PG – BOTANY REVISED CURRICULUM 2022-23

M. Sc., BOTANY

OBE REGULATIONS AND SYLLABUS

(With effect from the academic year 2022-23 onwards)

1. Preamble

The M.Sc., Botany course was introduced by the Department of Botany from the academic year 2011-2012. The new Outcome Based Education syllabus with CBCS pattern will be effective from the academic year 2022-2023. The OBE syllabus has been prepared to enrich subject knowledge with specific outcomes for Post Graduate Botany Students. The curriculum comprised broadening perspectives of Life Sciences and provides current needs of Post Graduate students such as advanced computational skills, biostatistics and Emerging Techniques relevant to the biomedical applications. The significant feature of this curriculum has been presented new core papers on Plant Diversity –I- Phycology and Bryology, Plant Diversity –II – Mycology, Lichenology and Plant Pathology with modern arenas of Life Sciences.

In addition five different Elective and Non major category papers were offered like Microbial Biotechnology, Algal Biotechnology, Mushroom Technology, Plant Genetics and Plant Breeding Techniques, Biofertilizer and Organic Farming where five different application aspect papers for allied science students viz., Plant and Life, Photochemistry, Climate Change and Sustainable Biodiversity, Horticulture and Gardening, Commercial Horticulture.

From the academic year 2018-2019 SWAYAM online courses were added to our curriculum. The programme has been to provide updated information along with conventional concepts of botany so that the students are;

- able to understand and adopt inter-disciplinary attitudes in the study of botany
- to gain subject knowledge and which is play a role in societal development
- to obtain practical and hands on experience techniques which provides knowledge and use modern scientific applications

2. General Graduate Attributes

The Post graduate student of Botany, Periyar University can able to

- Apply knowledge to the modern tools of biology with advanced computational methods
- Solve the complex problems through the fundamental and advanced concepts of plant sciences as well as relevant domain disciplines
- Identify and provide the conclusions for present societal needs according to gathered basic and advanced research knowledge through innovative techniques and methods

- Understand and recognize the lifelong learning and development of different concepts of plant sciences to become a entrepreneur
- Communicate effectively about problem and solutions to the scientific community even common layman society at large
- Understand and respect the global concern along with professional ethics
- Act effectively an individual or team towards the succeed of rectify the problems at different extent

3. Programme Specific Qualification Attributes

The students acquire high level confidence to get relevant job opportunities along with provide employment through commencement of entrepreneurship

Knowledge and understanding level (K1 and K2)

The learners can able to understand the different levels of plant kingdom, life of plants (Reproduction and physiology), involvement of plants in biochemical and geochemical cycles in biotic and abiotic of earth, and respectively, internal structures of plants, ecology and environment, interaction of genes of plants, emerging techniques of plant biotechnology, genetic engineering and nanobiotechnology, methods of crop production, application of biofertilizers, role of microorganisms, disease of plants and crops, advanced and applications of computational methods, medicinal plants and their significance

Application level (K3)

The Students will also be competent of opening Mushroom cultivation, Biofertilizer and vermicompost production and Herbal industries.

Analytical level (K4)

Every student can able to analyze the reason and methods of plant's involvement in inter and multidisciplinary aspects

Evaluation capability level (K5)

The students can be evaluate different levels of plant kingdom, life of plants (Reproduction and physiology), involvement of plants in biochemical and geochemical cycles in biotic and abiotic of earth, and respectively, internal structures of plants, ecology and environment, interaction of genes of plants, emerging techniques of plant biotechnology, genetic engineering and nanobiotechnology, methods of crop production, application of biofertilizers, role of microorganisms, disease of plants and crops, advanced and applications of computational methods, medicinal plants and their significance.

Scientific or synthesis level (K6)

The students can able to invent or produce new and novel techniques for present problems depending on the needs of society, health and safety of earth.

4. Vision

To equip our students to meet the nations demand

5. Mission

- Discover, maintain and transmit the knowledge concerning basic plant biology and provide leadership in the biological sciences
- Advance, integrate, evaluate and communicate knowledge of plant sciences from lab to land and beyond – using and improving plants to feed, clothe, fuel, restore and beautify the planet
- Seek out, anticipate and lead in addressing the agriculture, ecological and environmental needs of industry, communities and people throughout the world

6. Programme Objectives and Outcomes

Programme Educational Objectives (PEO)

Post graduates of Botany program will be

PEO 1: able to understand and adopt inter-disciplinary attitudes in the study of botany

PEO 2: able to gain subject knowledge and which is play a role in societal development

PEO 3: able to obtain practical and hands on experience techniques which provides knowledge and use modern scientific applications including computational techniques

Programme Outcomes (PO)

At the end of the programme, the students are able to

PO1: Apply fundamental knowledge of plant science and relevant interdisciplinary domains to solve the distinct problems and needs of society as well as environment.

PO2: Handle modern computational techniques in the specialization of biology

PO3: Realize and entrust the professional ethics regarding relevant disciplines of life sciences to implicate any regulations, responsibility and norms of ecobalance.

PO4: Know independent learning and development of concepts about plant sciences become a entrepreneur

PO5: Utilize research based knowledge create and adapt suitable techniques for various current issues of life sciences.

Programme Specific Outcomes (PSO)

On successful completion of postgraduate botany student can able to

PSO 1: Obtained knowledge of fundamental and advanced plant science

PSO 2: Explore the knowledge of subject in practically at various extent

PSO 3: Apply life science concepts in to innovation through basic and advanced research

PSO 4: Acquire high level confidence get subject oriented jobs in various research institutes across the world even start entrepreneurship also

7. Eligibility for Admission:

Candidate who has passed the B.S., degree in Botany/Plant Science/Life Science of the university or an examination of any other University accepted by the syndicate as equivalent thereto shall be eligible for admission to M.Sc., degree of this university recognized by the syndicate as equivalent thereto shall be eligible to register for the degree of master in Botany and undergo the prescribed course of study in an approved department of this university.

8. Mode of selection:

Applicants have selected through entrance examination and also as per the norms of Tamil Nadu Government.

9. Duration of the course:

The duration of the M.Sc., degree shall be two years consist of four semesters under Choice Based Credit System.

10. Internship

Internship programme is introduced to enrich the research and employability awareness for students. The students undergo Internship programme for 7 – 14 days duration in the II Semester holidays in Life Science related industries/institute/HEI/laboratory and should submit Internship report for evaluation. In internship, the students will be guided one teacher from the parent Department (Internal Supervisor) and one teacher from suitable or selected industries/institute/HEI/laboratory (External Supervisor) by joint guidance. The students will submit a project report to the parent Department along with certification of both the supervisors. External Supervisor will provide a letter certifying that the candidate has successfully completed the project and also award marks/ grade to him/ her. The evaluation report will be submitted to the parent department confidentially.

