicine (https://www.sciencedirect.com/journal/journal-of-traditional-and-co medicine)
3. Economic Botany (https://www.springer.com/journal/12231)
4. Journal of Intellectual Property Rights (https://nopr.niscpr.res.in/handle/123456789/45)

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO 4	PSO5	
CO 1	2									3				K1
CO 2	3									3				K2
CO 3	3									3				K3
CO 4	3									3				K4
CO 5	3									3				K5
Wt. Avg.	2.8									3				
Overall Mapping of the Course												2.9		

Paper 1b ELECTIVE THEORY :PHARMACOGNOSY

Course Code	212BO1E02		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Elective**	**Theory**
Semester	**I**		
Year of Implementation	**From the academic year 2021-2022 onwards**		
Course Objectives	To understand the concepts and importance of Pharmacognosy To get acquainted with plant drug evaluation and adulteration To identify the phytochemicals, present in various crude drugs To familiarize with information about applications of secondary metabolites in modern medicine.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)

On completing the course successfully, the student will be able to

CO 1	recall the concept and scope of Pharmacognosy	**PSO 1**	**K1**
CO 2	classify the Crude drugs based on various criteria	**PSO 1**	**K2**
CO 3	identify the adulteration in plant based crude drugs	**PSO 1**	**K3**
CO 4	analyze the different types of crude drugs from various botanical sources	**PSO 5**	**K4**
CO 5	assess the application of Secondary Metabolites in modern medicine	**PSO 5**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Introduction to Pharmacognosy - Definition, history, scope and development of pharmacognosy. Sources Introduction about alternative system of medicines (Ayurveda, Siddha, Homeopathy and Unani).	**10**	**CO1-5**	**K1-K5**
II	Sources of crude drugs. Organized and Unorganized Crude drugs. Classification of crude drugs - Alphabetical, Morphological, Taxonomical, Chemical, Pharmacological, Chemotaxonomical and Serotaxonomical Classification. Cultivation, Collection, Processing and Storage of crude drugs.	**10**	**CO1-5**	**K1-K5**
III	Pharmacopoeias in the world and India. Adulteration and Evaluation of Crude Drugs by Organoleptic, Microscopic, Physical, Chemical & Biological methods and their Formulation as per Standard Pharmacopoeia and WHO guidelines.	**10**	**CO1-5**	**K1-K5**
IV	Study of Traditional Drugs - Common Vernacular names, Botanical sources, Morphology, Chemical nature of Active Constituents, Pharmacology, Uses and Marketed Formulations of Following Drugs: Ashoka, Amla, Brahmi, Bilawa, *Gymnema*, Neem, *Rauwolfia*, Satavari, Senna and Vetiver.	**18**	**CO1-5**	**K1-K5**
V	Herbal remedies. Biological Screening of Herbal drugs. WHO and AYUSH guidelines for Safety Monitoring of Natural Medicine. Linking Indigenous Traditional Knowledge on Herbal medicine. Plant products in Pharmaceuticals and Nutraceuticals.	**12**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. ARUMUGAM, K.R. AND N. MURUGAN. 2011. Text book of Pharmacognosy. Sathya Publishers, India.
2. BIREN SHAH AND A.K. SETH. 2010. Textbook of Pharmacognosy and Phytochemistry. Elsevier, Haryana, India.
3. KALIA, A.N. 2005. Textbook of Industrial Pharmacognosy. CBS Publishers, New Delhi, India.
4. PUROHIT, A.P., S.B. GOKHALE AND C.K., KOKATE. 2008. Pharmacognosy. Nirali Prakashan, Arihant Printers, Pune- 411 037, India.
5. WALLIS, T. E. 1985. Text book of Pharmacognosy, Jain Publisher, New Delhi, India.

References

1. ANONYMOUS. 1998. Macroscopic and microscopic examination: quality control methods for medicinal plant materials. WHO, Geneva.
2. FAROOQI, A.A. AND B.S. SREERAMU. 2004. Cultivation of medicinal and aromatic crops. Universities Press, New Delhi, India.
3. INDIAN PHARMACOPOEIA. 1996. Controller of Publications, Ministry of Health and Family Welfare, Government of India, New Delhi, India.
4. KRITIKA K.R. AND B.L. BASU. 2003. Indian Medicinal plants with illustrations. Oriental Enterprises, Dehradun, India.
5. MUKHERJEE, P.K. 2008. Quality control of herbal drugs. 3rd edition. Business Horizons Pharmaceutical Publishers, New Delhi, India.

Suggested Reading

1. EVANS, W.C. 2002. Trease and Evans Pharmacognosy. 15th edition, W.B. Sounders & Co., London.
2. NADKARINI, K.M. 1976. Indian *materia medica*. Popular Prakashan Private Limited, Bombay, India.
3. SINGH, G. K. AND ANIL BHANDARI. 2008. Textbook of Pharmacognosy. CBS Publishers & Distributors, New Delhi, India.
4. VASUDEVAN NAIR, R. 2003. Controversial drug plants. Universities Press, New Delhi, India.

Course Articulation Matrix

Course Outcome	Programme Outcomes	Programme Specific Outcomes	Cognitive Level

s	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	3		-	-	-	-	-	-	-	3	-	-	-	-	K1
CO 2	3		-	-	-	-	-	-	-	3	-	-	-	-	K2
CO 3	3		-	-	-	-		-	-	3	-	-	-	-	K3
CO 4	3		-	-	-		-	-	-		-	-	-	3	K4
CO 5	3	3	-	-	3		-	-	-		-	-	-	3	K5
Wt. Avg.	3	3	-	-	3			-	-	3	-	-	-	3	
Overall Mapping of the Course													3		

Paper 5a Core Theory :BIODIVERSITY AND CONSERVATION BIOLOGY

Course Code	212BO2M01		
Credits	5		
Hours / Cycle	90		
Category	Part	Major	Theory
Semester	II		
Year of Implementation	2021-2022 onwards		
Course Objectives	To educate the students with components of biological diversity, biodiversity indices, species composition of major ecosystems, evaluation of conservation status of endemic species, and national and international legislations for conservation.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	define the different types of biological diversity and its components	PSO-3	K1
CO 2	explain the status of biological diversity using various indices and to estimate their values	PSO-3	K2
CO 3	identify and solve various anthropogenic threats to the biodiversity; Apply various national and international legislations to conserve biodiversity	PSO-3	K3
CO 4	compare different molecular marker methods to estimate the genetic diversity studies	PSO-3	K4
CO 5	evaluate the flora and fauna of different ecosystems in India and evaluate their endemic and global conservation status	PSO-1,3,6	K5

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Characterization of Biodiversity: Definitions of the following terms: Biodiversity, Domesticated Biodiversity, Agrobiodiversity, Introduced Biodiversity and Native Biodiversity. Components of Biodiversity: 1) Ecosystem Diversity – Forests, Wetlands, Grasslands and Mangrove ecosystems. 2) Species Diversity – α, β and γ diversity. Endemic Plant species and patterns of distribution with special reference to India. 3) Genetic diversity – factors that shape population genetics. Measuring genetic diversity using Molecular Markers.	20	**CO1-5**	**K1-K5**

II	Magnitude, distribution and measuring of Biodiversity: Current estimates of Biodiversity. Megadiversity countries. Biodiversity indices and sampling techniques. Inventorying and Monitoring biodiversity. Endemic Plant species and patterns of distribution with special reference to India.	15	**CO1-5**	**K1-K5**
III	Threats to Biodiversity: Habitat degradation, fragmentation, overexploitation and natural calamities. Climate Change and its impact on Biodiversity, mitigation and adaptation. Alien Invasive Plant Species and their Impact. Threatened Plant species of India. Concept of IUCN Red List Categories and Criteria.	20	**CO1-5**	**K1-K5**
IV	Valuing Biodiversity: Biodiversity values - Direct and Indirect. Biocentrism and Ecocentrism. Assessing the Economic value of Biodiversity. Bioresources and Intellectual Property Rights.	15	**CO1-5**	**K1-K5**
V	Conservation Approaches: In situ and Ex situ approaches. Eco regions (WWF), Biosphere Reserves (UNESCO), Protected Areas (IUCN), Biodiversity Hotspots (CI). International and National legislations and conventions on biodiversity – CBD, NBA, CITES and TRAFFIC. Protected Areas (National Park, Sanctuaries, Community Reserves and Conservation Reserves) and Biosphere Reserves of India. Sacred Groves - A Community approach to conservation. Introduction to Sustainable Development Goals (SDGs) and its significance.	20	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. DAVIS, S.D., V.H. HEYWOOD, AND A.C. HAMILTON, (Eds.). 1995. Centres of Plant Diversity: A Guide and Strategy for their Conservation. Volume 2. Asia, Australia and The Pacific. Published by The World Wide Fund for Nature(WWF) and IUCN - The World Conservation Union. Information Press, Oxford, U.K.
2. DOBSON, A.P. (Ed.), 1996. Conservation and Biodiversity. Scientific American Library, New York.
3. GADGIL, M., U. GHATE AND P. PRAMOD. 1996. Biodiversity: Resource Material for Courses, Practical Exercises and Student Projects at College and University Levels. Volume 1 - 5. Indian Academy of Sciences. Bangalore.
4. KOTHARI, A., N. SINGH, AND S. SURI, (Eds.). 1997. People and Protected Areas: Towards Participatory Conservation in India. Sage Publications India Pvt. Ltd. New Delhi.
5. KRISHNAMURTHY, K. V. 2003. An Advanced Textbook on Biodiversity Principles and Practice. Oxford & IBH Publishing Co. Pvt. Ltd.
6. RODGERS, W.A., H.S. PANWAR & V.B. MATHUR, 2000. Wildlife Protected Area Network in India: A Review. Wildlife Institute of India Dehradun.

References

1. BELL, P. R. AND A.R. HEMSLEY. 2000. Green Plants Their Origin and Diversity. (2nd Edition). Cambridge University Press, United Kingdom.
2. GADGIL, M. AND R. GUHA. 1992. This Fissured Land: An Ecological History of India. Oxford University Press. New Delhi.
3. HEYWOOD, V.H. 1992. Global Biodiversity Assessment. UNEP. Cambridge University Press.
4. KATE, K. T. & S.A. LAIRD.2002. The Commercial Use of Biodiversity Access to Genetic Resources and Benefit – Sharing. Earth scan Publication Ltd. London.
5. KAUFMAN, D.G., AND C.M. FRANZ. 1993. Biosphere 2000: Protecting Our Global Environment. Harper Collins College Publishers. New York.

Suggested Reading

1. KOOPOWITZ, H., AND H. KAYE. 1990. Plant Extinction - A Global Crisis. Christopher Helm. London.
2. KOTHARI, A. 1997. Understanding Biodiversity: Life, Sustainability and Equity. Tracts for the times. 11. Orient Longman Ltd. New Delhi.
3. MINISTRY OF ENVIRONMENT AND FORESTS. 1994. Conservation of Biological Diversity in India: An Approach. Government of India. New Delhi.
4. UNEP. 1992. Convention on Biological Diversity. United Nations Environment Programme, Nairobi.

Web Resources

1. Convention of Biological Diversity (https://www.cbd.int/)
2. International Union for Conservation of Nature (https://www.iucn.org/)
3. Convention on International Trade in Endangered Species of Wild Fauna and Flora (https://cites.org/eng/disc/what.php)
4. Sustainable Development Goals (https://www.undp.org/sustainable-development-goals)
5. National Biodiversity Authority (http://nbaindia.org/)

Course Articulation Matrix

Course Outcomes	**Programme Outcomes**								**Programme Specific Outcomes**						**Cognitive Level**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	PSO6	
CO 1	3					3					3				

CO 2	3					3		3	
CO 3	3					3		3	
CO 4	3					3		3	
CO 5	3	3	3	3	3	3	3	3	3
Wt. Avg.	3	3	3	3	3	3	3	3	3

Overall Mapping of the Course 3

Paper 6a Core Theory: ALGAL BIOLOGY AND BIOTECHNOLOGY

Course Code	212BO2M02		
Credits	4		
Hours / Cycle	75		
Category	Part	Major	Theory
Semester	II		
Year of Implementation	2021-2022 onwards		
Course Objectives	Study and impart knowledge about the diversity, structure, interrelationships of algae and it's the commercial value and Environmental application.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	list the freshwater and marine algae from liquid preservations and herbarium techniques.	**PSO 1**	**K1**
CO 2	explain the techniques employed in enumeration, digital documentation and identification of algae.	**PSO 1**	**K2**
CO 3	make use of on the isolation of algae and various methods involved in cultures of Algae.	**PSO 1**	**K3**
CO 4	analyse different types of culture media and laboratory cultivation of micro and macroalgae.	**PSO 1**	**K4**
CO 5	recommend different types of Mass cultivation of Freshwater and Marine algae.	**PSO 1**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**Cos**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to algae; Classification of algae (Robert Edward Lee 2008); Criteria for the classification of algae; Characteristic features of major classes of algae; Phylogeny and interrelationships among algae. Green algae as ancestors of higher plants. Life-cycles in algae: Haplontic/zygotic life-cycle, Diplontic/gametic life-cycle; Diplohaplontic/ Sporic life-cycle; Diplobiontic/ sporic life-cycle and Somatic life cycle.	**15**	**CO1-5**	**K1-K5**
II	Thallus organization (unicellular to multicellular), asexual (various types of spores), sexual reproduction and life cycle of the members of the Cyanophyceae, Rhodophyceae and Dinophyceae.	**15**	**CO1-5**	**K1-K5**
III	Thallus organization (unicellular to multicellular), asexual (various types of Spores), sexual reproduction and life cycle of the members of the Chlorophyceae, Phaeophyceae, and Bacillariophyceae.	**15**	**CO1-5**	**K1-K5**

IV	Biotechnological Potential of Algae: Food and Feed; Recipes with Algae. Algal source of Carotenoids, Amino acids, Fatty acids, Restriction enzymes, Exo-cellular polysaccharides. Bioactive compounds from algae; Pharmaceutical uses of algae. Immobilized algae and its Industrial uses.	**15**	**CO1-5**	**K1-K5**
V	Algae biofertilizers - Bluegreen algal (BGA) biofertilizers and Liquid seaweed fertilizers (LSF) preparation and application. Pollution indicators; Phycoremediation; Biofuel - Algae as a source of fuels such as Methane and Hydrogen; Algae as a source of Biodiesel. Role of Algae in Atmospheric Carbon di-oxide Reduction: CO2 Sequestrations.	**15**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

1. BARSANTI, LAURA AND PAOLO GUALTIERI 2014. *Algae-Anatomy, Biochemistry and Biotechnology*. Taylor & Francis, London, New York.
2. FRITSCH, F.E. 1935 *Structure and Reproduction of Algae*, Vol. I, Cambridge University Press, Cambridge.
3. FRITSCH, F.E. 1945 *Structure and Reproduction of Algae*, Vol. II, Cambridge University Press, Cambridge.
4. LEE, R. 2018. *Phycology*, 5th edition, Cambridge University Press, Cambridge.
5. LOBBAN, C.S. AND M.J. WYNNE 1981.*The Biology of Seaweeds*. Blackwell Scientific Publications, Oxford.

References (3 – 5)

1.CHANDRAMOHAN, D. 2007. Prospects of Biodiesel from marine microorganisms. Proceedings of the National Workshop on BIODIESEL Organised by School of Energy, Environment &Natural Resources, Madurai Kamaraj University, Madurai and Ahimsa Agri division, Chennai.

2. CHAPMAN, V.L. AND DL. CHAPMAN, 1980. Seaweed and their uses. Chapman & Hall, London.
3. DESIKACHARY, T.V. 1959. Cyanophyta. ICAR, New Delhi.
4. DESIKACHARY, T.V., V. KRISHNAMURTHY AND M.S. BALAKRISHNAN. 1990. Rhodophyta. Madras Science Foundation, Madras.
5. DIXON, B.S. 1973. Biology of the Rhodophyta. Oliver and Boyd, Edinburgh.
6. IYENGAR, M.O.P. AND T.V. DESIKACHARY. 1981. Volvocales. ICAR, New Delhi.