11. Distribution of credit points:

The minimum credit requirement for M.Sc., degree shall be 94 credits. The break-up of credits for the programme is as follows:

Course	Course Title	No.of. courses	Hrs/Week	Max. Marks	credits
Core course	Theory	13	52	1300	52
Core course	Practical	03	18	300	09
Elective	Elective course	04	16	400	16
Supportive	Supportive	01	04	100	04
Swayam	Swayam	01	--	--	02
Internship	Internship	01	--	--	--
Human rights	Human rights	01	02	100	02
	Project	01	20	200	09
	Library & Field Study	--	08	--	--
		25	120	2400	94

12. Credit calculation

Method of teaching	Hours	Credits
Lecture/ Tutorial/Demonstration/	1	1
Practical/Internship/self-learning	2	1

13. PG Programme M.Sc., Botany – Course Structure

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

SEMESTER-I

Core course	Code	Subject	Hrs /week	credits	CIA	EA	Total
I	22PBOT1CT01	Plant Diversity –I- Phycology and Bryology	4	4	25	75	100
II	22PBOT1CT02	Plant Diversity –II – Mycology, Lichenology and Plant Pathology	4	4	25	75	100
III	22PBOT1CT03	Plant Diversity –III- Pteridophytes, Gymnosperms and Palaeobotany	4	4	25	75	100
IV	22PBOT1CT04	Microbiology and Immunology	4	4	25	75	100
V	22PBOT1CT05	Plant Anatomy and Developmental Botany	4	4	25	75	100
VI	22PBOT1CP01	Practical – 01 (core I, II, III,IV & V)	6	3	40	60	100
	22PBOTE01	Elective - I	4	4	25	75	100
	22PBOT1SC01	SWAYAM	-	2	-	-	-
		Sub total	30	29	190	510	700

SEMESTER-II

Core course	Code	Subject	Hrs/ week	credits	CIA	EA	Total
VII	22PBOT2CT06	Plant Ecology, Phytogeography and Conservation biology	4	4	25	75	100
VIII	22PBOT2CT07	Cell biology, Genetics and Molecular Biology	4	4	25	75	100
IX	22PBOT2CT08	Bioinstruments and Techniques	4	4	25	75	100
X	22PBOT2CT09	Plant Physiology and Biochemistry	4	4	25	75	100
XI	22PBOT2CP02	Practical – 02 (core VII,VIII,IX & X)	6	3	40	60	100
	22PBOTE02	Elective – II	4	4	25	75	100
		Human rights	2	2	25	75	100
		Library	2	-	-	-	-
	22PBOT2IN01	Internship	-	-	-	-	-
		Sub Total	30	25	190	510	700

SEMESTER-III

Core course	Code	Subject	Hrs/ week	Credits	CIA	EA	Total
XII	22PBOT3CT10	Taxonomy of Angiosperms and Economic Botany	4	4	25	75	100
XIII	22PBOT3CT11	Plant Biotechnology and Genetic Engineering	4	4	25	75	100
XIV	22PBOT3CT12	Nanobiotechnology	4	4	25	75	100
XV	22PBOT3CP03	Practical – 03 (core (XII, XIII & XIV)	6	3	40	60	100
	22PBOTE03	Elective – III	4	4	25	75	100
	22PBOT3S01	Supportive – I	4	4	25	75	100
		Library	2	-	-	-	-
		Field study	2	-	-	-	-
		Sub Total	30	23	165	435	600

SEMESTER-IV

Core course	Code	Subject	Hrs/ week	credits	CIA	EA	Total
XVI	22PBOT4CT13	Research Trends in Botany	04	4	25	75	100
	22PBOT4PR01	Project work	20	09	50	150	200
	22PBOTE04	Elective – IV	04	04	25	75	100
		Library	02	-	-	-	-
		Sub Total	30	17	100	300	400
		Grand Total	**120**	**94**	**670**	**1830**	**2400**

Summary of credits

Semester	Hrs/week	credits	CIA	EA	Total
I	30	29	190	510	700
II	30	25	215	585	700
III	30	23	165	435	600
IV	30	17	100	300	400
Total	**120**	**94**	**670**	**1830**	**2400**

14. Elective courses:

The University Department of Botany offers elective course subjects.

- Microbial Biotechnology
- Algal Biotechnology
- Mushroom Technology
- Plant Genetics and Plant Breeding Techniques
- Biofertilizer and Organic Farming

15. Supportive courses:

The University Department of Botany offers supportive course subjects to other department students.

- Plant and Life
- Phytochemistry
- Climate Change and Sustainable Biodiversity
- Horticulture and Gardening
- Commercial Horticulture
- Siddha Medicine and Disease Ailments
- Phyconutraceuticals

16. Course of Study

The course of the study for the M.Sc., degree shall be in Botany (CBCS) with internal assessment according to syllabi prescribed from time to time.

17. Value added Course

Mushroom Cultivation

18. Add-on Course

Bonsai techniques

The component of Continuous Internal Assessment:

Internal test (Best one out of two test)	5 Marks
Model Examination	5 Marks
Seminar	5 Marks
Assignment	5 Marks
Attendance	5 Marks
Total	25 Marks

Marks allotment and Scheme of Examination

Theory core paper:

External	75 Marks
Internal	25 Marks
Total	100 Marks
Duration	3 hrs

Practical Internal and External:

Model practical	35 Marks
Record	05 Marks
Total	40 Marks
External	60 Marks
Total	100 Marks

Marks allotment for attendance as follows:

% of attendance	Marks
100%-91%	5
90%-81%	4
80%-71%	3
70%-61%	2
Below 60	No marks

19. Details of project marks:

Submission of Dissertation	100 marks
Viva-voce	50 marks
Internal marks **The marks should be provide by Internal Examiner only (Supervisor of the student)**	50 marks
Total	200 marks

20. Question paper pattern

Time duration: 3 hrs **Max.Marks**: 75

Part – A: 20x1= 20

Answer all the questions

(Four objectives type question from each unit)

Part – B: 3x5=15

Answer any three questions out of five questions

(One question should be taken from each unit)

(Questions must be analytical type)

Part – C: 5x8=40

Answer all the questions

(Either or type one pair from each unit)

21. Passing minimum

- There shall be no passing minimum for internal
- For External, the passing minimum shall be 50% (i.e. 38 marks) out of 75 marks.
- In the aggregate (internal+ external) the passing minimum shall be 50% for each paper/practical/project and viva-voce.
- Grading shall be based on overall marks obtained .