Suggested Reading (2 -5)

1. BECKER, E. W. 1994. Microalgae-Biotechnology and microbiology. Cambridge University Press.
2. PEREIRA L. AND J. M. NETO 2015. Marine Algae: Biodiversity, Taxonomy, Environmental Assessmen.t, and Biotechnology. Taylor & Francis, NW, USA.
3. RAMANATHAN, K.R. 1964. Ulotrichales. ICAR, New Delhi. RANDHAWA, M.S. 1939. Zygnemataceae. ICAR, New Delhi.

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	3		-	-	-	-	-	-	-	3	-	-	-	-	K1
CO 2	3		-	-	-	-	-	-	-	3	-	-	-	-	K2
CO 3	3		-	-	-	-		-	-	3	-	-	-	-	K3
CO 4	3		-	-	-		-	-	-	3	-	-	-		K4
CO 5	3		-	-			-	-	-	3	-	-	-		K5
Wt. Avg.	3		-	-				-	-	3	-	-	-		
													Overall Mapping of the Course		3

Paper 7a Core Theory: MOLECULAR BIOLOGY AND GENETICS

Course Code	212BO2M03		
Credits	4		
Hours / Cycle	75		
Category	Part	Core	Theory
Semester	II		

Year of Implementation	2021-2022 onwards		
Course Objectives	To enable students gain understanding of RNA, DNA, Proteins and their functions.		
CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall Mendelian principles, structure, nature and organization of Nucleic acids, DNA, Gene and Chromosome and	**PSO 5**	**K1**
CO 2	illustrate the relationship between genomic and organelle DNA	**PSO 5**	**K2**
CO 3	identify the mechanism of prokaryotic and eukaryotic Replication and Gene expression	**PSO 5**	**K3**
CO 4	compare and contrast the varying complexities in prokaryotic and eukaryotic gene regulation	**PSO 5**	**K4**
CO 5	explain gene rearrangement and assess the causes and effects of mutation.	**PSO 5**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Mendelian Genetics: Dominance, segregation and Independent assortment. Concept of gene: Allele, Multiple allele, Pseudo allele. Extension of Mendelian principles- Linkage and Crossing over, Sex linkage and Linkage mapping. Sex determination in plants, Maternal inheritance.	**10**	**CO1-5**	**K1-K5**
II	Organization of genes and chromosomes: Structure of chromatin and chromosomes. Unique and repetitive DNA, Histones, Histone Octamer, Euchromatin and Heterochromatin-Telomeric Constitutive Heterochromatin, Interstitial Constitutive Heterochromatin, Centromeric Constitutive Heterochromatin, and Facultative Heterochromatin. Internal organization of Prokaryotic DNA, DNA Methylation. Organelle genomes: Organisation and function of Chloroplast and Mitochondrial DNA. Giant Chromosome: Polytene and Lampbrush Chromosomes. DNA Replication and Repair: Replication in Prokaryotes and Eukaryotes-enzymes involved, Replication origin, Replication fork. DNA editing and Proofreading.	**20**	**CO1-5**	**K1-K5**
III	RNA synthesis and Processing: Transcription in Prokaryotes and eukaryotesfactors and machinery, Formation of initiation complex, Transcription activator and repressors, RNA polymerases, RNA processing, RNA editing and function of different types of RNA in transport. Protein synthesis and Processing: Translation in Prokaryotes and EukaryotesRibosome, Formation of initiation complex, Initiation factors and their regulation, Elongation and Elongation factors, Termination, Genetic code, t-RNA identity, Translational proofreading, Post translational modification of Proteins.	**15**	**CO1-5**	**K1-K5**
IV	Gene Regulation: Regulation of gene action in Prokaryotes with reference to Lac operon, Positive and Negative control and His operon. Regulation of gene action in eukaryotes with reference to Britten and Davidson Model / Gene battery model. Gene regulation and Floral morphogenesis in Arabidopsis thaliana – ABC model.	**15**	**CO1-5**	**K1-K5**
V	Mutation: Types –Substitution, Insertion Deletion, Frame shift, Point mutation. Causes of Mutation and Mutant types – Lethal, Conditional, Biochemical, Loss of function, Gain of function, Germinal verses somatic mutants. Gene rearrangement: T-cells and B-cells. Somatic Recombination, Allelic exclusion.	**15**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. LEWIN, B. 2003. Genes VIII. Oxford University Press.
2. WATSON, J.D. et al. 2003. Molecular Biology of the Gene. Fourth Edition. The Benjamin. Cummings Pub. Co.
3. FRIEFELDER, D. 2005. Molecular Biology. Second Edition. Narosa Pub. House.
3. WINTER, P.C et.al., 2007. Instant Notes in Genetics. Taylor and Francis Group.
4. PHIL TURNE, R et.al., 2006. BIOS Instant Notes in Molecular Biology. Taylor and Francis Group.

References

1. GOEFRY, M. COOPER, et al.2016. The Cell - A Molecular approach. 7th Edition.Sinauer Associates Inc.
2. LEWIN, B. 2001. Genes VII. Oxford University Press.
3. JEREMY W. DALE. 2011. From Genes to Genomes - Concept and Applications of DNA Technology. Third Edition. Wiley-Black Well Publishers.
4. ROBERT BROOKES, 2014. Genetics- Analysis and Principles. Fifth Edition. McGrawHill Education.

Suggested Reading

1. BURTON E. TROPP, 2014. Genes to proteins. Fourth Edition. Jones & Bartlett Publishers.
2. GERALD KARP. 2002. Cell and Molecular Biology, John Wiley & Sons, New York. GEOFFREY. H. COOPER, et al., 2004. Cell - Molecular approach, ASM press, Washington.
3. GUPTA, P.K. 2004. Cell and Molecular Biology. Third Edition. Rastogi Publications.
4. SOBTI, R.C. and GOBE. 1991. Eukaryotic chromosomes. Narosa Publishing House.
5. SMITH-KEARY, P. 1991. Molecular Genetics. Macmillan Pub. Co. Ltd. London.
6. STEWARD, M.W. 1984. Antibodies: Their structure and function. Chapman and Hall Ltd.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3	3			3								3		K1
CO 2	3	3			3								3		K2
CO 3	3	3			3								3		K3
CO 4	3	3			3								3		K4
CO 5	3	3			3								3		K5
Wt. Avg.	3	3			3								3		
Overall Mapping of the Course													3		

PAPER 8A COMBINED PRACTICAL: ALGAL BIOLOGY AND BIOTECHNOLOGY & MOLECULAR BIOLOGY AND GENETICS

Course Code	212BO2M04		
Credits	4		
Hours / Cycle	120		
Category	Part	Core	Practical
Semester	2		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	To enable the students to learn algal distribution from natural habitat; basic hands-on training towards culture, cultivations and preparation of various products from algae. To help students to learn techniques to visualise the chromosomes and understand to the nature of DNA.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	tell the Natural habitats and the commercial importance of algae and recollect the protocols for the cell division studies and isolation and separation of genomic DNA	PSO1&PSO5	**K1**
CO 2	explain the vegetative and reproductive structures and life cycle of each algae and demonstrate the stages in mitosis and meiosis and the DNA extraction	PSO1&PSO5	**K2**

CO 3	utilize various techniques involved in isolation, purification and culture of various fresh water algal strains under laboratory conditions and solve the problems in genetic engineering and gene regulations.	PSO1&PSO5	**K3**
CO 4	compare the phycocolloids present in algae and analyze the mitotic indices and mitotic anomalies.	PSO1&PSO5	**K4**
CO 5	assess the preparation of biofertilizers, antimicrobial activity and bioremediation using algae and compare the various protocols used for DNA extraction and stages in mitosis and meiosis	PSO1&PSO5	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Identification of micro and macro algae collected from natural habitats. Examination of selected algae belonging to the Cyanophyceae, Chlorophyceae Phaeophyceae and Rhodophyceae for studying their morphology and reproductive structures. Identification of selected freshwater and marine diatoms. Preparation of algal culture medium (Bold's basal medium). Isolation and culturing of any freshwater alga under laboratory conditions. Preparation of alginate beads of immobilized algae. Preparation of blue green algal biofertilizer. Preparation of liquid seaweed fertilizer. Phycoremediation of sewage using algae. Screening marine algae for their antimicrobial activity. Extraction of agar-agar. Extraction of carrageenan. Extraction of alginic acid/sodium alginate	**60**	**CO1-5**	**K1-K5**
II	Squash preparation of Allium cepa root tips and observation of stages of mitosis Determination of mitotic indices in control and Chemical treated root meristems. Determination of mitotic anomalies in control and Chemical treated root meristems. Squash preparation of Tradescantia flower buds and observation of stages of meiosis Preparation of squash of Polytene chromosome from Chironomus larva. Isolation,Quantification and Electrophoretic separation of plant	**60**	**CO1-5**	**K1-K5**
	(Cauliflower)genomic DNA Solving problems in genetic engineering and gene regulation.			

Paper 2b Elective Theory:MICROBIAL TECHNOLOGY

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	3	3	-	-	-	3			-	3	-	-	-	3	K1
CO 2	3	3	-	-	-	3			-	3	-	-	-	3	K2
CO 3	3	3	-	-	-	3			-	3	-	-	-	3	K3
CO 4	3	3	-	-	-	3			-	3	-	-	-	3	K4
CO 5	3	3	-	-	-	3			-	3	-	-	-	3	K5
Wt. Avg.	3	3	--	-	-	3			-	3	-	-	-	3	
Overall Mapping of the Course													3		

Course Code	212BO2E01

Credits	5
Hours / Cycle	60
Category	Part Elective Theory
Semester	2
Year of Implementation	From the academic year 2021-22 onwards
Course Objectives	To expose the students to the various opportunities biologists can have in the industrial sector by manipulating and tapping the microbial resources.

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
	On completing the course successfully, the student will be able to		
CO 1	list the industries working with microbes in India and other parts of the world.	PSO-2 & 5	**K1**
CO 2	outline the microbes used in food industries and products such as SCP, cheese, yoghurt etc.,	PSO-2 & 5	**K2**
CO 3	make use of the pharmaceutical products such as antibiotics, drugs, vaccines and vitamins etc.,	PSO-5	**K3**
CO 4	categorize enzymes (amylase, protease, pectinase, lipase), amino acids (L-glutamic acid and L- Tryptophan) and organic acids (Citric acid, acetic acid and Lactic acid) produced from different microbes.	PSO-3 & 5	**K4**
CO 5	Assess the role of microbes in biofertilizer & biopesticide, its mass production, principles and application	PSO-5	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	Cos	BLOOM'S TAXONOMY LEVEL
I	Introduction – general information on microbial industries – substrates for industrial fermentation. Basic functions of a fermentation vessel, construction of typical fermentor and its attachments and role in the process.	**11**	**CO1-5**	**K1-K5**
II	Food, dairy and beverage industries: Production of single cell proteins (SCP) from bacteria, fungi, and algae, Lactic acid production, yogurt and cheese production. Alcoholic beverages: Beer and wine fermentation.	**13**	**CO1-5**	**K1-K5**
III	Pharmaceutical and related industries: Antibiotics – sources and types – production of penicillin and streptomycin. Recombinant drugs and vaccines – insulin and Hepatitis B vaccine. Principles of biotransformation – transformation of steroids. Vitamins – production of B12 and β – carotene.	**13**	**CO1-5**	**K1-K5**
IV	Enzymes, Amino acids and Organic acids: Microbial enzymes – amylase, protease, pectinase, lipase production and uses. Microbes used for amino acid production – commercial production of Lglutamic acids, L-tryptophan. Organic acids – citric acid, acetic acid production.	**13**	**CO1-5**	**K1-K5**
V	Biofertilizers and Biopesticides: Biofertilizers – mass production of phosphate solubilizing bacteria – BGA and Mycorrhizae. Biopesticides – principles, production and application. Exopolymer production.	**10**	**CO1-5**	**K1-K5**

Text Books

1. ADAMS, M.R. AND M.O. MOSS. 1995. Food Microbiology. New Age International (p) Ltd., Chennai.
2. AGARWAL, 2006. Industrial Microbiology: Fundamentals and Application, IBD publishers, New Delhi.
3. ANATHANARAYAN, R AND C.K.J. PANIKER. 2000. Text book of Microbiology, 6th Edition. Orient Longman.
4. CRUEGER F. AND ANNELIESE CRUEGER, 2000. Biotechnology: Industrial Microbiology. Panima Publications.
5. PATEL A. H. 2005. Industrial Microbiology. Macmillan India Ltd. New Delhi.

References

1. ATLAS, R.M. 1989. Microbiology - Fundamentals and Applications. McMillan Publishing Company. New York.
2. GLAZER, A.Z. AND H. NIKAIDO. 1994. Microbial Biotechnology. W.H. Freeman and Company.
3. MADIGAN, M.T. AND J.N. MARTINKO. 2006, Brock Biology of Microorganisms. 11thedition. Pearson Education, Inc. Upper Saddle River, USA
4. MCKANE, L. AND J. KANDEL. 1996. Microbiology - Essentials and Applications. McGraw Hill Inc., New York.
5. PELCZAR Jr. M.J., E.C.S. CHAN AND N.R. KRIEG. 1986. Microbiology. 5th Edition. McGraw Hill Book Company. New York.
6. PRESCOT, L.M., J.P. HARLEY AND B.A. KLEIN. 2005. Microbiology. 6th Edition. Mc Graw Hill Book Company, New York.

Suggested Reading

1. PUROHIT. 2005. Microbiology Fundamentals and Applications 6th edition. International book distributors, Dehradun.
2. RAJA, K. 2005. Microbial Biotechnology for sustainable development and productivity. IBD Publishers, New Delhi.

.Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	3	3				3					3			3	
CO 2	3	3				3					3			3	
CO 3	3	3				3								3	
CO 4	3	3				3	3					3		3	
CO 5	3	3				3								3	
Wt. Avg.	3	3				3	3				3	3		3	
Overall Mapping of the Course													3		

Paper 2b Elective Theory: PHYCOTECHNOLOGY

Course Code	212BO2E02		
Credits	5		
Hours / Cycle	60		
Category	Part	Elective	Theory
Semester	2		
Year of Implementation	From the academic year 2021-22 onwards		
Course Objectives	This will enable the students to learn the methodology for identification, documentation of algae. Learn more about the medium used for algal culture and various techniques related to culture and cultivation of algae.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	relate collection of freshwater and marine algae with its liquid preservations and herbarium techniques.	**PSO 1**	**K1**
CO 2	explain the techniques employed in enumeration, digital documentation and identification of algae.	**PSO 1**	**K2**

CO 3	develop techniques on the isolation of algae and various methods and culture of Algae.	**PSO 1**	**K3**
CO 4	compare different types of culture media and laboratory cultivation of micro and macroalgae.	**PSO 1**	**K4**
CO 5	evaluate different types of Mass cultivation of Freshwater and Marine algae.	**PSO 1**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Methods of Collection of Algae: Collection of Planktonic algae: Plankton net, Sedimentation method. Collection of Filamentous and other Macro Algae Transportation and Preservation of Freshwater and Marine Algae; Liquid preservation and Herbarium techniques.	**12**	**CO1-5**	**K1-K5**
II	Methods of studying Phytoplankton: Enumeration of Planktonic Algae using Haemocytometer. Calibration of Microscope. Using Camera Lucida to draw Algal diagrams. Digital Image Recording using a Photomicrographic Unit and Measuring the Dimensions of Algae using Computer Software. Methods of Identification of Algae using Algal Monographs.	**12**	**CO1-5**	**K1-K5**
III	Methods of Isolation of Microalgae: Serial Dilution and Streak Plate Method for Planktonic Algae; Isolation Methods for Filamentous and Macro Algae. Types of Culture: Mixed culture, Enrichment culture, Unialgal culture and Axenic culture.	**12**	**CO1-5**	**K1-K5**
IV	Laboratory Culture of Microalgae and Macroalgae. Types of Culture Media for Algae and Methods of Preparation of Solid Medium, Broth Culture and Agar Slants. Selected Media for different groups of Algae such as F/II for Blue Green Algae, Bold's Basal medium for Green Algae and Chu 10 medium for Blue-green and Green Algae. Preparation of CFTRI and Zarruk medium.	**12**	**CO1-5**	**K1-K5**
V	Mass Cultivation of Microalgae: Open tank, Raceway ponds, Photobioreactors, Batch cultures and Continuous cultures. Mass cultivation of Marine Macro Algae: Rope cultivation, Bag cultivation, Net cultivation and Raft cultivation methods.	**12**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. BARSANTI, LAURA AND PAOLO GUALTIERI 2014, Algae-Anatomy, Biochemistry and Biotechnology. Taylor & Francis, London, New York.
2. BECKER, E.W. 1994. Microalgae Biotechnology and Microbiology. Cambridge University Press.
3. BELLINGER, E. G. AND D. C. SIGEE, 2015. Freshwater Algae: Identification, Enumeration and use as Bioindicators. John Wiley & Sons, UK. 275pp.
4. BOROWITZKA, M.A. and I.J. BOROWITZKA, 1988. Microalgal Biotechnology. Cambridge University Press, Cambridge.
5. RICHMOND A. AND Q. HU, 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology. John Wiley & Sons, UK. 719pp.
6. TRIVEDI, P.C. 2001. Algal Biotechnology. Tata Mc Graw Hill Publishing Ltd., New Delhi. STEIN, J.R. Handbook of Phycological Methods. University Press, Cambridge.