22. Classification of successful candidates

75 % and above	**First class with Distinction**
60 %– 74%	**First class**
Below 60%	**Second class**

23. Marks and Grades

Conversion of Marks to Grade Point and Letter Grade (Performance in a subject) as follows.

Range of Marks	Grade Points	Letter Grade	Description
90 - 100	9.0 – 10.0	O	Outstanding
80 – 89	8.0 – 8.9	D+	Excellent
75 – 79	7.5 – 7.9	D	Distinction
70 - 74	7.0 – 7.4	A+	Very Good
60 – 69	6.0 – 6.9	A	Good
50 – 59	5.0 – 5.9	B	Average
00 – 49	0.0	U	Re-Appear
ABSENT	0.0	AAA	Absent

24. Plant collection

As per part of M.Sc., Botany degree students shall undertake a study tour and field visit of different types of vegetation, ecosystem etc., under the guidance of faculty members not less than 4-5 days.

Semester – I

Core Course – I

Plant Diversity – I – Phycology and Bryology - 22PBOT1CT01 Credits - 4

Course Objectives:

- To learn and understand the lower plant kingdom and their evolutionary trends
- To know the morphology, physiology, ecology, reproductive biology of algae, fungi, lichen and bryophytes
- To study the classification and economic importance of algae, fungi, lichen and bryophytes

Unit – I

Phycology – History and Development of Phycology – Modern Phycology – Classification of algae (F.E. Fritch) – Criteria for algal classification - Occurrence and Distribution– range of thallus structure – Ultra structure (Flagella, Chloroplast, Pyrenoids, Photosynthetic pigments and Eyespot) – Ecology (Habit and Habitat), cytology, reproduction, life cycles and economic importance of algae - molecular phylogeny of algae.

Unit – II

Nomenclature – Significant features – Occurrence - Cell structure - Thallus organisation – Reproduction and broad classification – Life cycles – Economic importance of Cyanophyta, Xanthophyta, Bacillariophyta, Dinophyta, Chlorophyta, Phaeophyta, Cryptophyta and Rhodophyta and their comparative account.

Unit – III

Physiology of algae (Inorganic Nutrients, Vitamins and Pheromones in algae – Nitrogen fixation in algae – Movements and rhythm in algae) – Water Blooms and Red Tides – Algae and the Environment (Toxic algae – Fossil algae – Algae as Indicators of water pollution – control of algae nuisance) – Methods of algal study.

Unit – IV

Bryology – Introduction – Classification of Bryophytes – Hepaticopsida – Anthoceratopsids – Bryopsida – Origin of Bryophytes – Ecology of Bryophytes -Reproduction in Bryophytes – Life cycle pattern in Bryophytes – Cytology of Bryophytes - Diagnostic characters of Liverworts, Mosses, Hornworts – Life histories of *Sphagnum*, *Marchantia* and *Anthoceros*.

Unit – V

Chemical constituents of Bryophytes – Bryophytes as indicators of Pollution – Role of bryophytes in global climate regulation (Carbon concentration and sequestration)- Uses of Bryophytes (Ecological uses – Treatment of waste – Horticultural uses – Bryophytes as fuel – Medicinal uses – Food sources) – Threats and conservation of Bryophytes.

References

Phycology

1.Ahluwalia, A.S. (Ed.). Phycology: Principles, Processes and Applications. Daya Publishing, House, New Delhi. 2003.

2. Kumar, H.D. Introductory Phycology. 2nd Ed. Affiliated East-West Press, New Delhi.651 pp.1999.

3. Lee, R.E. Phycology. 4th Ed. Cambridge University Press, London. 2008.

4. Chapman, V.J. and D.J. Chapman. The Algae. ELBS and Macmillan , NY. 1977.

5. Fritsch, F.E. The Structure and Reproduction of Algae (Vol. I and II). Vikas Publishing House Pvt., Ltd., New Delhi. 1979.

6. Grahm, L.E. and L.W. Wilcox. Algae. Prentice Hall, U.S.A. 2000.
7. Grahm,L.J. and L.Wilcox. Algae. 2nd Ed. Benjamin Cummings (Pearson), San Francisco, CA.720 pp. 2009.
8. Sharma O.P. Series on Diversity and Microbes - Algae. Tata MCGraw – Hill, New Delhi. 2011.

Bryology

1.Chopra, R.N. and P. K. Kumar. Biology of Bryophytes. Wiley Eastern Ltd., New Delhi.350 pp.1988.
2. Rashid, A. An Introduction to Bryophyta. Ist Ed. Vikas Publishing House Pvt. Ltd., New Delhi. 298 pp. 1998.
3. Chopra, R.S. and S.S. Kumar. Mosses of Western Himalayas and adjacent Plains. Chronica Botanica, New Delhi. 142 pp. 1981.
4. Dyer, A. F. and J. G. Duckett.(Eds.). The Experimental Biology of Bryophytes. Academic press, London. 281 pp. 1984.
5. Goffinet, B. and A.J. Shaw. Bryophyte Biology.2 nd Ed. Cambridge Univ. Press, Cambridge.580 pp. 2009.
6. Kashyap, S.R.. Liverworts of Western Himalayas and the Punjab plains. Vols I II. Researchco Publications, New Delhi. 1932
7. Kumar, S.S. An approach towards Phylogenetic Classification of Mosses. Jour. Hattori Bot. Lab. Nichinan , Japan. 1984.

Course Outcomes (COs)

CO 1	Provide the students with the knowledge of algae and bryophytes.	K1, K2	LOT
CO 2	Get acquainted with the basic understanding about evolution of algae and bryophytes	K1, K2	LOT
CO 3	Acquire Knowledge about History and development of Phycology and Bryology.	K1, K2	LOT
CO 4	Develop an understanding of Classification, Nomenclature, Occurrence and Distribution, Ultra structure of cell components of algae and bryophytes	K3, K4, K5	HOT
CO 5	Understand the life cycle patterns and economic importance of algae and bryophytes.	K3, K4, K5	HOT

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate,K6- Create
LOT – Lower Order Thinking (Remember, Understand and Apply)
HOT – Higher Order Thinking (Analyse, Evaluate and Create)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	-	M	M	L
CO 2	S	-	M	M	L
CO 3	S	-	M	M	L
CO 4	S	-	M	M	L
CO 5	S	-	M	M	M

S- Strong: M-Medium: L-Low

Semester – I

Core Course – II

Plant Diversity –II – Mycology, Lichenology and Plant Pathology- 22PBOT1CT02

Cedits-4

Course Objectives

- ✓ To learn and understand the evolutionary trends and classification of fungi
- ✓ To know the morphology, physiology, ecology, reproductive biology of fungi and lichen
- ✓ To study the classification and economic importance of lichens
- ✓ To be acquainted plant disease classifications and diseases management

Unit-I

Mycology - Introduction - Systematics of fungi (Ainsworth) - Evolution of fungi – Ecology of fungi (Habit and Habitat) – Reproduction and life cycles - Chemistry of Fungal cell - Growth - Nutrition - Metabolism and regulation of metabolism - Diagnostic characters of Myxomycota, Oomycota, Chytidriomycota, Zygomycota, Ascomycota, Basidiomycota and Deutromycota - Economic importance of Fungi.

Unit-II

Classification and diversity of fungi Ascomycotina: *Aspergillus, Xylaria, Claviceps. Pezzia Morchella.* Basidiomycotina*: Lycoperdon, Ustilago, Polyporus.* Deuteromycotina :Alternaria, *Fusarium*. Spore dispersal and factors affecting spore germination, reproduction, life history, phylogeny and affinities of the major groups of Fungi. Heterothallism, Parasexual cycle, Degeneration of sexuality.

Unit-III

Lichens - Components of lichens - Occurrence - Classification - Morphology and anatomy of thallus - Different types of reproduction in lichens - Recent developments in lichen's research - Economic importance of lichens - Phycobionts (Photobionts) - Mycobionts.

Unit-IV

Plant Pathology: Definition and classification of plant disease - Etiology - Disease caused by fungi (Blast of paddy, Red rot of Sugarcane, Tikka disease) - Bacteria (Blight of paddy, Black arm of Cotton) - Virus (Bunchy top of Banana & TMV) - Mycoplasma (Little leaf disease) - A detailed account on Nematodes and Phytoplasma - Non-Parasitic diseases.

Unit V

Epidemiology and forecasting of Plant Diseases - Host parasite interrelationship and interaction - Environment and nutrition in relation to disease development - Defence mechanisms - Principles of plant diseases - Integrated Disease Management (IDM) -Biotechnology in relation to plant pathology.

References.

Text books

- Alexopolous, C.J., C.W. Mims and M. Blackwell. Introductory Mycology. 2007. 4 th Ed. John Wiley & Sons, New York. 880 pp.
- Bilgrami, K.S. and R.N. Verma. Physiology of Fungi. 2nd Ed. Vikas Publication House, New Delhi. 1986.
- Sharma, P.D. The Fungi. 2 nd Ed. Rastogi Publications, Meerut. 2004.
- Charles lane, Paul Beales, Kevin Hughes. 2012. Fungal Plant Pathogens. CABI publing.
- Prescott, L.M., Harley, J.P. and Klien, D.A. 1996. Microbiology (3rd ed.), Brown W.C.Publishers, Boston, USA.
- Anne M.T, David B .C, Annika Djurle, Lisa Munk, 2020. Plant Pathology and Plant Diseases, CABI publing

References books

- Bryophytes and Lichens in a Changing Environment. Bates, J.W., and A.M. Farmer, 1992. eds. Oxford: Clarendon.
- Webster, C.J. Introduction to Fungi. 2007. 3rd., Cambridge University Press, Cambridge.
- Moore, D., Robson, G.D. and Trinci, A.P.J. 2011. 21st Century Guide book of Fungi, Cambridge University Press, N.Y.

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

CO. No.	Course Outcomes		
CO 1	Get acquainted with the basic understanding about evolution of plants and fungi	K1,K2	LO
CO 2	Develop an understanding of Classification, Nomenclature, Occurrence and Distribution, Ultra structure of cell components.	K3	LO
CO 3	Understand the life cycle patterns and economic importance lichens	K3,K4	IO
CO 4	To be acquainted plant disease classifications	K3,K5	LO
CO5	Understand the disease management	K5,K2	HO

K1- Remember, K2- Understand, K3- Apply, K4 - Analyse, K5- Evaluate, K6- Create

Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5
CO 1	M	L	-	L	-
CO 2	S	M	M	M	M
CO 3	S	M	M	-	-
CO 4	S	M	M	-	-
CO 5	S	M	M	M	-

STRONG-S, L-LOW, MEDIUM

Semester – I

Core Course – III

Plant Diversity III **Credits: 4**

Pteridophytes, Gymnosperms and Palaeobotany - 22PBOT1CT03

Course Objectives:

- To understand the morphology, structure and reproduction of some pteridophytes
- To know about the structure, life history and economic importance of gymnosperms
- To understand about the geological time scale
- To Study the methods of Fossilization and fossil plants and gain knowledge about Institute of Paleobotany

Unit - I

Pteridophytes – Introduction – Vascular cryptogams – Characteristic features – Habitat of Pteridophytes – Lifecycles - Origin of Pteridophytes – Evolution of Sporophyte - Classification (Sporne, 1967) – Economic Importance – Recent scenario in Pteridology.

Unit - II

Morphology, structure and reproduction of Selaginella, Isoetes, Gleichenia, Equisetum, Ophioglossum, Marselia, Salvinia, Adiantum, Psilopsida, Lycopsida, Sphenopsida, Pteropsida and Pteris. Stelar and soral evolution. Telome theory - Heterospory and Seed habit. Apogamy and Apospory.

Unit - III

Classification of Gymnosperms (Sporne, 1967). Evolution of pollination mechanisms and embryogeny of gymnosperms. Comparative study of vegetative, anatomy and reproduction structure of Cycadales, Coniferales and Taxales. Woods of gymnosperms.

Unit - IV

Comparative study of vegetative, anatomy and reproductive structure of Ginkgoales and Gnetales. Economic importance of gymnosperms- as food, medicine, industry and ornamental plants. Impact of coniferous forest on human life.

Unit - V

Geological times scale. Fossilization, types and age determination. Rajmahal hills, Deccan intertrappean flora. Study of morphology, anatomy and evolutionary trends of following groups of fossil forms. Lepidodendrales, Rhyniales Sphenophyllales, Psilophytales, Pterdospermales, Bennettitales, Cycadales, Cordaitales and Coniferales. Institute of Palaeobotany - Birbal Sahni.

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Text books

- Govil C.M. 2011. Gymnosperm. Krishna Prakashan Media.
- Sambamurthy, A.V.S.S. 2005. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I.K. International Publishing House. New Delhi.
- Trivedi P.C. 2002. Advances in Pteridology. Pointer Publishers.
- Vashishta B.R. 2001. Botany for degree students– Pteridophytes. S Chand & Co Ltd; 5th edition.
- Bhatnagar S.P. and Alok Moitra1996. Gymnosperms. New Age International.
- Rashid A 1978. An introduction of Peridophytes. Vikas publishers.
- Parihar N.S. 1959. An introduction of Peridophytes. Central Book Depot. Publishers.
- S.P. Bhatnagar, S.P, and Alok Moitra (2018). Gymnosperms New Age International (P) Ltd., Publishers
- Bhojwani S.S/Bhatnagar S.P. & Dantu P.K. (2015). The Embryology of Angiosperms, 6th Edition.