References

1. BOROWITZKA, M. A AND N. R. MOHEIMANI. 2013. Algae for Biofuels and Energy. Springer, New York.
2. ISRAEL, A., EINAV, E AND J. SECKBACH, 2010. Seaweeds and their role in Globally Changing environments. Springer, New York.
3. KIM, S. 2012. Handbook of Marine Macroalgae: Biotechnology and Applied Phycology. Wiley-Blackwell, UK.
4. KIM, S. AND K. CHOJNACKA, 2015. Marine Algae Extracts- Processes, Products, and Applications. Wiley-VCH Verlag GmbH & Co., Germany, 766pp.

Suggested Reading

1. PEREIRA L. AND J. M. NETO, 2015. Marine Algae: Biodiversity, Taxonomy, Environmental Assessment and Biotechnology. Taylor & Francis, NW, USA.
2. SAHOO, D. AND J. SECKBACH, 2015. The Algae World. Springer, New York. 594pp.
3. WEHR J. D. AND R. G. SHEATH. 2003. Freshwater Algae of North America: Ecology and Classification. Academic Press, California, USA.
4. WONG Y. S AND N. F.Y. TAM. 1998. Wastewater treatment with algae I. Springer, NY.

Course Articulation Matrix

Course Outcomes	Programme Outcomes	Programme Specific Outcomes	Cognitive Level

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3		-	-	-	-	-	-		3				
CO 2	3		-	-	-	-	-	-		3				
CO 3	3		-	-	-	-	-	-		3				
CO 4	3		-	-	-	-	-	-		3				
CO 5	3		-	-	-	-	-	-		3				
Wt. Avg.	3		-	-	-	-	-	-		3				
Overall Mapping of the Course													3	

Paper 9a. ANGIOSPERM SYSTEMATICS

Course Code	**212BO3M01**		
Credits	**5**		
Hours / Cycle	**75**		
Category	**Part**	**Major**	**Theory**
Semester	**III**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To educate students with various angiosperms classifications, taxonomic literature, method of phylogenetic systematics, applications of nomenclature rules, and diagnosis and circumscription of selected flowering plant families.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall various angiosperms classifications. Classify flowering plants based on Angiosperm Phylogeny Group Classifications	**PSO 2**	**K1**
CO 2	compare local flora using taxonomic keys given in flora, revision and monograph.	**PSO 2**	**K2**
CO 3	construct cladograms and infer the relationships between taxa in phylogenetic tree.	**PSO 2**	**K3**
CO 4	distinguish various ICN rules and apply them to describe a new taxon and solve various nomenclatural problems.	**PSO 2**	**K4**
CO 5	select a detailed technical description of flowering plants and construct an unambiguous taxonomic keys.	**PSO 2**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Systematics – aims and phases. A brief history of pre-Darwinian and postDarwinian classification systems. An outline of classifications proposed by Bentham and Hooker, Engler and Prantl and Kubitzki. A detailed study on Angiosperms Phylogeny Group (APG) Classifications (I–IV).	**10**	**CO1-5**	**K1-K5**
II	Herbarium – Preparation, Maintenance and Digitization. World and Indian Herbaria: Royal Botanic Gardens (Kew), Natural History Museum (London) and Botanical Survey of India and regional centres. Taxonomic Keys – Dichotomous and Bracketed. Floras, Revisions and Monographs. Botanic gardens and their importance. Species Concepts – Morphological, Biological and Phylogenetic.	**15**	**CO1-5**	**K1-K5**

III	Nomenclature – Outline of International Code of Nomenclature for Algae, Fungi and Plants (Shenzhen Code), Typification, Priority, Author Citation, Effective and Valid Publications, New Combinations, Names at New Rank, Replacement Name, Homonym, Synonym, Tautonym, Autonym, Basionym and Conserved Names	**15**	**CO1-5**	**K1-K5**
IV	Phylogenetic Systematics – Characters: Morphological and Molecular, Plesiomorphous and Apomorphous, Homologous and Analogous, Homoplasy and Convergence. Character Coding: Binary and Multistate, Polarity. Cladistics: Cladogram Construction, Monophyly, Paraphyly and Polyphyly, Principle of Parsimony, Polytomy, Outgroup Comparison, Consensus Trees.	**15**	**CO1-5**	**K1-K5**
V	A Systematic study of the following families: Nymphaeceae, Magnoliaceae, Lauraceae, Alismataceae, Orchidaceae, Arecaceae, Cyperaceae, Poaceae, Menispermaceae, Euphorbiaceae, Rhamnaceae, Moraceae, Melastomataceae, Polygonaceae, Nyctaginaceae, Rubiaceae, Convolovulaceae, Bignoniaceae, Acanthaceae and Asteraceae.	**20**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- DAVIS, P.H. AND V.H. HEYWOOD. 1965. Principles of Angiosperm Taxonomy. Oliver & Boyd. Edinburgh.
- HENRY, A.N. AND M. CHANDRABOSE. 1980. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.
- JAIN, S.K. AND R.R. RAO. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.
- LAWRENCE, G.H.M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.
- SIMPSON, M.G. 2010. Plant Systematics. Elsevier Academic Press, California, USA.
- SINGH, G. 2005. Plant Systematics - Theory and Practice. Oxford & IBH Publishing & Co., New Delhi.
- SIVARAJAN, V.V. 1989. Introduction to Principles of Plant Taxonomy. Oxford and IBH Publishing Co. New Delhi.
- STUESSY, T.F. 2009. Plant Taxonomy. The systematic evaluation of comparative data. Columbia University Press, New York.

References (3 – 5)

- AHMEDULLAH, M. AND M.P. NAYAR. 1987. Endemic Plants of the Indian Region. Vol. I Botanical Survey of India. Howrah. GAMBLE, J.S. AND C.E.C. FISCHER. 1915–1935. Flora of the Presidency of Madras. Vols. I-III. Adlard & Sons., London.
- TURLAND, N.J., WIERSEMA, J.H., BARRIE, F.R., GREUTER, W., HAWKSWORTH, D.L., HERENDEEN, P.S., KNAPP, S., KUSBER, W.H., LI, D-Z., MARHOLD, K., MAY, T.W., MCNEILL, J., MONRO, A.M., PRODO, J., PRICE, M.J. & SMITH, G.F. (2018) International Code of Nomenclature for algae, fungi and plants (Shenzhen Code). Regnum Vegetabile 159. Koeltz Scientific Books, Koenigstein.
- NAYAR, M.P., AND R.K. SASTRY. 1987-1990. Red Data Book on Indian Plants. Vols. I - III. Botanical Survey of India. Howrah.
- TAKHTAJAN, A. 1997. Diversity and Classification of Flowering Plants. Bishen Singh and Mahendra pal Singh, DehraDun, India.
- SINGH, P. & AL. 2015. Endemic Vascular Plants of India. Botanical Survey of India, Kolkata.
- STEARN, W.T. (1992). Botanical Latin. David & Charles, Abbott.

Suggested Reading (2 -5)

- BRUMMIT, R.K. AND POWELL, C.E. (1992). Authors of Plant Names. Royal Botanical Gardens, Kew.
- CRONQUIST, A. 1968. The Evolution and Classification of Flowering Plants. Houghton Mifflin. Boston.
- FORMAN, L. AND BRIDSON, D. 1989. The Herbarium Handbook. Royal Botanic Gardens, Kew.
- JUDD, W.S, CAMPBELL, C.S., KELLOGG, E.A., STEVENS, P.F. AND N.J. DONOGHUE. 2008. Plant Systematics – A phylogenetic approach. 3rd Edition. Sinauer Associates, Massachusetts, USA.

Web Resources (3-5)

http://www.mobot.org/MOBOT/research/APweb/
https://www.ipni.org/ http://www.efloras.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes					Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	
CO 1	3		-	-	-	-	-	-		3				
CO 2	3		-	-	-	-	-	-		3				
CO 3	3		-	-	-	-	-	-		3				
CO 4	3		-	-	-	-	-	-		3				
CO 5	3		-	-	-	-	-	-		3				
Wt. Avg.	3		-	-	-	-	-	-		3				

	Overall Mapping of the Course	3

Paper 10a. PLANT PHYSIOLOGY AND BIOCHEMISTRY

Course Code	**212BO3M02**		
Credits	**5**		
Hours / Cycle	**75**		
Category	**Part**	**Major**	**Theory**
Semester	**III**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To understand the mode of transport process in plants. To comprehend the vegetative and reproductive growth processes of plants in relation to environment. To study the biochemical reactions of different metabolic pathways.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	match the transport phenomena in Plants.	**PSO4**	**K1**
CO 2	explain the regulation of plant growth and Elaborate on the ecophysiology of plants.	**PSO 1&4**	**K2**
CO 3	identify the structure, classification and function of biomolecules.	**PSO 4**	**K3**
CO 4	analyse the regulation of enzyme activity.	**PSO 4**	**K4**
CO 5	assess the metabolic reaction pathways.	**PSO 4**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Transport Phenomena: Properties of water. Water relations in plants. Mechanism of absorption and transport of water. Transpiration and regulation of stomatal movements. Mineral absorption and nutrition. Phloem translocation - Phloem loading, Long-distance transport and grain-filling process with special reference to cereals. Regulation of Plant Growth: Growth dynamics. Control of vegetative and reproductive growth in plants. Role of plant hormones in plant growth. Application of Plant Growth Regulators in agriculture for crop production.	**15**	**CO1-5**	**K1-K5**
II	Ecophysiology: Plant Morphogenesis. Phytochrome and Photoperiodism. Florigen theory-Chailakhyan concept. Floral initiation, induction- causative factors, role of photoperiod, temperature, hydroperiodic stimulus. Physiology of seed dormancy. Mechanism of seed germination. Plant responses to biotic and abiotic stresses. Signal transduction in plants.	**15**	**CO1-5**	**K1-K5**
III	Biomolecules: Classification, structure, function and properties of primary metabolites - Carbohydrates, Amino acids and Proteins. Secondary Metabolites - Alkaloids, Terpenoids, Phenolics and Flavonoids. Plant Membranes: Ultrastructure and function, transport across membranes. Membrane and ATP synthesis. Hormone receptors and cellular communication.	**15**	**CO1-5**	**K1-K5**

IV	Enzymes: Classification, structure, reaction kinetics, inhibition and regulation of enzyme activity. Interpretation of enzyme kinetics using Michaelis-Menten plots. Nitrogen Metabolism: Nitrogen cycle and Metabolism. Introduction to nitrogen fixation. Nitrogen fixing organisms. Nitrate and ammonia assimilation.	**15**	**CO1-5**	**K1-K5**
V	Photosynthesis: History and evolutionary importance of photosynthesis. Nature of light and its absorption by plant pigments. Chlorophyll-a fluorescence. Molecular structure of chloroplast proteins. Organization of pigments and proteins in membranes. Photosystems I and II. Light reaction, electron flow, ATP production in functional model of chloroplast membrane and generation of NADPH. Pathways of carbon fixation C3, C4, C4 Subtypes-NADP-ME, NAD-ME & PEP-CK and CAM. Photorespiration. Quantum yield, efficiency of energy transfers and crop productivity. Respiration: Ultrastructure of mitochondria, importance of glycolysis and Kreb's cycle, ETC in mitochondria and chemiosmotic hypothesis. Respiration of pentose and lipids and cyanide resistant respiration.	**20**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- DAVIS, P.H. AND V.H. HEYWOOD. 1965. Principles of Angiosperm Taxonomy. Oliver & Boyd. Edinburgh.
- HENRY, A.N. AND M. CHANDRABOSE. 1980. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.
- JAIN, S.K. AND R.R. RAO. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.
- LAWRENCE, G.H.M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.
- SIMPSON, M.G. 2010. Plant Systematics. Elsevier Academic Press, California, USA.
- SINGH, G. 2005. Plant Systematics - Theory and Practice. Oxford & IBH Publishing & Co., New Delhi.
- SIVARAJAN, V.V. 1989. Introduction to Principles of Plant Taxonomy. Oxford and IBH Publishing Co. New Delhi.
- STUESSY, T.F. 2009. Plant Taxonomy. The systematic evaluation of comparative data. Columbia University Press, New York.

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- AHMEDULLAH, M. AND M.P. NAYAR. 1987. Endemic Plants of the Indian Region. Vol. I Botanical Survey of India. Howrah.
- GAMBLE, J.S. AND C.E.C. FISCHER. 1915–1935. Flora of the Presidency of Madras. Vols. I-III. Adlard & Sons., London.
- TURLAND, N.J., WIERSEMA, J.H., BARRIE, F.R., GREUTER, W., HAWKSWORTH, D.L., HERENDEEN, P.S., KNAPP, S., KUSBER, W.H., LI, D-Z., MARHOLD, K., MAY, T.W., MCNEILL, J., MONRO, A.M., PRODO, J., PRICE, M.J. & SMITH, G.F. (2018) International Code of Nomenclature for algae, fungi and plants (Shenzhen Code). Regnum Vegetabile 159. Koeltz Scientific Books, Koenigstein.
- NAYAR, M.P., AND R.K. SASTRY. 1987-1990. Red Data Book on Indian Plants. Vols. I - III. Botanical Survey of India. Howrah.
- TAKHTAJAN, A. 1997. Diversity and Classification of Flowering Plants. Bishen Singh and Mahendra pal Singh, DehraDun, India.
- SINGH, P. & AL. 2015. Endemic Vascular Plants of India. Botanical Survey of India, Kolkata.
- STEARN, W.T. (1992). Botanical Latin. David & Charles, Abbott.