Reference Books

- Bower F.O. 1963. The Ferns
- Taylor D.V. and Hickey L.J. 1997 Flowering plants: Origin, evolution and phylogeny.
- Sporne K.R. 1996. Morphology of Pteridophytes. Hutchinson; 3rd edition.
- Arnold C.A. 1972. An introduction to Paleobotany. New York, McGraw-Hill Publishers.

Course Outcomes (COs)

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

CO1	Learn about the general characters, classification by sporne and evolution of sporophytes	**K1,K2**	**IO**
CO2	Gain knowledge about the stelar and soral evolution, telome theory - Heterospory and Seed habit. Apogamy and Apospory	**K2**	**IO**
CO3	Comparative study of vegetative, anatomy and reproduction of C*ycadales*, C*oniferales* and *Taxales*	**K3,K4**	**HO**
CO4	Know about the economic importance of Gymnosperms	**K3,K4**	**HO**
CO5	Studied the methods of Fossilization and fossil plants	**K2, K5**	**LO**

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	M	S	S	M
CO 2	S	M	M	L	M
CO 3	S	M	M	M	L
CO 4	S	M	S	L	L
CO 5	S	M	S	M	L

S- Strong; M-Medium; L-Low

Semester – I

Core Course – IV

Microbiology and Immunology - 22PBOT1CT04 Credits-4

Course objective

The candidates undertaking this course will gain knowledge about the structure of bacteria and virus; types of microscopes and microscopy; sterilization methods and quality control; disinfection, antibiotics – testing and quality control. The candidate will gain knowledge about immunity, organs of immunity and cells involved; Types of antigens and properties; immunoglobulin – types; MHC and its significance reactions.

Unit-I

History and scope of microbiology – Criteria for classification of microorganisms – Microbiological staining methods. Bacteriology: General characters and classification (Bergey's Manual) – Growth: Continuous & synchronous culture. Virology: General characters, types of virus (Corono virus, Nipha virus) classification, structure, Replication– lytic and lysogenic cycles.

Unit-II

Brief outline of virology: Discovery of virus; early development of virology – nomenclature – classification and taxonomy of viruses - based on host, nucleic acids and structure; Evolution of Viruses.

Unit-III

Role of microbes using in Biogeochemical cycles of Carbon, Nitrogen, Phosphorous and Sulphur. Biodegradation of xenobiotic – hydrocarbons, Pesticides and Plastics. Bio deterioration of wood, pulp and paper. Food & Dairy microbiology: Food spoilage & poisoning - Waste water treatment, general characterization and its significance of bioreactor screening of industrially useful fungal strains. Fungi as biocontrol agent and Quorum sensing in fungi.

Unit-IV

Immunology of structure and components, innate and acquired immunity, humoral and cell mediated immunity, organ and cells involved in immunity T & B cell. Major Histocompatibility Complex (MHC). Human leucocyte antigen (HLA). Complement pathways: classical, alternative & lectin.

Unit - V

Antigens: Types, Properties, Haptens, Epitopes, Adjuvants, Auto antigens, Blood group antigens. Immunofluorescence, ELISA, RIA, Immuno electrophoresis. Hybridoma technology and Monoclonal antibodies - applications. Vaccines - DNA vaccines recombinant vaccines - Edible vaccines, multivalent, subunit and anti – Idiotye vaccines. Autoimmune disorders.

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

Course Outcomes (COs)

CO. No.	Course Outcomes		
CO 1	To study the classification, structure and reproductive features of bacteria and virus	K1,K2	LO
CO 2	Isolation and identification of Microorganisms	K3	LO
CO 3	Role of microorganism and interactions	K3,K2	IO
CO 4	To impact knowledge on the basic concepts of cells and components of immune system	K3,K4	LO
CO 5	Identification of diagnostic techniques	K5,K4	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5
CO 1	M	L	-	L	-
CO 2	S	M	M	M	M
CO 3	S	M	M	-	-
CO 4	S	M	M	M	S
CO 5	S	M	M	M	S

S- Strong; M-Medium; L-Low

Semester – I

Core Course – V

Plant Anatomy and Developmental Botany - 22PBOT1CT05
Credits - 4

Course Objectives

- To inculcate the basics of tissues and anatomical features of plants.
- To impart the knowledge about the various aspects of plant development.
- To understand the key aspects of embryology of Angiosperms

UNIT I

Structure and Organisation of tissue – unicellular, colonial and multicellular forms– organization of shoot and root apical meristem - Cambium and seasonal activities, Cambium in monocotyledons. Vascular cambium – Ontogeny – structure, function and types - Secondary xylem– structure and pattern of distribution – Wood - sap wood, heartwood, reaction wood, growth rings.

UNIT II

Structure and development of bark - Anomalous secondary thickening in dicot (*Aristolochia*, *Boerhaavia*, *Bignonia*, *Achyranthes*, *Nyctanthes*) and monocot stems (*Dracaena* and *Yucca*) - Nodal anatomy - Leaf development – phyllotaxy – floral meristem and development (*Arabidopsis*) – Vascular skeleton of flower and fruit.

UNIT III

Unique features of plant development, Cell determination, Differentiation, Germline development, Specialization, Cell lineage, Predictability of cell fate, Positional information in plant development, Cell layer and Chimeras - Floral meristem and development.

UNIT IV

Floral parts - Microsporogenesis and formation of male gametophyte-Anther differentiation - Pollen development and maturation - Male gametogenesis - Megasporogenesis and formation of female gametophyte - embryo sac – types – Palynology.

UNIT-V

Pollination – Pollen-pistil interaction - Double fertilization - Pre-zygotic barriers to self fertilization - Endosperm- Types – Embryogenesis - Development of embryo - Gene action during embryogeneis – Polyembryony – Apomixes - Seed development, maturation and

germination - Stages of fruit development - Fruit ripening - Alternative developmental strategies - Somatic Embryogenesis and pollen Embryogenesis.

Text books:

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Course Outcomes

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

CO1	To know the fundamentals of cells, morphology and internal structure of plants	K1, K2	HO
CO2	To understand the development of secondary growth in plants	K3	HO
CO3	To know the stages of plant development	K4	HO
CO4	To study the development of floral parts, palynology and fertilization	K5, K2	HO
CO5	To acquire knowledge of sexual incompatibility and embryology in plants	K6	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PSO1	PSO2	PSO3	PSO4
CO 1	M	S	-	-
CO 2	S	S	L	-
CO 3	M	S	M	-
CO 4	S	M	-	-
CO 5	S	L	-	-

S- Strong; M-Medium; L-Low

Semester - I

Core Course – VI

Practical – 01 (22PBOT1CP01)

Plant Diversity –I- Phycology and Bryology

Plant Diversity –II – Mycology, Lichenology and Plant Pathology

Plant Diversity –III- Pteridophytes, Gymnosperms and Palaeobotany

Microbiology, Immunology, Plant Anatomy and Developmental Botany Microbiology

Phycology

- Morphology and internal structures of vegetative and reproductive organs in the genera
- Cyanophyta : *Oscillatoria, Nostoc, Anabaena*.
- Chlorophyta: *Volvox, Hydrodictyon, Chlorella, Oedogonium,*
- Xanthophyta : *Vaucheria, Botrydium*.
- Bacillariophyta : *Cyclotella*.
- Phaeophyta : *Ectocarpus, Fucus, Laminaria, Sargassum, Padina*.
- Rhodophyta : *Porphyra, Gelidium.*
- Preparation and submission of fifteen (15) herbaria specimen (Seaweeds) in the course of field study in fresh and coastal ecosystem.

Bryology

- Study of morphology and internal structures of vegetative and reproductive organs in the genera of *Marchantia, Sphagnum, Fossombronia, Anthoceros* and Moss

Mycology

- Study of diagnostic features of the following types of fungi
  Myxomycota*: Stemonitis, Physarum.* Oomycota*: Albugo, Phytophthora.* Chytidriomycota*: Synchitrium, Allomyces, Blastocladia.* Zygomycota*: Mucor, Rhizopus, Pilobolus.* Ascomycota*: Aspergillus, Penicillium, Xylaria, Morchella, Peziza, Saccharomyces.* Basidiomycota*: Puccinia, Auricularia, Agaricus, Ustilago, Polyporus, Pleurotus.* Anamorphic fungi*: Fusarium, Cercospora, Alternaria*

Lichenology

- Study of morphology and anatomical features of foliose, crustose and fruticose lichens through permanent slides (*Parmelia* and *Usnea*).

Plant Pathology

- Isolation of pathogens from diseased tissues (leaf, stem and fruit)

- Symptoms and identification of diseases caused by fungi (Blast of paddy, red rot of sugarcane, Tikka disease), Bacteria (Blight of paddy, Black arm of Cotton) Virus (Bunchy top of Banana & TMV), – Mycoplasma (little Leaf diseases).

Pteridophytes

- Study of vegetative, anatomy and reproductive structure of *Selaginella*, *Ophioglossum*, *Equisetum*, *Gleichenia*, *Marselia* and *Azolla*.

Gymnosperms

- Study of morphology, anatomy and reproductive structure of *Araucaria*, *Cupressus*, *Podocarpus*, *Ginkgo*, *Taxus*, *Ephedra* and *Gnetum*.

Palaeobotany

- Study of salient features of the following through permanent slides; *Lepidodendron*, *Lepidocarpon*, *Gleichenties*, *Williamsonia*, *Calamites*, *Sphenophyllum*, *Glossopteris* and *Cycads*

Microbiology

- Cleaning and Sterilization of Glassware
- Preparation of culture media
- Sterilization techniques
- Serial dilution techniques – Pure culture (Pour/Streak/Spread)
- Differential staining methods of bacteria by using Gram stain
- Antibacterial assay - disc diffusion/agar well method
- Isolation of microorganisms from various sources (Milk, Water, Air, Vegetables, Fruits and Bread)
- Motility of Bacteria

Immunology

- Blood group determination (Demonstration), ELISA, Monoclonal Antibodies, DNA vaccines, Immuno electrophoresis

Plant Anatomy and Developmental Botany

- Estimation of stomatal index
- Study the anomalous, primary and secondary features in selected Monocot and Dicot plants
- Detailed study of TS, TLS and RLS from various wood for to identify the soft and hard wood
- Study the anatomical abnormality of C4 and CAM plants (Leaf/Stem).
- Study the morphology of pollen grains of Hibiscus, Tribulus, Ocimun and Grass
- Pollen germination experimental study
- Identify the different types of embryos, polyembryony, endosperm types, types of pollen grains.
- Any stage of embryo excision from Cucumber seeds.

Semester – II

Core Course – VII

Plant Ecology, Phytogeography and Conservation Biology - 22PBOT2CT06 Credits 4

COURSE OBJECTIVES

- To learn and understand the basic structure of ecosystem
- To create awareness about the threats to environment and its management
- To obtain the complete understanding about the conservation of ecosystem and environment in addition to NGOs.

Unit – I

Basic ecological principles: definition of ecology and environment- components and characters of ecosystem- homeostasis. Ecosystem-structure and the function.Factors affecting environment-abiotic-edaphic, climatic, topographic.Biotic- allelopathy. Biotic I and abiotic interaction, population ecology, curve, r and k selection, metapopultion, species interaction, interspecific competition.

Unit – II

Ecosystem – types – aquatic, terrestrial, desert and forest ecosystem. Estuarine and mangrove ecosystem – adaptations. Studying vegetation – types – list and count quadrat methods - density abundance frequency, Ecological niche, ecotone, edge effect. Flow of energy in ecological system, quality of energy, Primary and secondary foundation species enhance biodiversity. Non Conventional Sources of Energy (Solar, Hydro, Wind, Biogas, Geothermal, Ocean thermal, Tidal energy).

Unit – III

Ecological succession – Seral and Climax communities – Hydrosere, Xerosere. Bog succession, sand dune succession. Ecosystem components – energy flow, food chain, food web and ecological pyramids. Biogeochemical cycle – water cycle, carbon cycle and nitrogen cycle

Unit – IV

Pollution : types – Pollutants, air, water, soil, thermal, radiation and noise pollution and their impact in environment and control measures. Global environmental changes; biodiversity status, monitoring and documentation; major drivers of biodiversity change; - biodiversity management approaches; Green house effect and its consequences. Waste recycling. Environmental Impact Assessment (EIA). Disaster management: Floods, earthquake, Cyclone and landslides and Tsunami – Ozone depletion-El-nino and La-nina effects – Invasive species – Global warming and glaciers.