Suggested Reading (2 -5)

- BRUMMIT, R.K. AND POWELL, C.E. (1992). Authors of Plant Names. Royal Botanical Gardens, Kew.
- CRONQUIST, A. 1968. The Evolution and Classification of Flowering Plants. Houghton Mifflin. Boston.
- FORMAN, L. AND BRIDSON, D. 1989. The Herbarium Handbook. Royal Botanic Gardens, Kew.
- JUDD, W.S, CAMPBELL, C.S., KELLOGG, E.A., STEVENS, P.F. AND N.J. DONOGHUE. 2008. Plant Systematics – A phylogenetic approach. 3rd Edition. Sinauer Associates, Massachusetts, USA. **Web Resources (3-5)**

http://www.mobot.org/MOBOT/research/APweb/

https://www.ipni.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3											3			K5
CO 2	3								3			3			K5
CO 3	3											3			K5
CO 4	3											3			K5

CO 5	3		3	K5
Wt. Avg.	3	**3**	3	

Overall Mapping of the Course 3

PAPER 11a ECOLOGY, FORESTRY AND REMOTE SENSING

Course Code	**212BO3M03**		
Credits	**4**		
Hours / Cycle	**75**		
Category	**Part**	**Major**	**Theory**
Semester	**III**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	This course is particularly suited to know the current speed of habitat and species diversity loss caused by human activities and to develop knowledge amongst students to restore them		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall the structure and function of ecosystems, biogeography and remote sensing.	**PSO3**	**K1**
CO 2	understand with major forest types and their conservation.	**PSO3**	**K2**
CO 3	develop awareness of population ecology and remote sensing.	**PSO3**	**K3**
CO 4	examine the impact of global climatic change and its multiple threats.	**PSO3**	**K4**
CO 5	assess the current advances in remote sensing technology and its applications to manage natural resources.	**PSO3**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Ecosystem ecology: Structure and function of some Indian ecosystems: Terrestrial (forest, grassland) and Aquatic (fresh water, marine). Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche, Ecological niche modelling; resource partitioning; character displacement. Biogeography: Major Terrestrial Biomes; theory of Island Biogeography; Biogeographical zones of India. Holdridge Life Zone Classification.	**15**	**CO1-5**	**K1-K5**
II	Community ecology: Nature of Communities; Community structure and attributes; levels of Species Diversity and its measurement; Edges and Ecotones. Forest community as an Interacting system. Synusiae in a forest community and their relationship with the forest environment. Microclimate and Macroclimate. Ecological succession: Hydrosere and Xerosere, mechanisms, changes involved in Succession; Seral stages; Autogenic and Allogenic succession, Concept of Climax.	**15**	**CO1-5**	**K1-K5**
III	Population Ecology: Characteristics of a population; Population growth curves; Population regulation; r-selection and k-selection in species populations. Concept of Metapopulation – Demes and Dispersal, Interdemic Extinctions, Age structured populations. Sympatry and Allopatry speciation. Demography and Survivorship curves. Competition exclusion principle. Types of species interactions: Interspecific and Intraspecific Competition, Herbivory, Carnivory, Predation, Parasitism, Pollination, Symbiosis, Commensalism, Mutualism.	**15**	**CO1-5**	**K1-K5**

IV	Forestry: Introduction to Forestry, their ecology, Distribution and Extent. Classification of Indian Forests by Champion and Seth (1968). Timber and Non-timber Forest produce. Silviculture of Indian Teak. Forest Management and Conservation: National Forest Policy and Forest Conservation act (1980). Estimation of Growing Stock. Yield Regulation - Concept, Basis and Yield Regulation Models - Estimation of Growth and Yield Prediction in Forest Stands - Stand Structure - Stand density		**CO1-5**	**K1-K5**
V	Remote Sensing: Principles of Remote Sensing. The Electromagnetic spectrum. Data Acquisition Platforms: Aircrafts, LANDSAT, SPOT, IRS and INSAT. Sensors: Basic Characteristics of Sensors and Pixel, Spatial, Spectral, Temporal, Radiometric Resolutions. Geographical Information System (GIS): Definition, Components of GIS, Digital analysis and Ground Truth. Data Input and Output in GIS. Photographs and FCC. Applications of Remote Sensing.		**CO1-5**	K1-K5

Prescribed Books/Textbooks (1-5 books)

- Eugene P. Odum and Gray W. Barrett. 2009. Fundamentals of Ecology. Fifth Edition. Brooks/Cole, a part of Cengage Learning.
- Michael P. 1984. Ecological Methods for Field and Manual Laboratory Investigations. Tata McGraw Hill Publishing Company Limited, New Delhi.
- Singh, J.S., Singh, S.P. & Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Company Pvt. Ltd., New Delhi.
- Harry G. Champion & S.K. Seth. 2005. A Revised Survey of the Forest Types of India.
- Upendra Arora for Natraj Publishers, Publications Division, Dehradum, New Delhi.
- Trivedi, P, R and Sudarshan, K, N. (1996). Forest Management. Discovery publications, New Delhi.

References (3 – 5)

- Aulay Mackenzie, Andy S. Ball and Sonia R. Virdee. 2002. Ecology – Instant Notes. Second Edition. Viva Books Pvt Ltd, New Delhi.
- Kutty, R., and Kothari, A. 2001. Protected areas in India – A profile. Kalpavriksh, MoEF. New Delhi, India.
- Yanney, E. 1985. Elements of Ecology. ELBS Publication. Heinemann Educational Books.
- George Joseph. 2005. Fundamentals of Remote Sensing by George Joseph Edition II. University Press private limited.

Suggested Reading (2 -5)

- Krishnamurthy. KV, 2003. An Advanced Textbook on Biodiversity - Principles and Practice, Oxford and IBH Publishing, NewDelhi.
- Miller.G.T., Jr. 2014. Environmental Science. 14th Edition, Thomson, California. Sharma. P.D. 2003. Environmental Biology and Toxicology. Second Edition. Rakesh Kumar Rastogi for Rastogi Publications, Gangotri Shivaji Road, Meerut.
- Richard T. Wright and Dorothy F. Boorse. 2010. Environmental Science Toward a Sustainable Future. 11th Edition. PHI Learning Private Limited, New Delhi.

Web Resources (3-5)

Course Articulation Matrix

Course Outcomes	Program Outcomes								Programme Specific Outcomes						Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	
CO 1	3					3					3				
CO 2	3					3					3				
CO 3	3					3					3				
CO 4	3					3					3				
CO 5	3					3					3				
Wt. Avg.	3					3					3				
Overall Mapping of the Course												3			

PAPER 11a ECCOMBINED PRACTICAL ON ANGIOSPERMS SYSTEMATICS; PLANT PHYSIOLOGY, BIOCHEMISTRY & ECOLOGY, FORESTRY AND REMOTE SENSING

Course Code	**212BO3M04**		
Credits	**4**		
Hours / Cycle	**75**		
Category	**Part**	**Major**	**Theory**
Semester	**III**		
Year of Implementation	**2021-2022 onwards**		

Course Objectives	To equip students with the preparation of a detailed description with taxonomic key and herbarium specimen based on the fresh collections, and solve basic nomenclatural problems according to the ICN rules. To familiarize students with the Laboratory experiments related to Plant Physiology and Biochemistry for effective learning. To train students in field techniques for the analysis of vegetation using quadrat methods.

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	define basic nomenclatural problems and construct unambiguous taxonomic key and Preparation and maintenance of herbarium specimens.	**PSO2**	**K1**
CO 2	explain flowering plants based on taxonomic technical Terms.	**PSO2**	**K2**
CO 3	identify the importance of water, minerals and food transport in plants and Evaluate the biomolecules present in plants.	**PSO4**	**K3**
CO 4	analyse water and soil for pH, acidity, alkalinity, chlorinity, free carbon dioxide, dissolved oxygen and organic matter.	**PSO4**	**K4**
CO 5	assess the vegetation Simpson's and Shannon-Wiener indices and Quantitative sampling of biodiversity.	**PSO6**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	ANGIOSPERMS SYSTEMATICS 1. Systematic study of locally available plants belonging to the families mentioned in the theory. To draw L.S of flower and floral diagram. 2. Construction of dichotomous indented keys. 3. Construction of simple cladograms and phenograms. 4. Solving nomenclatural problems based on ICN rules. 5. Field visits to study flora. 6. A set of 20 herbarium specimens and field diary to be submitted during the End of Semester Practical Examination.	**30**	**CO1 -5**	**K1-K5**

II	PLANT PHYSIOLOGY AND BIOCHEMISTRY 7. Preparation of different solutions: Molar, Molal and Normality solutions, pH and Buffers. 8. Determination of water potential using Chardakov's, and plasmolytic methods. 9. Effect of temperature and organic solvents on permeability of beet root cells. 10. Separation of known and unknown amino acids by paper chromatography. 11. Separation of chloroplast pigments by paper / column chromatography and quantification of chlorophyll a, b and carotenoids. 12. Estimation of total carbohydrates (Anthrone reagent method / Phenol Sulphuric Acid method). 13. Estimation of free amino acids by Ninhydrin method. 14. Estimation of total proteins (Lowry's method / Bradford method). 15. Determination of the activity of enzyme catalase and amylase. 16. Effect of light and wind on rate of transpiration. 17. Localization of potassium ions in the guard cells of stomata during stomatal opening and closure. 18. Structure, function and relationship in C3 and C4 photosynthetic sub types. (C3-Bambusa, Oryza; C4 Subtypes- NADP-ME - Aristida, Digitaria, Cenchrus; NAD-ME – Cynodon, Eleusine; PEP-CK – Chloris, Eragrostis). 19. Comparative rate of respiration in the plant samples by titration method. 20. Demonstration of Hill reaction with isolated chloroplast by DCPIP method. 21. Demonstration of Gravitropic response in grass pulvinus. 22. Demonstration of effect of PGRs on seed germination.	**60**	**CO1 -5**	**K1-K5**
III	ECOLOGY, FORESTRY AND REMOTE SENSING 23. Qualitative study of pH in soil and water samples. 24. Determination of dissolved oxygen in the water samples. 25. Determination of free CO2 in water samples. 26. Estimation of salinity in brackish water sample. 27. Estimation of concentration of chloride ions (chlorinity) in water samples. 28. Estimation of Alkalinity in water samples. 29. Determination of organic matter in the soil sample. 30. Measurement of soil temperatures using soil thermometer. 31. Field Techniques forPopulation Sampling and Estimation of trees in MCC using. Line transect methods. 32. Field Techniques forPopulation Sampling and Estimation of trees in MCC using Belt transect methods. 33. Determination of frequency, frequency percentage, density and abundance of plant species by using quadrat method. 34. Analysing the vegetation using Simpson's and Shannon-Wiener indices. 35. Study of bioclimates, construction of ombrothermic diagrams and interpretation of their ecological implications using meteorological data. 36. Study of the environmental profile of a local pond ecosystem. 37. Estimation of dry biomass in a forest ecosystem. 38. Map of phytogeographical regions of India using GIS. 39. Field exercise for the estimation of actual growing stock volume.	**45**	**CO1 -5**	**K1-K5**

Course Articulation Matrix

Course Outcomes	**Program Outcomes**								**Programme Specific Outcoms**						**Cognitive Level**
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**	**PSO 5**	**PSO 6**	
CO 1	3									3					K1
CO 2	3									3					K2
CO 3	3											3			K3
CO 4	3											3			K4
CO 5	3	3	3	3	3									3	K5

Wt. Avg.	3	3	3	3	3					3		3		3	
Overall Mapping of the Course													3	

Paper 13b BIOINFORMATICS

Course Code	212BO3E01		
Credits	5		
Hours / Cycle	60		
Category	Part	Core elective	Theory
Semester	III		
Year of Implementation	2021-2022 onwards		
Course Objectives	To make the students to efficiently organize large amounts of data generated in the field of molecular biology and to identify/ develop the tools that aid the analysis & interpretation of such data. .		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall the principles of in silico studies, the aim, tasks, scope, and applications of bioinformatics as a multidisciplinary tool	PSO-5	K2
CO 2	understand the basic concepts that underpin bioinformatics analysis.	PSO-5	K2
CO 3	compare protein structures from a given set of data.	PSO-5	K3
CO 4	analyze the sequence analysis and evolutionary relationships using phylogenetic analysis.	PSO-5	K4
CO 5	evaluate phylogenetic analysis and the concepts of pharmacogenomics by using drug discovery using drug discovery softwares.	PSO5	K5

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Introduction to Bioinformatics: Aim, Tasks, Scope and Applications of Bioinformatics. Bioinformatics as a Multidisciplinary Tool. Introduction to Genomics, Transcriptomics, Proteomics. Information Retrieval System. DNA Sequencing and Human Genome Project.	15	**CO1-5**	**K1-K5**
II	Biological Databases: Structure, Sequence and Literature databases. Protein Sequence, Database - PIR, SWISS-PROT, MIPS. Protein Structure Database - PDB, SCOP. DNA Sequence Databases Gen Bank, EMBL, DDBJ. Literature database – Med Line, PubMed. Patterns, Motifs and Profile databases. Metabolic Pathway Databases (KEGG).	15	**CO1-5**	**K1-K5**
III	Protein Structure Prediction and Protein Folding: Protein architecture, classification of protein structures – Primary, Secondary, Tertiary and Quaternary structures. Protein Stability and Folding – Ramachandran Plot. Protein Structure Prediction – Fold Recognition, Conformational Energy Calculations.	15	**CO1-5**	**K1-K5**
IV	Alignment and Analysis, Homology and Phylogeny: Local and Global Alignment Sequence. Scoring matrices. Database Similarity Searches: BLAST, FASTA; Pairwise sequence alignment EMBOSS. Multiple sequence alignments – CLUSTAL W. Sequence Analysis. Alignment and Phylogenetic Trees. Homology and Similarity, Phylogeny and Relationships, Hidden Markov Models for Homology Modeling.	15	**CO1-5**	**K1-K5**

V	Pharmacogenomics: Important Parameters in Drug Discovery and the Role of Computational Methods. Processes of Drug Discovery, Computer Aided Drug Design (CADD). Molecular Docking-Ligand-Receptor Interaction, Concepts of Pharmacophore.	15	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

- IGNACIMUTHU. S.S.J. (2005). Basic Bioinformatics, Narosa Publishing House, India.
- MURTHY. C. S.V. (2006). Bioinformatics. Himalaya Publishing House, New Delhi.
- KOTHEKAR V AND T. NANDI. (2009). An introduction to Bioinformatics. Panima publishing crop, New Delhi.
- RON WEHRENS AND REZA SALEK. (2019) 1st edition. Chapman and Hall/CRC; Metabolomics: Practical Guide to Design and Analysis

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- MURTHY, C.S.V. Bioinformatics. (2019). Himalaya Publishing House, New Delhi.
- ZHUMAR GHOSH AND BIBEKANAND MALLICK. (2008) Bioinformatics principals and Applications. Oxford University Press.
- DAVID MOUNT. (2004). Bioinformatics: Sequence and Genome Analysis, Second Edition. Publisher: Cold Spring Harbor Laboratory Press Bookstore.
- IFRAN ALI KHAN AND ATIYA KHANUM. (2004). Fundamentals of Bioinformatics. Ukaaz Publication, Hyderabad.

Suggested Reading

- ANDREAS D. BAXEVANIS AND B. F. FRANCIS OUELLETTE. (2001). Bioinformatics. A Practical Guide to the Analysis of Genes and Proteins (Second Edition). John Wiley & Sons, Inc.
- ARTHUR M. LESK. (2003). Introduction to Bioinformatics. Oxford University Press.
- MALCOLM CAMPBELL, A. AND LAURIE J. HEYER. (2003). Discovering Genomics, Proteomics and Bioinformatics. Pearson Education (Singapore) Pvt. Ltd.
- JEAN-MICHEL CLAVERIE AND CEDRIC NOTREDAME. (2006). Bioinformatics- A Beginner's Guide. Wiley Publishing, Inc.
- LESK, A.M. (2006). Introduction to Bioinformatics. (2nd Edition). Oxford University Press, New Delhi.
- GAUTHAM, N. (2006). Bioinformatics - Databases and Algorithms, Narosa Publishing House Hall of India Pvt. Ltd, New Delhi.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3	3			3								3		K1
CO 2	3	3			3								3		K2
CO 3	3	3			3								3		K3
CO 4	3	3			3								3		K4
CO 5	3	3			3								3		K5
Wt. Avg.	3	3			3								3		
													Overall Mapping of the Course		3

PAPER 13b NANOBIOTECHNOLOGY

Course Code	**212BO3E02**		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Core/** Allied / **Elective**	**Theory** / Practical
Semester	**III**		
Year of Implementation	**From the <u>academic year 2022-2023</u> onwards**		

Course Objectives	To familiarize the students about the concepts, application and prospects in nanobiotechnology.

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	Know about the concepts and prospects in biological nanoobjects and nanoparticle.	PSO4 & PSO5	**K1**
CO 2	understand the methods in analysis of nanostructure.	PSO5	**K2**
CO 3	develop an insight to biosensors and its types.	PSO5	**K3**
CO 4	classify the various application of Nanobiotechnology.	PSO4 & PSO5	**K4**
CO 5	evaluate the implication of nanoscience on society, issues on policies and public perception and involvement.	PSO5	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Nanobiology- History, Concepts, Definitions, Prospects & Challenges. Biological Nanoobjects – Topology of DNA, Protein, Lipid Assembly - Biological Networks. Nanoparticles - Shape, Structure & Types. Nano Composites. Diagnosis and Screening of Nano particle.	12	**CO1-5**	**K1-K5**
II	Methods of Nanobiotechnology - Analysis of bimolecular Nanostructures by Atomic Force Microscopy, Scanning Probe Electron Microscopy, Scanning Tunneling Microscopy, Infrared	12	**CO1-5**	**K1-K5**

	Spectrum, NMR, X-ray Crystallography, Immuno PCR and Lithography.			
III	Biosensors – Types: Potential, Electrochemical & Biomembrane based sensors. Biochips - DNA Microarrays, Digital & Molecular Biochip Imaging techniques -Nanorobots. Determination of Mechanical properties - Mechanical Testing, Elasticity, Toughness.	12	**CO1-5**	**K1-K5**
IV	Application of Nanobiotechnology - Nanotechnology in: Computers, Fabrics, Mobile, Electronics, Biology, Environment (Nanoremediation), Agriculture (nanofertilizers and nanopesticides), Defence (nanobomb). Drug Delivery Systems - Polymer Therapeutics - Polymer Drug Conjugates; Liposome. Nanosized Reporter Probes. Application of Nanobiotechnology in Medicine, Drug Designing and Cancer treatment, Nano Surgery, Nanoparticulate Based Synthetic Bone.	14	**CO1-5**	**K1-K5**
V	Medical, Social and Economic Status of Nanobiotechnology. Implications of Nanoscience on society, Issues on Nano policies, Public perception and Public involvement in the Nano Discourse. Pitfalls, Future and Scope of Nanotechnology. Nano technology in India.	10	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- CHRISTOF M. NIEMAYER, CHAD A. MIRKIN. 2004. Nanobiotechnology: Concepts, applications and perspectives, Wiley VCH publishers.
- JAIN K.K. 2001. Nanobiotechnology: Molecular Diagnosis, Taylor Francis Group.

References (3 – 5)

- MUKHERJI, H. 1982. Plant Groups. 9th Edition. New Central Book Agency. Calcutta.
- SALISBURY, F.B., AND C.W. ROSS. 1992. Plant Physiology. 4th Edition. Wadsworth Pub. Co. California.

Suggested Reading (2 -5)

- ANANTA SWARGIARY. 2017. Biological Tools & Techniques (A textbook for UG/PG students of Life Sciences). Kalyani Publishers, New Delhi.
- BAJPAI P.K. 2010. Biological Instrumentation & Methodology. S Chand & Company.
- RAJA, K. 2005. Microbial Biotechnology for sustainable development and productivity. IBD Publishers, New Delhi.
- TUAN VO-DINH. 2010. Protein Nanotechnology: Protocols, Instrumentation, and Applications. Edition II. Springer Science & Business Media.

Web Resources (3-5)

- Nanodot: News and Discussion of Coming Technologies. http://nanodot.org
- Nanoforum – European Nanotechnology Gateway. http://www.nanoforum.org
- Nanomagazine. http://www.nanomagazine.com
- Nanospot: A Search Tool for Nanotechnology. http://www.nanospot.org
- Nanotechnology. http://www.nanotechnology.com

Course Articulation Matrix

Course Outcomes	Programme Outcomes									Programme Specific Outcomes					Cognitive Level
	PO 1	PO 2	PO 3	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	3	3				3							3	3	K1
CO 2	3	3				3								3	K2
CO 3	3	3				3								3	K3
CO 4	3	3				3							3	3	K4
CO 5	3	3				3								3	K5
Wt. Avg.	3	3				3							3	3	-
Overall Mapping of the Course													3		

13a. Biotechnology, Plant Tissue Culture and Crop Improvement

Course Code	**212BO4M01**
Credits	**5**
Hours / Cycle	**75**

Category	Part	Core	Theory
Semester	IV		
Year of Implementation	2021-2022 onwards		
Course Objectives	To impart knowledge that leads to comprehensive understanding of the principles, tools and practices of biotechnology. To empower the students with the ability to think and solve the problems in the field of biotechnology. To enable students to gain basic understanding of plant tissue culture techniques and its applications.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall the organization of PTC Lab, techniques plant tissue culture, branches of biotechnology and techniques in genetic engineering.	**PSO4& 5**	**K1**
CO 2	understand the importance of large scale in vitro propagation of plants and commercial production through micropropagation.	**PSO4& 5**	**K2**
CO 3	identify the importance of plant secondary metabolites, their production, and the tools and techniques in biotechnology for the isolation and manipulation of DNA	**PSO4& 5**	**K3**
CO 4	apply the methodologies in crop improvement through biotechnology.	**PSO4& 5**	**K4**
CO 5	evaluate plant tissue culture methods and techniques for crop improvement	**PSO4& 5**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Introduction to Biotechnology: Branches-Red, Blue, White and Green Biotechnology, history and scope. Genetic transformation and production of Transgenic Plants: Direct and Indirect (Physical, Chemical and Biological) methods with special emphasis on Chloroplast and Protoplast Transformation. Confirmation of Stable Integration of DNA-Genomic, Transcript and Translational level.	**15**	**CO1-5**	**K1-K5**
II	Tools and Techniques in Biotechnology- Isolation of Genomic DNA and Plasmid, Restriction Enzymes, Ligases, other DNA Modifying Enzymes- (Polynucleotide Kinase, Phosphatase, DNases, Polymerases), Vectors (Viral Vectors and Agrobacterial Vectors). Plant Genome Organization: Nuclear, Chloroplast and Mitochondrial Genome and its Importance in Genetic Engineering, Isolation and Characterization of DNA and RNA DNA libraries, DNA Sequencing (Maxam & Gilbert method, Sanger's Chain Termination Method and Pyrosequencing), DNA Fingerprinting and DNA Foot Printing, Transcript Analysis, SSH and RACE.	**15**	**CO1-5**	**K1-K5**
III	Biotechnology in Crop Improvement: Methodologies adopted in the followingtransgenic plants, increased shelf life of fruits (Flavr Savr Tomatoes), increased biomass production (nif gene transfer), nutritional enhancements (Vitamins,proteins), plants with herbicide resistance (round up crops), pest resistance (Bt andother gene candidates), stress tolerance (salt and drought), and horticultural quality (Designer flowers), Molecular farming for therapeutic protein (Edible Vaccines, Plantibodies, Plantigens), Protection of Intellectual Property (Seed Terminator Technology) - Safety & Ethical issues related to Transgenic Plants.	**15**	**CO1-5**	**K1-K5**
IV	Plant Tissue Culture, Methods and Techniques: Concept of totipotency. Media for in- vitro Culture - Plant Growth Regulators. Design of plant tissue culture laboratory (R&D and commercial). Sterilization Procedures: Mechanical, Physical and Chemical methods. Steps involved in the	**15**	**CO1-5**	**K1-K5**

	production and maintenance of Axenic cultures. Morphogenesis, Caulogenesis, Callusogenesis, Somatic Embryogenesis- Direct and Indirect methods. Importance and steps involved in Shoot, Callus, Anther / Ovule, Embryo, Root, Cell Suspension and Protoplast Culture.			
V	Applications of Plant Tissue Culture in Crop Improvement: Micropropagation, Synthetic Seed production, In vitro flowering and fertilization, In vitro Grafting, Embryo Rescue, Somatic Cell Hybridization and Cybrids, Hairy-Root Culture, Cell Aggregate Cloning, Secondary Metabolite Production, Cryopreservation and Conservation of Plants, Mericloning for Virus-Free Plants, Somaclonal Variant selection.	**15**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. SATYANARAYANA, U. Biotechnology, Allied Pvt. Ltd. Kolkata, 2007.
2. PUROHIT S.S., Agricultural Biotechnology, Agrobios India., Jodhpur, 2002.
3. CHAWLA H.S., Introduction to Plant Biotechnology, 2nd Edition, Oxford and IBH Press, 2003.

References

1. BHOJWANI S. S. AND RAZDAN M.K., Plant tissue culture: Theory & practice-a revisededition, Elsevier, Netherlands 1996.
2. ADRIAN SLATER, NIGEL SCOTT, AND MARK FOWLER, Plant Biotechnology, Oxford University Press, NewYork, 2008.
3. HAMISH A COLLIN, SUE EDWARDS, Plant Tissue Culture, Bioscientific Publishers, 1998.
4. ABDIN, M.Z., KIRAN, U., KAMALUDDIN, M., ALI, A. Plant Biotechnology: Principles and Applications, Springer publishers, 2017.

Suggested Reading

1. PRIMROSE, S.B. AND TWYMAN, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing, 2006. 7th ed.
2. LEWIN, B., Genes XI, International Edition, Jocelyn Krebs, Stephen Kilpatrick, and Elliott Goldstein. Jones & Bartlett Learning, 2017.
3. JOHN E. SMITH, Biotechnology-fifth Edition, Cambridge University Press 2009.
4. ROBERTA H. SMITH, Plant Tissue culture- techniques and experiments, Third edition,Elsevier Publications, 2013.
5. DIXON, R.A. ANA R.A. GONZALES, Plant Cell Culture a Practical Approach, 2 Edition,Oxford Uty Press, 2004.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3	3			3							3	3		K1
CO 2	3	3			3							3	3		K2
CO 3	3	3			3							3	3		K3
CO 4	3	3			3							3	3		K4
CO 5	3	3			3							3	3		K5
Wt. Avg.	3	3			3							3	3		
Overall Mapping of the Course													3		

Paper 14a PLANT ANATOMY, EMBRYOLOGY AND PALYNOLOGY

Course Code	**212BO4M02**		
Credits	**4**		
Hours / Cycle	**75**		
Category	**Part**	**Core**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2021-22 onwards**		

Course Objectives	**The students will acquire knowledge and skills in the field of plant anatomy especially on commercial timber. Students will gain deep knowledge about the development and structures of reproductive organs; basic and applied aspects of Palynology.**

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall the cellular components and ultra-structural details of various plant tissues and cell wall characters.	**PSO2**	**K1**
CO 2	explain the secondary plant structure of stem and root; the various characteristic features of leaves, their development and significance.	**PSO2**	**K2**
CO 3	identify the anatomical abnormality occurs in certain plant species, various economically important timbers and their compositions and determine the age of trees through the dendrochronology method.	**PSO2**	**K3**
CO 4	compare the plant anatomical structure with its function and reproduction.	**PSO2**	**K4**
CO 5	Interpret the structure of meristematic permanent tissues, pollen grains and its importance in various applied fields.	**PSO2**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Cell Wall: Cell wall components, Microscopic structures, Pits and its ultrastructure. Meristems: Meristems - Apical, Lateral, Intercalary, Axillary, Basal. Shoot Apex: Organisation of Shoot Apex. Root apex: Organisation of Root Apex. Vascular cambium: Vascular Cambium and Cork Cambium.	**15**	**CO1-5**	**K1-K5**
II	Xylem: Primary and Secondary xylem; Cell types: Tracheids, Vessels, Fibers and Parenchyma. Phloem: Primary and Secondary Phloem; Cell types: Sieve cell, Sieve tube element, Companion cell, Phloem fibers, Phloem; Parenchyma; Ontogeny of sieve element; Internal and External phloem. Leaf: Development & Structure based on Symmetry, Environment & Photosynthetic Types; Stomata, Senescence and Abscission. Secretory Structures: External Secretory Structures (Glandular trichomes, Salt glands, Stinging hairs and Nectaries); Internal Secretory Structure (Internal Secretory Cells, Secretory Cavities and Ducts, Laticifers).	**15**	**CO1-5**	**K1-K5**
III	Anomalous Secondary Growth: Stem- Dicots (*Bignonia* and *Pachygone*) and Monocots (*Dracaena*). Root: Dicots (*Tinospora* and *Achyranthes*). Wood: External features- Colour, hardness, odor, luster, texture. Internal Features-Porous wood, non-porous wood, Ultrastructure and Diagnostic Features [Heart wood and Sap wood]. Types and Uses of Wood; Commercial wood (Teak, Padok and Kongu). Dendrochronology - Concept and Applications of Dendrochronology (Sampling, Dating). Applied Anatomy: Application of plant Anatomy in Taxonomy, Food Adulterants and Forensic science.	**15**	**CO1-5**	**K1-K5**
IV	Pollination: Significance of Pollination; Contrivances for Cross Pollination; Pollination syndromes; Primary and Secondary Attractants. Self-Incompatibility: Gametophytic and Sporophytic Self-incompatibility; Style and Stigma - Types and Function; Microsporangium (Anther): Ontogeny and Ultrastructure; Tapetum - Structure and Function; Male Gametophyte: Structure, Development and Function. Megasporangium (Ovule) and Female Gametophyte: Structure, Development and Types. Fertilization; Endosperm; Embryo: Structure and Development	**15**	**CO1-5**	**K1-K5**

V	Definition and Scope; Sporoderm: Structure, Function and Development; Exineless Pollen; Pollen threads. Pollen Morphology: Dispersal unit, Size and Shapes of Pollen, aperture: NPC Classification; Exine Ornamentation; Acetolysis method of pollen preparation; Applied palynology: A brief account on Melitopalynology, Aeropalynology, Latropalynology, Pharmacopalynology, Forensic Palynology, Copropalynology, Paleopalynology and Palynotaxononomy	**15**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

- CUTLER, D.F., BOTTA, C.E.J. AND STEVENSON, D.W. 2008. Plant Anatomy An Applied Approach. Blackwell Publishing, U.S.A.
- CUTTER, E. 1978. Plant Anatomy. Part I and II. Edward Arnold, London. ESAU, K. 1977. Anatomy of seed plants. John Willey and Sons. USA.
- EVERT, R. F. 2006. Esau's Plant anatomy: meristems, cells, and tissues of the plant body: their structure, function, and development, Wiley & Sons, Inc., Hoboken, New Jersey, 601pp.
- FAHN, A. 1989. Plant Anatomy.Pergamon Press, Oxford, London.
- JANE, F.W. 1956. The structure of wood. Adam and Charles Black, London.
- BHOJWANI, S.S. AND S.P. BHATNAGAR. 1981. The embryology of Angiosperms. Vikas Publishing House Pvt Ltd. New Delhi.
- FAEGRI, K. AND J. IVERSON. 1989. Text Book of Pollen Analysis. John Wiley and Sons, New York.
- HESSE, M.; HALBRITTER, H.; ZETTER, R.; WEBER, M.; BUCHNER, R.; FROSCH-RADIVO, A. and ULRICH, S. 2009. Pollen Terminology: An illustrated handbook. Springer Verlag, Vienna New York, pp. 264.
- JOHRI, B.M. 1984. Embryology of Angiosperms.Spriger-Verlag. Berlin.
- MAHESWARI, P. 1950. Embryology of Angiosperms. McGraw Hill Book Co. Inc. New York.
- NAIR, P.K.K. 1985. Essentials of palynology. Today and Tomorrow Printers and Publishers, New Delhi. WILLMER, P. 2011. Pollination and Floral Biology. Princeton University Press.

References (3 – 5)

- CARLQUIST, S. 1965. Comparative Plant Anatomy. Holt Rinehart and Winston, New York. U.S.A.
- CLOWS, F.A.L. 1961. Apical Meristems. Blackwell Scientific Publications, London.
- DAFNI, A.; KEVAN, P. G. and HUSBAND, B.C. 2005. Practical pollination Biology.
- Enviroquest Ltd.
- DORMER, K.J. 1972. Shoot Organization in Vascular Plants. Chapman and Hall Ltd., London.
- ERDTMAN, G. 1954. An Introduction to Pollen Analysis. Chronica Botanica, Waltham, Mass. U.S.A.
- FOSTER, A.S. 1949. Practical Plant Anatomy.D. van Nostard Compay, Inc., California, U.S.A.
- LINSKSENS, R.G. AND R.G. STANLEY. 1974. Pollen. Springer - Verlag, Berlin. MOORE, P.D. and J.H. WEBB. 1978. An Illustrated Guide to Pollen Analysis. Hodder
- and Stoughton, London.