Unit – V

Phytogeography – major biome in world and India. Continental drift - hypothesis - Gondwana land factors involved in distribution., Introduction to IUCN criteria - Red data, rare, endangered species, conservational Biology- Introduction, problems in conservation- causes of threats in environment-human interference, deforestration, habitat destruction, over-exploitation of resources, strategies in conservation- insitu, exsitu, biosphere reserves, national parks, genebanks, cryopreservation and seed bank. Afforestration-social and agroforestry. Environmental protection acts, role of NGO's in environmental protection. Endemism - Age and Area hypothesis. Hot spots, Plant exploration.Invasion and introduction. Remote sensing-introduction and its principle

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COURSE OUTCOMES

On the successful completion of the course students will be able to

CO1	To Understand the basic ecological principles	KI, K2	HO
CO2	To understand the ecosystems and its types	K2,K3	HO
CO3	To acquire knowledge about the ecological succession	K4	HO
CO4	To understand and obtain knowledge on pollutions and its impacts on environment	K5,K2	HO
CO5	To acquire knowledge about phytogeography	K6	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PSO1	PSO2	PSO3	PSO4
CO 1	M	S	L	-
CO 2	S	S	M	L
CO 3	M	S	M	-
CO 4	S	M	-	-
CO 5	S	M	L	-

S- Strong; M-Medium; L-Low

Semester II

Core Course – VIII

Cell Biology, Genetics and Molecular Biology - 22PBOT2CT07 Credits: 4

Course Objectives:

- To get adequate knowledge about the cell biology and basic concept of genetics
- To study the structure of organisms and advanced molecular techniques.

Unit - I

The plant cell: Structure and function of cell wall, membrane, chloroplast, mitochondria, ribosomes, peroxisomes, golgi apparatus, nucleus, nucleolar organizer and ER. Structure and functions of biomolecules, stablizing interaction - Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction. Cell division- Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle. crossing over – synaptonemal complex and cell cycle –cytokinesis.

Unit - II

Organization of gene and chromosomes: Morphology and chemistry of chromosome; molecular organization of centromere and telomere. Karyotype. Polytene, lampbrush and B- chromosomes, Structural and numerical alteration of chromosome (Eu and polyploidy) and its significance. Detection of molecules using immunoprecipitation, flowcytometry and immunofluorescence microscopy. In –situ hybridization – FISH and GISH.

Unit - III

Mendalian principles – Laws of inheritance - monohybrid, dihybrid, test cross, back cross. Alleles, Epitasis, Interaction of genes, complementary genes, dominance, segregation, independent assortment - Gene mapping methods, Linkage maps - Sex determination. Extra chromosomal inheritance involving chloroplast and mitochondria. Mutation types, causes and detection, mutant types, insertional mutagenesis.

Unit - IV

Chromatin organization – DNA replication and control of gene expression in prokaryotes and eukaryotes. repair, recombination, C- value paradox, Operon concept, transposans. Interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin. Transcription, RNA splicing – post transcriptional modification. Enzymes involving in replication and transcription. Translation – targeting of proteins to different cellular compartments.

Unit - V

Plastome – structure and function. Transcription and processing of chloroplast RNA. Gene knock out and knocking in bacterial and eukaryotic organisms. Genomic imprinting- RNAi. Isolation, separation and analysis of carbohydrate and lipid molecules. Gene expression analysis micro array based techniques.

References

Text Books

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Course Outcomes (COs)

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

CO1	Understand about the structure and organisation about the Cell membranes and know about the functions of biomolecules	**K1,K2**	**IO**
CO2	Gain knowledge on organisation of gene and chromosomes and gain skill on working principles of immunoprecipitation, flow cytometry, immunofluorescence microscope, FISH and GISH	**K2**	**IO**
CO3	Know about the different types of genetic interaction, monohybrid, dihybrid, test and back cross and study about mutation types, causes, detection and insertional mutagenesis	**K3**	**IO**
CO4	Understand the concept of chromatin organisation, DNA replication, Operon concept, Transcription, Translation, RNA splicing	**K3,K4**	**HO**
CO5	Gain skill knowledge about isolation, separation and analysis of carbohydrate and lipid molecules and study the concept of gene expression analysis micro arraybased techniques	**K4, K5**	**HO**

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate,

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	M	S	S	L
CO 2	S	M	M	L	M
CO 3	S	S	L	M	L
CO 4	S	M	S	L	L
CO 5	S	M	S	M	L

S- Strong; M-Medium; L-Low

Semester – II

Core Course - IX

Bioinstruments and Techniques - 22PBOT2CT08 Credits 4

Course Objectives

- To know and learn the different analytical techniques principles and mechanism
- To study advanced instruments and their applications

Unit I

Microscopy – Principles and applications – types of microscopes (Compound, Phase contrast, Fluorescent, SEM, TEM and Cryo-electron microscopy) - Photomicrograph – Preparation of microscopic Slides – Types - Microtomy - Staining and Mounting – Whole mount methods – Squash and smears – Labelling methods – Histochemistry and Cytochemistry.

Unit II

General Principles of Biochemical analysis – Principles and Methodology of Colorimetry, Spectrophotometry, pH meter, Centrifugation techniques and Chromatographic techniques: principles and methods (Paper. Thin layer, Column, Adsorption, Partition, Ion-Exchange, Gas-liquid, chromatography and HPLC).

Unit III

Electrophoretic techniques – Principles, Methodology, Types of Electerophoresis (Agarose gel electerophoresis, SDS-PAGE) - Principles and applications of FTIR, XRD, LCMS, NMR, MALDI-TOF – PCR (Thermocycler and Real Time PCR) – ELISA – Flow Cytometry – AAS.

Unit IV

Structure, function and application of basic equipments used in biology experiments - Rotary evaporator, Autoclave, Laminar air flow chamber, Laboratory freezer, Hot air oven, Incubator, Magnetic stirrer, Water, Refrigerated, thermostatic and Plasma thawing bath, Shakers (Orbital, Rotary, Vortex, Gyratory sieve shaker and rotary flask shaker) – Distillation Unit – Photo flame meter, Ultrsonicator – Transilluminator – Soxhlet apparatus – Lyophilizers.

Unit V

Research – Literature collection – Literature citation – Research report – Bibliography – Article preparation of publication – Plagiarism – Immunological techniques – Measurement of Antibody Affinity – Types of Antigen – Antibody Reactions – Precipitation Reactions – Monoclonal Antibodies – Purifying Antibodies – Monoclonal therapy.

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Course Outcomes (COs)

CO 1	gets a deep practical knowledge about biological techniques	K1, K2	LOT
CO 2	understand much knowledge about different separation techniques of biomolecules	K1, K2	LOT
CO 3	obtained knowledge about structure, function and application of basic and advanced equipments used in biology and molecular biological techniques	K3, K4	HOT
CO 4	gathered knowledge about different principles and mechanism of basic and advanced instruments including microscopy	K3, K4, K5	HOT
CO 5	capable to operating knowledge of basic and advanced instruments	K3, K4, K5	HOT

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate,K6- Create

LOT – Lower Order Thinking (Remember, Understand and Apply)

HOT – Higher Order Thinking (Analyse, Evaluate and Create)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	-	M	-	S
CO 2	S	-	M	-	S
CO 3	S	M	M	-	S
CO 4	S	S	M	-	S
CO 5	S	S	M	-	S

S- Strong: M-Medium: L-Low

Semester – II

Core Course – X

Plant Physiology and Biochemistry (22PBOT2CT09) Credits 4

Course Objectives

- Learn physiological mechanisms underlying plant metabolism.
- Understand the various steps involved in the basic functioning of plant growth
- Emphasize functions of plants biomolecules and their metabolism.