Suggested Reading (2 -5)

- BARTH, F.G. 1985. Insects and Flowers. George Allen and Onwin, Sydney.
- CHOWDHURY, K.A. and GHOSH, S.S. 1958. Indian woods Vol. I and II. Their identification, properties and uses.
- MAUSETH, J.D. 1988.Plant Anatomy. The Benjamin/Cummings Pub.Company, Inc.
- USA.
- PHILIPSON, W.R., M.W. JOSEPHINE AND B.G. BUTTERFIELD. 1971. Vascular Cambium. Chapman and Hall Ltd., London.
- PUNT, W; HOEN, P.P.; BLACKMORE, S.; NILSSON, S. and Le THOMAS, A. 2007.
- Glossary of pollen and spore terminology. Review of Palaeobotany and Palynology:
- 1–81.
- RAMESH RAO, K. AND K.B.S. JUNEJA, 1971. A handbook for field identification of fifty important timbers of India. Forest Research Institute, DehraDun.

Web Resources (3-5)

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	PSO 6	
CO 1	3									3					k5
CO 2	3									3					k5

CO 3	3									3					k5
CO 4	3									3					k5
CO 5	3									3					k5
Wt. Avg.	3									3					
Overall Mapping of the Course														3	

Paper 15a: Biotechnology, Plant Tissue Culture and Crop Improvement & Plant anatomy, Embryology and Palynology

Course Code	212BO4M03		
Credits	**4**		
Hours / Cycle	**120**		
Category	**Part**	**Core**	**Combined practical**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	The students will have a clear knowledge of plant tissue culture and biotechnology of plants. They will learn the internal structures of various parts of the plants. Students gain knowledge on commercial wood and anomalous structures.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall media formulations and plant growth regulators for inducing various morphogenic response in plant tissue culture	**PSO 5**	**K1**
CO 2	explain the isolation procedure for good quality genomic DNA from plant sources using conventional methods	**PSO 5**	**K2**
CO 3	develop skill in various tissue culture activity	**PSO 5**	**K3**
CO 4	analyse the primary and secondary structures of Plants. Characterise the commercial timber based on wood anatomy	**PSO 5**	**K4**
CO 5	evaluate various stages of plant reproductive structures. Study and characterise the Plant visitor's attractants such as nectaries; Pollen characters.	**PSO 5**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Familiarization of tissue culture lab and lab equipment: Culture room, transfer room, Laminar air flow hood, autoclave- sterilization, handling of glassware.Preparation of solid, semi-solid and liquid media (MurashigeSkoog, Whites and Nitsch & Nitsch media).Culturing of excised cambial tissue, leaves, roots, shoot tips, axillary buds, flower buds, anthers, seeds, young embryos and cotyledons.Establishment and maintenance of callus and subculture of callus from tissueexplants of carrot and leaves. Regeneration of plantlets from explants and callus tissue- direct and indirect regeneration.Isolation of protoplast from mesophyll cells, determination of cell number and observation of cell wall formation. Cell suspension culture.Demonstration of cell immobilisation techniques/ Synthetic seed production.Isolation of plant genomic DNA.Quantitation and Separation of DNA by electrophoresis. Visit to a Biotechnology lab/tissue culture lab/breweries.	**60**	**CO1-5**	**K1-K5**

II	PLANT ANATOMY, EMBRYOLOGY AND PALYNOLOGY. Shoot apex (dissection of Hydrilla)Meristem (Permanent slides and photographs).Vascular cambium (free hand section) - Stratified (Dalbergia, GlIricidia), Non-stratified (Lannea).Xylem and Phloem (photomicrographs of Cucurbita).Maceration technique of tracheary cells and fibers.Diagnostic characters of wood (free hand section) - Identification of timbers (Teak: Tectona grandis, Padok: Pterocarpum dalbergiodes and Kongu: Hopea parviflora). Anomalous secondary growth (free hand section) – Dicot stem (Pseudocalyma, Pachygone and Tinospora), Monocot stem (Dracaena), Dicot root (Achyranthes).Leaf (free hand section) - Cross section of Dorsiventral Leaf (Polyalthia, Nerium),Isolateral leaf (Kalanchoe), Isobilateral leaf (Callistemon), C3 Leaf (Polyalthia,Nerium), C4 leaf (Chloris). CAM leaf (Kalanchoe). Types of Stomata (peeling) - Anomocytic (Bougainvillea), Anisocytic (Aralia), Paracytic (Pentas), Diacytic (Asystasia) and Grass type (Stenotaphrum). Pollination syndromes - photographs and field observations; Anther - Cross section of Datura & Ipomea anthers (free hand section). Sporoderm- Development (photomicrographs), Morphology (Permanent slides and photomicrographs). Pollen connecting threads (Photomicrographs) - Sporopollenin (Exinalbridges, Viscin thread), Non-sporopollenin threads (Elatoviscin, Threads from immature degenerated pollen, Cellular threads). Structure of male and female gametophyte (Permanent slides and photomicrographs). Nectaries (free hand section) - Floral and (Catharanthes, Tecoma, Bauhinia) and Extra-floral (Ricinus, Albizzia, Cassia).	**60**	**CO1-5**	**K1-K5**

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3	3			3								3		K1
CO 2	3	3			3								3		K2
CO 3	3	3			3								3		K3
CO 4	3	3			3								3		K4
CO 5	3	3			3								3		K5
Wt. Avg.	3	3			3								3		
Overall Mapping of the Course													3		

Paper 4b APPLICATIONS OF PLANT TISSUE CULTURE IN BIOTECHNOLOGY

Course Code	212BO4E01		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Elective Choice based**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To enable students to gain a deeper understanding of plant tissue culture and its various applications.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall the organization of R & D with commercial Lab.	**PSO 5**	**K1**
CO 2	interpret the problems associated large scale in vitro propagation of plants and commercial production through micropropagation.	**PSO 5**	**K2**

CO 3	apply the principles of micropropagation for mass multiplication	**PSO 5**	**K3**
CO 4	discover tissue culture techniques for the production of secondary metabolites	**PSO 5**	**K4**
CO 5	evaluatevarious applications of tissue culture in agriculture, horticulture, and forestry	**PSO 5**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Tools, techniques and procedures of Tissue culture: Stocks and media preparation. Laboratory organization in R&D and Commercial labs.Sterilization procedures and maintenance of axenic cultures. Criteria in the selection of explants, Steps involved in tissue culture techniques, major trouble shoots during the process of tissue culturesystemic contamination, browning, exudation, vitrification, habituation, genetic variation.	**10**	**CO1-5**	**K1-K5**
II	Principles of Micropropagation:Direct and indirect morphogenesis, somatic embryogenesis, Multiple shooting, caulogenesis, rhizogenesis, acclimatisation. Genetic uniformity testing & viral indexing. Reasons for somaclonal variation. Synthetic seed production,Haploid and polyploid plant production using tissue culture.Mericloning for virus-free plants.	**12** **CO1-5**	**K1-K5**	
III	Secondary metabolite production using tissue culture: Classes of secondary metabolites, optimization of Cell, shoots, adventitious and hairy root culturesmanipulations of media, precursors and use of elicitors.Aggregate cloning techniques, cell line selection and modification. Bioreactors for cell and root cultures.	**15** **CO1-5**	**K1-K5**	
IV	Application of tissue culture in Agriculture, Horticulture and Forestry :Conservation of germplasm and cryopreservation, in vitro flowering and fertilization, embryo rescue, in vitro grafting, Somatic hybridization and cybrid production.	**11** **CO1-5**	**K1-K5**	
V	Industrial application of tissue culture- Tissue culture industries and their activities, Immobilization of cells and use of bioreactors.In vitro production of pharmaceutical products.Cost effective techniques in plant tissue culture, cost- benefit analysis of plant tissue culture. Job opportunities and entrepreneurships in plant tissue culture	**12** **CO1-5**	**K1-K5**	

Prescribed Books/Textbooks

5. BHOJWANI S. S. AND RAZDAN M.K., Plant tissue culture :Theory & practice-a revised edition, Elsevier, Netherlands 1996 ROBER H.SMITH, 2013, Plant Tissue Culture: Techniques and Experiments, Academic Press, Elsevier. ROBERT N. TRIGIANO AND DENNIS J. GRAY (Eds.) 2011, Plant Tissue Culture, Development, and Biotechnology, CRC Press, Taylor & Francis Group. ROBERT N. TRIGIANO AND DENNIS J. GRAY (Eds) 2000, Plant Tissue Culture Concepts and Laboratory Exercises, CRC Press, Taylor & Francis Group

References

5.MICHAEL R. DAVEY, PAUL ANTHONY, 2010, Plant Cell Culture: Essential Methods, Wiley& Blackwell publishers ABDIN, M.Z., KIRAN, U., KAMALUDDIN, M., ALI, A. (Eds.) 2017, Plant Biotechnology: Principles and Applications, Springer publishers KIRSI-MARJAOKSMAN-CALDENTEY AND WOLFGANG H. BARZ (Eds.) 2002, Plant Biotechnology and Transgenic Plants, CRC Press, Taylor & Francis Group FETT-NETO, ARTHUR GERMANO(Ed.) 2016, Biotechnology of Plant Secondary Metabolism:Methods and Protocols, Springer publishers.

Suggested Reading

7. ANIS MOHAMMAD, AHMAD NASEEM (Eds.) 2016, Plant Tissue Culture: Propagation, Conservation and Crop Improvement VÍCTOR M. LOYOLA-VARGAS AND NEFTALÍ OCHOA-ALEJO (Eds.) 2012, Plant Cell Culture Protocols, Springer publishers POLLARD JEFFREY W., WALKER, JOHN M. (Eds.) 1990, Plant Cell and Tissue Culture, Springer publishers

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	
CO 1	3	3			3								3		K1
CO 2	3	3			3								3		K2
CO 3	3	3			3								3		K3

CO 4	3	3	3	3	K4
CO 5	3	3	3	3	K5
Wt. Avg.	3	3	3	3	

Overall Mapping of the Course 3

Paper 4b BIOPROSPECTING OF ALGAE

Course Code	**212BO4E02**		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Core**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To enable students gain knowledge on culture and applications of Algae.		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	list the uses of algae or algal products in various levels and culture techniques	**PSO 1**	**K1**
CO 2	explain the sources, composition, extraction methods and commercial uses of algal biochemical.	**PSO 1**	**K2**
CO 3	plan the mass cultivation of algae and extractions of metabolites.	**PSO 1**	**K3**
CO 4	classify the algae with environment and various industries.	**PSO 1**	**K4**
CO 5	justify algae as alternative sources for food, feed, fuel, medicine, *inter-alia*.	**PSO 1**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Historical perspective of use of algae for human needs. Algae as source of Food and Feed. Single cell protein: Chemical constituent of Spirulina, its Vitamin and Mineral content, Chemical Constituent of Chlorella. Biofertilizers: Nitrogen Fixing Algae; structure and function of heterocysts; reaction involved in Nitrogen Fixation. Significance of using Blue Green Algal Fertilizers.	**12**	**CO1-5**	**K1-K5**
II	Industrial uses of Algae: Structure, Source, Extraction and uses of Agaragar, Carrageenin and Alginic acid. Liquid seaweed Fertilizers - Preparation, Composition and uses.	**12**	**CO1-5**	**K1-K5**
III	Cultivation of Macroalgae: Macroalgal cultivation in India. Rope cultivation, Net cultivation and Raft cultivation. Application of Fertilizers. Control of Diseases with reference to the Cultivation of *Laminaria* and *Porphyra*. National laboratories involved in Marine Algal Cultivation.	**12**	**CO1-5**	**K1-K5**
IV	Mass Cultivation of Microalgae: Mass Culturing of Spirulina: Composition of Medium, Techniques involved in their Culture, Harvest. Importance of Algae in Fisheries; Parasitic Algae; Algae in Medicine: Algal Antibiotics and other substances of Pharmaceutical and Nutraceutical importance.	**12**	**CO1-5**	**K1-K5**

V	Aquatic Pollution - Causes and Consequences: - Algae as Pollution Indicators; Algal Cultures and their utility; Algal Culture Collection Centres of the world; Phycoremediation of Sewage and Industrial Effluents. Algae as a source of Biodiesel; Algal Bio-refineries; Algae in Nanotechnology and its application. Molecular Taxonomy of Algae. Environmental DNA (eDNA) and its application.	**12**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

7. ANDERSON, R. A. 2005. Algal culturing Techniques. Phycological Society of America, Elsevier's Academic Press.
8. BARSANTI, L. AND P. GUALTIERI. 2006. Algae-Anatomy, Biochemistry and Biotechnology, Taylor & Francis, London.
9. BRODIE, J. AND J. LEWIS 2007. Unravelling the algae. the past, present and future of algal systematic. CRC Press, NW, 414pp.
10. DEMIRBAS, A AND M. F. DEMIRBAS, 2010. Algae Energy- Algae as a New Source of Biodiesel. Springer-Verlag London Limited, 203pp.
11. FRITSCH, F.E. 1935. Structure and Reproduction of Algae. Vol. I. Cambridge University Press. Cambridge.

References (3 – 5)

7. GUPTA, R. K. AND V. D. PANDEY, 2007. Advances in applied phycology. Daya Publishing House, New Delhi, 309pp.
8. KIM, S. AND K. CHOJNACKA, 2015. Marine Algae Extracts- Processes, Products, and Applications. Wiley-VCH Verlag GmbH & Co., Germany, 766pp.
9. LEMBI, C. A. AND J. R. WAALAND. 1988. Algae and human affairs. Cambridge University Press. Cambridge.

Suggested Reading (2 -5)

4. DIXON, B.S. 1973. Biology of the Rhodophyta. Oliver and Boyd. Edinburgh.
5. GRAHAM, L.E. 1993. Origin of Land Plants. John Wiley and Sons. Inc. New York.
6. LOBBAN, C.S., AND M.J. WYNNE. 1981. The Biology of Sea-weeds. Blackwell Scientific Publications. Oxford.
7. PARKER, S.P. 1982. Synopsis and Classification of Living Organisms. McGraw-Hill Book Company. New York.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cogniti ve Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO2	PSO 3	PSO 4	PSO5	PSO 6	
CO 1	3								3						K4
CO 2	3								3						K5
CO 3	3								3						K5
CO 4	3								3						K5
CO 5	3								3						K5
Wt. Avg.	3								3						
													Overall Mapping of the Course		3

Paper 4b ECOLOGY AND ENVIRONMENT

Course Code	212BO4E03		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Elective Choice based**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To enable students to have deep understanding of how ecosystem recover from human disturbance		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall about the types of ecosystems.	**PSO 3**	**K1**

CO 2	summarize different pollution types.	**PSO 3**	**K2**
CO 3	experiment bio-fertilizer in reducing soil Pollution.	**PSO 3**	**K3**
CO 4	analyse different pollution types in our surroundings	**PSO 3**	**K4**
CO 5	evaluate about the goal and future prospects of bioremediation.	**PSO 3**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Ecosystems ecology: Abiotic and Biotic Components - Autotrophs and Heterotrophs, Energy flow, Food chain, Food web, Ecological Pyramidstypes. Ecological succession (primary and secondary succession). Study of Pond, Forest, Desert and Grassland ecosystems. Mineral Cycling (C,N,P).	**10**	**CO1-5**	**K1-K5**
II	Soil Ecology: Definition, Basic concepts of Ecology, Climatic factors - Light, Temperature, Precipitation, Edhaphic factors-soil profile, Soil formation, Soil classification and Soil conservation, Biotic factors - Relationship among Organisms - Positive and Negative Interactions.	**10**	**CO1-5**	**K1-K5**
III	Biodiversity Measurement - Species Richness & Abundances, Diversity Indices - Shannon, Simpson & Index of Dominance. Biodiversity as Bioresources - Use and Values (Consumptive use values, Productive use values and Economic use values) of Biodiversity as sources of Food, Fodder, Timber, Medicinal and Ornamental plants. Threats and loss of Biodiversity - Global Deforestation Rate - Extinction crises. Causes for Extinction: Habitat Loss, Industrialization, Hunting and Bio Invasions. Current Extinction Trends. The theory of Island Biogeography; Edge Effect	**15**	**CO1-5**	**K1-K5**
IV	Atmosphere and Air Pollution: AQI, Structure and Composition of Atmosphere - Chemical reactions in the Atmosphere; Ozone chemistry- CFC's – Acid Rain - Photochemical Smog - Aerosols types - Production and Distribution- Aerosols and Radiation - Temperature Inversion - Green House Gases - Global warming. Methods of Monitoring and Control of air Pollution - Bioscrubbers, Biobeds, Biotrickling filters. Water pollution: Water resources, Physical and Chemical properties of Water, Primary Treatment: Sedimentation, Flocculation and Flotation. Secondary Treatment: Activated Sludge Process (ASP) - Trickling Filters - Oxidation Ponds and Bioreactors.	**15**	**CO1-5**	**K1-K5**
V	Bioremediation: Definition, in situ and ex situ Bioremediation, Constraints and Priorities of Bioremediation; Bioaugmentation and Biostimulation, Solid phase and Slurry phase bioremediation, Oxygen delivery for Bioremediation, Biostimulation of naturally occurring microbial activities. Role of bioreactors in Bioremediation; Treatment of liquid and solid wastes. Advantages and disadvantages of Bioremediation technologies.	**10**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

1. Singh JS, Singh SP and Gupta SR. 2014. Ecology, Environmental Science and Conservation.4th Edition. S. Chand & Company Pvt.Ltd.
2. Miller.G.T., Jr. 2014. Environmental Science. 4 thEdition, Thomson, California.
3. Eugene P. Odum and Gray W. Barrett. 2009. Fundamentals of Ecology. Fifth Edition. Brooks/Cole, a part of Cengage Learning.

References

1. Yanney, E. 1985. Elements of Ecology. ELBS Publication. Heinemann Educational Books.
2. George Joseph. 2005. Fundamentals of Remote Sensing. Edition II. University Press private limited.
3. Krishnamurthy K.V. 2003. An Advanced Textbook on Biodiversity - Principles and Practice, Oxford and IBH Publishing, NewDelhi.

Suggested Reading

1. Aulay Mackenzie, Andy S. Ball and Sonia R. Virdee. 2002. Ecology - Instant Notes. Second Edition. Viva Books Pvt Ltd, New Delhi.
2. Richard T. Wright, Dorothy F. Boorse. 2010. Environmental Science Toward a Sustainable Future. Eleventh Edition. PHI Learning Private Limited, New Delhi.

Course Articulation Matrix

Course	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
Outcomes	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PSO**	**PSO**	**PSO**	**PSO**	**PSO**	**PSO**	

	1	2	3	4	5	6	7	8	1	2	3	4	5	6	
CO 1	3					3					3				K1
CO 2	3					3					3				K2
CO 3	3					3					3				K3
CO 4	3					3					3				K4
CO 5	3					3					3				K5
Wt. Avg.	3					3					3				

Overall Mapping of the Course 3

Paper 4b FUNGAL BIOLOGY AND BIOTECHNOLOGY

Course Code	212BO4E04		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Elective Choice based**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To enable students to have deep understanding of how ecosystem recover from human disturbance		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	recall the key characteristics of various groups of higher fungi, understand the techniques in isolation, culturing and preservation of fungi, and various of media used for maintain different fungi.	**PSO 1&5**	**K1**
CO 2	understand application of fungi in agriculture and environment.	**PSO 1&5**	**K2**
CO 3	develop techniques in cultivation of various mushrooms and use various techniques in hybrid development etc.	**PSO 3&5**	**K3**
CO 4	analyse the role of molecular tools in systematic study of fungi.	**PSO 3&5**	**K4**
CO 5	compare the enzymes, other metabolites its production and role.	**PSO 3&5**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Characteristic features of higher fungal groups: Russulales, Agaricales, Boletales, Aplyllophorales, Phallales, Lycoperdales, Sclerodermatales, Nidulariales, Xylariales, Pezizales. Isolation & Collection techniques: Serial dilution, Direct isolation, Moist chamber incubation. Techniques in collection, Culture & Preservation of Macrofungi; Medium for culturing: PDA, Czpexdox's malt agar, oat meal agar, modified MelinNorkon's medium.	**12**	**CO1-5**	**K1-K5**
II	Fungi in Agriculture: Mycorrhiza, AM Fungi and its importance. Bioremediation using Fungi: degradation of PHAB's, PCB's using white rot's and Biocontrol using Trichoderma and others.	**12**	**CO1-5**	**K1-K5**
III	Mushroom cultivation: Techniques in cultivation of Oyster Mushroom, Milky Mushroom and Button Mushroom. Hybrid development using Somatic Fusion, Mutation Technique, Protoplast Fusion etc.	**12**	**CO1-5**	**K1-K5**
IV	Molecular Mycology: Phylogenetic study using ITS region, β-tubulin and other genes; and its importance in Mycology. Protein Profiling Technique as a tool in Molecular Identification.	**12**	**CO1-5**	**K1-K5**

V	Fungal enzymes: Proteases, Lipases, Laccases, Peroxidases. Fungal metabolites: Taxol, Ganoderic acid. Fungal polysaccharide: Isolation and Importance.	**12**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

- Dilip K. Arora, P. D. Bridge, Deepak Bhatnagar. 2004. Handbook of Fungal Biotechnology. Marcel Dekker Inc.
- Jan S, Tkacz, Lene Lange. 2004. Advances in Fungal Biotechnology for Industry, Agriculture, and Medicine. Kluwer academic publishers, New York.
- Alexopoulos C. J, Charles W. Mims, Meredith Blackwell. 1996. Introductory mycology. John Wiley & sons inc. New york.
- Ram R.C. 2007. Mushrooms and their cultivation techniques. Aavishkar publishers and distributors, Jaipur, India.
- Richard P. Oliver AND Michael Schweizer. 1999. Molecular Fungal Biology. Cambridge University Press. Cambridge.

References

- David L. Largent. 1988. How to identify mushrooms to genus. Mad River Press.
- Jagjit Singh, K.R. Aneja, Jagit Singh. 1999. From ethnomycology to fungal biotechnology. Springer-Verlag New York, LLC.
- Rolf Singer. 1986. The agaricales in modern Taxonomy. Sven koeltz scientific books, Germany.

Suggested Reading

- Pegler D.N., 1977. A preliminary Agaric flora of East Africa. Kew Bull. Additional series Pegler D.N., 1983. A preliminary Agaric flora of Lesser Antilles. Kew Bull. Additional series.
- Pegler, D.N. 1986. Agaric flora of Sri Lanka. Kew Bull. Addit. Ser., 12: 328.
- Bakshi, B.K. 1971. Indian Polyporaceae (on trees and timber). ICAR Publication, New Delhi, p.188.
- Bakshi, B.K., Sen, M. and Singh, B. 1970. Cultural diagnosis Indian Polyporaceae—II. Genera Fomes and Trametes. Ind. Forest Rec. 2: 245-276.

 Kumar, M. 2020. A field guide to mushrooms and other fungi of tropical dry evergreen forests of peninsular India. Digital Age Publishers, India.

Online resources

- http://qldfungi.org.au/Australasian Mycological Society
- http://www.australasianmycologicalsociety.com/Australian Biological Resources Study: Fungi
- https://www.environment.gov.au/science/abrs/online-resources/fungi Fungi Australia
- http://www.anbg.gov.au/fungi/index.htmlPerth Urban Bushland Fungi
- http://www.fungiperth.org.au/Sydney Fungal Studies Group
- http://www.sydneyfungalstudies.org.au/Intro.htmlUniversity of Adelaide: Mycology Online http://www.indexfungorum.org/names/names.asp

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3	3			3				3				3		K1
CO 2	3	3			3				3				3		K2
CO 3	3	3			3	3					3		3		K3
CO 4	3	3			3	3					3		3		K4
CO 5	3	3			3	3					3		3		K5
Wt. Avg.	3	3			3	3					3		3		
													Overall Mapping of the Course		3

Paper 4b GENETICS

Course Code	212BO4E05		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Elective Choice based**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To enable students gain deeper understanding of gene mutation, gene regulation.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)

On completing the course successfully, the student will be able to			
CO 1	find the various aspects of genetic recombination.	**PSO 5**	**K1**
CO 2	understand the types of mutations and mutagens	**PSO 5**	**K2**
CO 3	identify gene regulation.	**PSO 5**	**K3**
CO 4	compare the transposition of genes.	**PSO 5**	**K4**
CO 5	analyse the difference between gene activity and epigenetics .	**PSO 5**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Genetic Recombination: Recombination; Independent assortment and Crossing over; Molecular mechanism of Recombination; Role of syn gene RecA and RecBCD enzymes - Repair of Double Stranded DNA; Site Specific Recombination. Holiday model of Recombination, Holliday unit , Holliday Intermediate- chi Structure, Branch Migration	**12**	**CO1-5**	**K1-K5**

II	Mutations: Spontaneous - Point Mutation -S, G1 and G2 phases - Tautomeric shifts, Wobble Base Pairing, Strand Slippage, Unequal Crossing Over, Depurination, Deamination. Induced Mutations; Chemical Mutagens - Base Analogs, Alkylating Agents, Hydroxylamine, Oxidative Reactions.	12	CO1-5	K1-K5
III	Gene Regulation: Regulation of ara- Positive and Negative control, tryp operon corepressor - in Prokaryotes.	12	CO1-5	K1-K5
IV	Transposable Genetic Elements: Ac element, Transposase, Transposon, DNA adenine methylase, DAM gene, Simple Transposon, Complex Transposon, Is Element, Selfish DNA.Transposons in Zea mays. Transposable elements in Prokaryotes and Mu viruses.	12	CO1-5	K1-K5
V	Epigenetics : Genome Imprinting, Epigenetic Mechanisms and its role in Plant Growth and Development, Vernalisation, Transposons and Role of sRNA.	12	CO1-5	K1-K5

Prescribed Books/Textbooks

- ROBERT BROOKES, 2014. Genetics- Analysis and Principles. Fifth Edition. McGraw-Hill Education.
- LEWIN, B. 2001. Genes VII. Oxford University Press.
- JEREMY W. DALE. 2011. From Genes to Genomes- Concept and Applications of DNA Technology. Third Edition. Wiley-Black Well Publishers

References

- FRIEDEDLER, D. 1990. Molecular Biology. Second Edition. Narosa Pub. House.
- LEWIN, B. 1994. Genes V. Oxford University Press.
- JEREMY W. DALE. 2011. From Genes to Genomes- Concept and Applications of DNA Technology. Third Edition. Wiley-Black Well Publishers.

Suggested Reading

- SMITH-KEARY, P. 1991. Molecular Genetics. Macmillan Pub. Co. Ltd. London.
- SUZUKI, D.T. et al. 1986. An introduction to genetic analysis. Third Edition. W.H. Freeman & Co.
- WATSON, J.D. et al. 1987. Molecular Biology of the Gene. Fourth Edition. The Benjamin Cummings Pub. Co.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3	3			3								3		K1
CO 2	3	3			3								3		K2
CO 3	3	3			3								3		K3
CO 4	3	3			3								3		K4
CO 5	3	3			3								3		K5
Wt. Avg.	3	3			3								3		
												Overall Mapping of the Course		3	

Paper 4b PALYNOLOGY

Course Code	**212BO4E06**		
Credits	**5**		
Hours / Cycle	**60/15**		
Category	**Part**	**Core Elective**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2021-22 onwards**		
Course Objectives	**This makes the Students to know about palynology both its basic and applied aspects; also enable them to carry out small project in this field of science.**		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	understand the history, basics and important terms of Palynology.	**PSO2**	**K1**
CO 2	describe the pollen morphological characters and aperture Characters.	**PSO2**	**K2**
CO 3	identify the pollen grains of various flowering plants of local flora.	**PSO2**	**K3**
CO 4	analyze the Pollen Grains through the Acetolysis Method and preserving them.	**PSO2**	**K4**
CO 5	assess the importance of Pollen Herbarium and its Maintenance, bee keeping, pollen in allergy, medicine, ecology, archeology, geology etc.	**PSO2**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	History of Palynology: Palynology in India. Contribution of Wodehouse, R.P., Erdtman, G., Iverson, J., Thanikaimoni and Nair, P.K. K in the field of palynology. Terminologies used in spore and pollen description according to LLP 1994. Difference between Pollen and Spores	**12**	**CO1-5**	**K5**
II	Sporoderm: Exine - Chemical composition, Structure and Function. Evolutionary trends. Intine-Ex-intine, End-intine - Structure and Function. Oncus. Exineless Pollen. Harmomegathy. Aperture: Inaperturate grain, Simple and Compound Aperture. NPC classification, Pseudoaperture, Aperture membrane. Pollen wall Ornamentation: Sculpture: LO Analysis, Types of Wall Ornamentation.	**12**	**CO1-5**	**K5**
III	Pollen Development in Angiosperms. Shape and Size of Pollen. Chemical Constituents of Pollen. Pollination Ecology with reference to Pollen. Pollen Connecting Threads - Sporopollenin and NonSporopollenin Threads. Pollenkitt - Origin, Chemical Composition and Function. Anemophilous, Entomophilous pollen, Saccate pollen, Orbicules. Pollen Dispersal Unit: Monad, Dyad, Polyad and Pollinium.	**12**	**CO1-5**	**K5**
IV	Pollen Physiology: Pollen Collection, Storage - Cryopreservation. Pollen Viability - Factors that affect Viability, Viability Test: - Germination Assay, in vitro, in vivo, Non Germination - FCR Test. Pollen Culture. Technique: Acetolysis method of Pollen preparation. Sample preparation for TEM and SEM.	**12**	**CO1-5**	**K5**
V	Palynotaxonomy - Use of pollen in classification of plants. Melittopalynology: Pollen in Honey. Geo/Paleopalynology: Pollen Production, Transport, Preservation, Sample collection, Pollen Diagram, Construction and Interpretation of Data. Aeropalynology - Collection, Identification, Pollen calender. Pollen allergy - Testing patients and Treatment of patients. Forensic Palynology: Pollen used as an aid to Identify Crime. Iatropalynology: Pollen in Pharmaceuticals. Copropalynology: Pollen in dung.	**12**	**CO1-5**	**K5**

Prescribed Books/Textbooks (1-5 books)

- ERDTMAN, G. 1952. Pollen morphology and Plant Taxonomy Angiosperms.Almquist and Wiksell, Stockholm, 650pp.
- FAEGRI, K AND J. IVERSON. 1989. Text book of Pollen analysis. John Wiley and Sons, New York.
- KEDVES, M. 1986. Introduction to the palynology of Pre-Quaternary Deposits. Part I & II Pub. House of the Hungarian Academy of Sciences, Budapest.
- HESSE, M., H. HALBRITTER, M. WEBER, R. BUCHNER, A. FROSCH-RADIVO, S. ULRICH AND R. ZETTER, 2009. Pollen Terminology – An illustrated handbook. Springer-Verlag, New York.
- MOORE, P.D AND J. A. WEBB. 1978. An Illustrated guide to pollen analysis. Hodder and Stoughton, London.
- SHIVANNA, K.R and N.S. RANGASWAMY. 1992. Pollen Biology, A laboratory manual. Narosa Pub. House, New Delhi.
- WODEHOUSE, R.P. 1935. Pollen grain – their structure, identification and significance in Science and Medicine.Hafner Publishing Co. New York.

References (3 – 5)

- EDRTMAN, G. 1960. The acetolysis method. Svensk Bot Tidskr 54: 561–564.
- PUNT, W., P.P. HOEN, S. BLACKMORE, S. NILSSON, AND LE A. THOMAS, 2007. Glossary of pollen and spore terminology. Review of Palaeobotany and Palynology, 143: 1 – 81.

Suggested Reading (2 -5)

- DRIESSEN, M.N.B.M. 1991. Pollen and Pollinosis.Medical and Botanical aspects.
- MISHRA, R.C. 1995. Honey Bees and their management in India ICAR. New Delhi.
- OGDEN, C.E., S.G. RAYNOV, V.J. HAYES, M. D. LEWIS AND J.H. HAINES. 1974. Manuel for sampling airborne pollen. Hafner Press, London.
- SINGH. S. 1962. Bee keeping in India. ICAR, New Delhi.
- THANIKAIMONI.G, C. CARATINI, B.S. VENKATACHALA, C.G.K. RAMANUJAM AND R.K. KAV. 1984. Selected angiosperm pollen from India and French Institute, Pondicherry.
- TILAK, S.T. 1989. Air borne pollen and fungal spores. Vijayanti Prakashan. Aurangabad.
- TISSOT, C., H. CHIKHI and T. S. NAYAR, 1994. Pollen of wet evergreen forests of the Western Ghats India; Inst. Fr. Pondichery 35, 133.
- TRAVERSE, A. 1988. Palaeopalynology. Unwin Hyman, London.

Web Resources (3-5)

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	PSO 6	**Cognitive Level**
CO 1	3									3					K5
CO 2	3									3					K5
CO 3	3									3					K5
CO 4	3									3					K5
CO 5	3									3					K5
Wt. Avg.	3									3					
Overall Mapping of the Course													3		

PAPER 4b - PHYTOCHEMISTRY

Course Code	212BO4E07		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Elective Choice based**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To impart in depth knowledge on the properties, analysis and elucidation of metabolites. To create awareness of adulterants in herbal drug formulations. To facilitate the students to appreciate the significance of phytochemicals as therapeutic agents. To equip students to analyse the phytochemical and pharmacological worth of plants.		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	list the physical and chemical properties and classification of primary metabolites.	**PSO 2&4**	**K1**
CO 2	explain the secondary metabolites and the various methods of extraction and analytical tests.	**PSO 4**	**K2**
CO 3	identify the adulterants and evaluate the herbal products by applying standardization guidelines..	**PSO 2**	**K3**
CO 4	discover the methods of isolation and elucidation of compounds and apply this knowledge to analyse the phytoconstituents.	**PSO 4**	**K4**
CO 5	Evaluate the significance of phytoconstituents as therapeutic agents and Design experiments to unravel the phytochemical wealth and therapeutic potential of plants.	**PSO 6**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Introduction to Primary Metabolites: Definition, General Introduction to Primary Metabolites, Classification, Physical and Chemical properties of Carbohydrates, Proteins, Lipids (waxes, fats, fixed oils).	**12**	**CO1-5**	**K1-K5**
II	Introduction to Secondary Metabolites: Definition, Classification of Secondary Metabolites, General method of Extraction, Physical and Chemical properties and Tests for Identification of Alkaloids, Glycosides, Flavonoids, Tannins, Volatile Oil and Resins.	**12**	**CO1-5**	**K1-K5**
III	Quality Control of Drugs of Natural Origin: Adulteration of Drugs of Natural Origin. Evaluation of drugs by Organoleptic, Microscopic, Physical, Chemical and Biological Methods and Properties. Quantitative Microscopy of Crude Drugs including Lycopodium Spore Method and Leaf Constants. Standardisation of Herbal Drugs as per WHO guidelines.	**12**	**CO1-5**	**K1-K5**
IV	Types of Solvents. Properties of Solvents. Solvent Extraction. Isolation and Structural elucidation of Phytoconstituents: Modern methods of isolation using Paper Chromatography, Gas Chromatography (GC), High Performance Thin Layer Chromatography (HPTLC). Structural elucidation by UV Spectroscopy, Infrared Spectroscopy, Mass Spectroscopy, Nuclear Magnetic Resonance (NMR) Spectroscopy, Electrophoresis, Paper Electrophoresis, Gel Electrophoresis, Capillary Electrophoresis.	**12**	**CO1-5**	**K1-K5**
V	Nutraceuticals: General aspects, Types of products available in the Market. Health benefits and role of Nutraceuticals as sources of Antipyretic, Analgesic, Antidiabetic, Anticancer, Antihypertensive and Antiinflammatory agents	**12**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

- ASHUTOSH KAR. 2002. Medicinal chemistry, 2nd ed., New Delhi: New Age.
- JAIN S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
- PATRICK G, 2002. Instant Notes Medicinal Chemistry, New Delhi: Viva Books.
- ROSELINE, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
- WALLIS, T. E. 1946. Text book of Pharmacognosy, J & A Churchill Ltd.
- YOUNG KEN, H.W. 1948. TextBook of Pharmacognosy. Blakiston C., Philadelphia.

References

- CRAIG, ROBERT, R. E. STITZEL. 2000. Modern Pharmacology. Boston: Little Brown.
- FINAR, I.L. 2005.Organic Chemistry: Stereochemistry and the Chemistry of Natural Products, London: Pearson.
- SHAROL TILGNER, N. D. 1999. Herbal medicine - From the heart of the earth. Edn. 1, Printed in the USA by Malloy Lithographing Inc.
- The Siddha Pharmacopoeia of India. Part-1, Volume-1, 1st edition. Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (Ayush).
- THOMAS L. LEMKE, WILLIAM ZITO, S., VICTORIA F. ROCHE, DAVID A. WILLIAMS. 2016.Essentials of Foye's Principles of Medicinal Chemistry.Philadelphia: LWW.

Suggested Reading

- CHATWAL, G.R., 2010. Organic Chemistry of Natural Products -Vol. I and II. New Delhi: Himalaya.
- DATTA AND MUKERJI, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No.1 Ministry of Health, Govt. of India.
- EVANS, W. C. AND G. E. TREASE. 2002.Trease and Evan's Pharmacognosy. W.B.Saunders., U.S.A. PAL, D.C. AND JAIN, S.K., 1998. Tribal Medicine. NayaPrakash Publishers, Calcutta.
- RAYCHUDHURI, S.P., 1991. Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi.
- SATYAJIT, D. SARKER, ZAHID LATIF AND ALEXANDER I. GRAY. 2006. Natural Products Isolation. New Jersey: Humana Press.

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3									3		3			K1
CO 2	3											3			K2
CO 3	3									3					K3
CO 4	3											3			K4
CO 5	3	3	3	3	3									3	K5
Wt. Avg.	3	3	3	3	3										
Overall Mapping of the Course													3		

Paper 4b PLANT HISTOCHEMISTRY

Course Code	212BO4E08		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Elective Choice based**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To get acquainted with this microscopic technique for qualitative localization of structural and storage biochemical substances. To identify the biomolecules present in the various plant parts		

CO #	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO 1	recall the importance of histochemical techniques in understanding the structure and development of plants.	**PSO 4**	**K1**
CO 2	Relate the sectioning methods and specimen preparations.	**PSO 4**	**K2**

CO 3	Elaborate different types of microscopic procedures	**PSO 4**	**K3**
CO 4	Classify biological stains and outline the procedures for histochemical stains.	**PSO 4**	**K4**
CO 5	explain the enzyme and immunohistochemistry.	**PSO 4**	**K5**

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Histochemistry: Definition, staining methods, Staining theory. Scope of Histochemistry and Cytochemistry in Biology. Use of Histochemical techniques in understanding Vegetative and Reproductive Structure and Development of Plants.	**12**	**CO1-5**	**K1-K5**
II	Micro technique: Free-hand Section; Clearing and Whole mounts; Waxembedded sections and Staining procedures; Plastic-embedded thin sections.	**12**	**CO1-5**	**K1-K5**
III	Microscopy: Selected Light Microscopic procedures - Normaski DIC; Polarized light Microscopy; Fluorescence Microscopy; Dark-field and Phase Contrast Microscopy.	**12**	**CO1-5**	**K1-K5**
IV	Classification and Chemistry of Biological Stains. Bright-Field Dyes and Flurochromes. Detection and Localization of Structural and Storage components in Plants using Specific Dyes and Fluorochromes - Starch (I2KI), Protein (Commassie Brilliant Blue, Toluidine Blue O), Lipid (Sudan IV, Nile Blue), Nucleic acids (Aceto-orecin), Cellulose (Cellofluor White), Lignin (Phloroglucinol), Potassium (sodium cobaltinirite reagent), Magnesium (Magneson reagent), Alkaloids (Dragendorf's reagent), Terpenoids (Carrprice reagent) and Phenolics (Nitroso reaction).	**12**	**CO1-5**	**K1-K5**
V	General Design and Application of Enzyme Histochemistry. Immuno – Histochemistry - Direct and Indirect Method. Principle and use of Immuno - Histochemistry.	**12**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks

- KRISHNAMURTHY, K. V. 1988. Methods in Plant Histochemistry. S. Viswanathan Printers and Publishers private limited, Madras.
- CHANDAK, T., CHAUDHARY, M. AND CHANDAK, V. 2012. Microtomy: Microtome and its applications. Lambert Academic Publishing.
- LACEY, A.J. 1989. Light microscopy in biology - a practical approach. IRL Press. Oxford University Press. U.K.
- BERLYN, G.P. AND J.K. MIKSCHE. 1976. Botanical Microtechnique and cytochemistry. Iowa State University Press. Iowa. USA. **References**
- CONN, H.J. 1991. Biological stains. Ninth Edition. Sigma Chemical Company, St. Louis. USA.
- CLARK, G. 1981. Staining Procedures. Fourth Edition. Williams & Wilkins Co. MD. U.S.A.
- GARTNER, H. AND SCHWEINGRUBER, F.H. 2013. Microscopic preparation techniques for plant stem analysis. Swiss federal Research Institute. Switzerland.
- ENSEN, W.A. 1962. Botanical Histochemistry. W.H. Freeman and Company. San Francisco.
- KIERNAN, J.A. 1990. Histological and Photochemical Methods. Theory and Practice. Pergamon Press. U.K.

Suggested Reading

- CLARK, G. 1981. Staining procedures. Williams and Wilkins, Baltimore.
- CONN, H. J. 1977. Biological stains. R. D. Lillie (ed.). The Williams and Wilkins Co. Reprinted by Sigma Chemical Company. St. Louis.
- Esau, K. 1972. Plant Anatomy. John Wiley and Sons, New York.
- LAWLOR, D. 2019. Introduction to Microscopy: Tips and tricks for beginners. Springer.
- ROBINSON, P.C. 1992 Qualitative polarized light microscopy. Royal Microscopical Society. Oxford University Press. U.K.

Online resources

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	
CO 1	3											3			K1

CO 2	3	3	K2
CO 3	3	3	K3
CO 4	3	3	K4
CO 5	3	3	K5
Wt. Avg.	3	3	

Overall Mapping of the Course 3

Paper 4b. PLANT TAXONOMY

Course Code	**212BO4E09**		
Credits	**5**		
Hours / Cycle	**60**		
Category	**Part**	**Elective**	**Theory**
Semester	**IV**		
Year of Implementation	**2021-2022 onwards**		
Course Objectives	To teach students with various classifications, methods in phytography, evaluation of different types of characters and character states, referencing different taxonomic literature and knowledge on earlier floristic studies in Tamil Nadu		

CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	Recall pre- & post-Darwin's classifications and classify flowering plants.	**PSO 2**	**K1**
CO 2	explain description and botanical illustrations.	**PSO 2**	**K2**
CO 3	Apply various taxonomic literature (flora, revision, and monograph) for the identification of local plants	**PSO 2**	**K3**
CO 4	Analyse different types of taxonomic characters (analytic vs synthetic; qualitative vs quantitative; primitive vs advanced, homologous vs analogous).	**PSO 2**	**K4**
CO 5	Discuss on different floristic regions of the world and floristic studies in Tamil Nadu.	**PSO 2**	**K5**

SYLLABUS

UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Classification systems prior to Darwin: Systems based on Habit, Sexual systems, Systems based on Form Relationships. Post-Darwinian Systems: Systems based on Ranalien School, Systems based on Englearean School.	**15**	**CO1-5**	**K1-K5**
II	Phytography - Methods and Styles of writing Descriptions. Botanical Illustrations, their importance and important illustrated floras. Plant photography and pictorial floras.	**10**	**CO1-5**	**K1-K5**
III	Taxonomic literature: Print (Journals, Floras, Revisions, Monographs, Dictionaries, Indices) and online sources as given under reference.	**15**	**CO1-5**	**K1-K5**

IV	Characters and character states: Introduction to different types of characters with five examples for each - analytic versus synthetic; qualitative versus quantitative; primitive versus advanced, and homologous versus analogous.	**10**	**CO1-5**	**K1-K5**
V	Floristic regions of the world and Phytogeographical regions in India. Vegetation types of India. Major milestones in Floristic studies in India with special reference to Tamil Nadu.	**20**	**CO1-5**	**K1-K5**

Prescribed Books/Textbooks (1-5 books)

DAVIS, P.H., AND V.H. HEYWOOD. 1965. Principles of Angiosperm Taxonomy. Oliver & Boyd. Edinburgh.

HENRY, A.N., M. CHANDRABOSE. 1980. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.

HEYWOOD, V.H. 1967. Plant Taxonomy. Edward Arnold Ltd. Great Britain.

HEYWOOD, V.H. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U.K.

LAWRENCE, G.H.M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.

SIMPSON, M. G. 2006. Plant Systematics. Elsevier Academic Press, California, USA.

SIVARAJAN, V.V. 1989. Introduction to Principles of Plant Taxonomy. Oxford and IBH Publishing Co. New Delhi.

TAKHTAJAN, A. 1997. Diversity and Classification of Flowering Plants. Bishen Singh and Mahendra pal Singh, Dehra Dun, India.

References (3 – 5)

HESLOP-HARRISON, J. 1953. New Concepts in Flowering Plant Taxonomy. Heinemann Ltd. London.

JUDD, W. S, C. S. CAMPBELL, E. A, KELLOG, P. F. STEVENS AND N. J. DONOGHUE. 2002. Plant Systematics – A phylogenetic approach. Sinauer Associates, Inc, Massachusetts, USA.

QUICKE, D.L.J. 1993. Principles and Techniques of Contemporary Taxonomy. Chapman and Hall. London.

SOLTIS, D. E., P. S. SOLTIS, P. K. ENDRESS AND M. W. CHASE.2005. Phylogeny and Evolution of Angiosperms. Sinauer Associates, Inc, Massachusetts, USA.

STUESSY, T. F. 2002. Plant Taxonomy. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

Suggested Reading (2 -5)

AHMEDULLAH, M., AND M.P. NAYAR. 1987. Endemic Plants of the Indian Region. Vol. I. Botanical Survey of India. Howrah.

GAMBLE, J.S., AND C.E.C. Fischer. 1967. Flora of the Presidency of Madras. Vols. I - III. Botanical Survey of India. Calcutta.

HUTCHINSON, J. 1973. The Families of Flowering Plants. 3rd Edition. Oxford University Press. Oxford. MABBERLEY, D.J. 2017. Mabberley's Plant–Book: A portable dictionary of plants, their Classification and uses. Fourth Edition. Cambridge University Press, Cambridge

NAYAR, M.P. 1996. "Hot Spots" of Endemic plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Thiruvananthapuram, India.

Web Resources (3-5)

http://www.mobot.org/MOBOT/research/APweb/
https://www.ipni.org/ http://www.efloras.org/
https://www.iapt-taxon.org/nomen/main.php https://www.ars-grin.gov/
http://www.plantsoftheworldonline.org/

Course Articulation Matrix

Course Outcomes	Programme Outcomes								Programme Specific Outcomes						Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	
CO 1	3									3					K1
CO 2	3									3					K2
CO 3	3									3					K3
CO 4	3									3					K4

CO 5	3									3					K5
Wt. Avg.	3									3					
Overall Mapping of the Course													3		

Credit Based semester system for UG Programme (Science)
B.Sc. va Plant Biology and Plant Biotechnology

QUESTION PAPER PATTERN FOR B.Sc. va

Part A

Answer all Ten questions, answer not to exceed half-a-page each. All questions compulsory. Each carries two marks. 10x2=20 marks

Part B

Answer any Five questions out of eight, answer not to exceed two pages each. Each carries eight marks. Draw diagram wherever necessary 5x8=40 marks

Part C

Answer any two questions, out of three, answer not to exceed five pages each. Each carries twenty marks. Draw diagram wherever necessary 2x20=40 marks

MADRAS CHRISTIAN COLLEGE (AUTONOMOUS)

Credit Based semester system for UG Programme (Science)
M.Sc. va Plant Biology and Plant Biotechnology

QUESTION PAPER PATTERN FOR M.Sc. va

Part A

Answer all Ten questions, answer not to exceed half-a-page each. All questions compulsory. Each carries two marks. 10x2=20 marks

Part B

Answer any Four questions out of six, answer not to exceed three pages each. Each carries ten
marks. Draw diagram wherever necessary 4x10=40 marks

Part C

Answer two questions either or pattern, answer not to exceed five pages each. Each carries twenty marks. Draw diagram wherever necessary 2x20=40 marks