UNIT I

Water relations of plants – Structure and physiochemical properties of water, transport and translocation of water, solutes and macromolecules through cells, xylem and phloem, role of aquaporins, mechanisms of loading and unloading of photoassimilates, source and sink relationship. Stomatal physiology- Mechanism of stomatal movement and transpiration.

UNIT II

Photosynthesis - Light harvesting complexes, Photophosphorylation, photoprotective mechanisms, CO2 fixation-C3, C4 and CAM pathways and regulation of photorespiratory pathway. Respiration– Glycolysis, Citric acid cycle, plant mitochondrial electron transport system, ATP synthesis and cyanide resistant respiration.

UNIT III

Nitrogen metabolism - Nitrate and ammonium assimilation, biological nitrogen fixation, amino acid biosynthesis. Plant hormones - Biosynthesis, physiological effects and mechanisms of action. Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, blue light mediated stomatal movement. Photoperiodism and biological clocks – vernalization - seed Dormancy. Stress physiology- mechanism of plant responses to biotic and abiotic stresses.

UNIT IV

Biomolecules of the cell- Classification of Carbohydrates: Monosaccharaides, Disaccharides, Polysaccharides, Homopolysaccharides and Heteropolysaccharides. Protein – Structure, function and classification of proteins. Lipids- structure, composition and classification, synthesis and breakdown of fatty acids.

UNIT V

Enzyme as catalysts - kinetics, classification, nomenclature, structure, properties and mechanisms of enzyme action. Vitamins - general characters, classification, structure and properties, fat soluble and water soluble vitamins. Secondary metabolites - Classification, biosynthesis, and functions of terpenoids, alkaloids, phenolics, flavonoids, steroids and coumarins.

Text books:

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

- Taiz et al., 2015. Plant Physiology and Development, 5th edition, Sinauer Associates, India.
- Pandey, N. S. and Pandey, P. 2016. Textbook of Plant Physiology. Daya Publishing House, New Delhi.
- Lincoln T, Eduardo Z, Ian Max M, and Angus M. 2018. Fundamentals of Plant Physiology. Sinauer Associates Inc., US
- Buchanan, B.B., Gruissem, W. and Jones, R.L. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK.
- Nelson,D.L and M.M.Cox. Lehninger. (2012). Principles of Biochemistry, 6th Edition, W.H.Freeman & Company, New York.
- Satyanarayana, U and Chakrapani, U. 2017. Biochemistry. Thomson press, India.

Reference books:

- Satish C Bhatla, Manju A. Lal. 2018. Plant Physiology, Development and Metabolism. Springer Nature, Singapore.
- Kochhar, S.L., Gujral, S.L. 2020. Plant Physiology, Theory and Applications. Cambridge University Press, New York.
- Jain, J.L. 2000 Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
- Rodwell, V.W., Bender, D., Botham, K.M. 2018. Harper's Illustrated Biochemistry, 31th edition, McGraw-Hill Education, New York.

Course Outcomes

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

CO1	To understand the basic fundamentals of physiological aspects of plants	KI, K2	HO
CO2	To know the energy production and its utilization in plants	K3	LO
CO3	To learn the plant metabolism, photobiology and response to various stress	K4	HO
CO4	To study the structural and functional properties of plant biomolecules	K5,K2	HO
CO5	To acquire knowledge of enzymatic action and functions of secondary metabolites	K6	HO

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PSO1	PSO2	PSO3	PSO4
CO 1	L	-	-	-
CO 2	M	L	M	-
CO 3	M	M	M	-
CO 4	S	M	S	L
CO 5	M	M	L	-

S -Strong; M-Medium; L-Low

Semester – II

Core Course – XI

Practical – 02 (22PBOT2CP02)

(Plant Physiology & Biochemistry Plant Ecology, Phytogeography, Conservation Biology, Cell biology, Genetics and Molecular Biology, Bioinstruments and Techniques)

PLANT PHYSIOLOGY & BIOCHEMISTRY

- Extraction and estimation of chlorophyll a, b and carotenoids in C3 and C4 plants by Arnon (1949).
- Leaf anatomy of C3 and C4 plants
- Preparation of buffers – Phosphate and Citrate buffers.
- Preparation of the standard curve of protein (BSA).
- Estimation of reducing and non-reducing sugars by Nelson's method (1994). Estimation of soluble starch by Hansen and Moller (1975).
- Estimation of soluble protein by Lowry's method (1951).
- Estimation of free amino acids by Bates and Waldren (1973).
- Estimation of lipid by volumetric method.
- Determination of catalase and peroxidase activity by Chance and Maehly (1955).
- Separation of amino acids by Paper and Thin Layer Chromatography.

PLANT ECOLOGY:

- Determination of linear changes in vegetation by using line and belt transect methods.
- Determination of frequency, density, abundance, dominance, FICC, dominance index, similarity index and diversity index by using quadrat frame.
- To find out the bulk density of a given soil sample To study soil density and porosity

PHYTOGEOGRAPHY:

- To determine the vegetational cover in a given area
- To prepare list of Endangered, Endemic and Threatened species in a selected areas.

CELL BIOLOGY

- Phase Contrast Microscope
- Fluorescence Microscope
- Karyotyping of monocot (mitosis)
- Karyotyping of dicot (mitosis)
- Induced aberration of chromosomes

GENETICS

- Genetic cross analysis monohybrid and dihybrid
- Test cross and back cross

MOLECULAR BIOLOGY

- Isolation of plant genomic DNA and RNA
- Analysis of nuclear DNA by agarose gel electrophoresis
- Demonstration of PCR

BIOINSTRUMENTS AND TECHNIQUES

- Hands on experience in the use of instruments like Calorimeter, Spectrophotometer, pH meter, Centrifuge, Thin layer chromatography, Agarose gel electrophoresis, PAGE and PCR
- Demonstration of Rotary evaporator, Autoclave, Laminar air flow chamber, Laboratory freezer, Hot air oven, Incubator, Magnetic stirrer, Water bath, Shakers, Distillation Unit, Photo flame meter, Ultrsonicator, Transilluminator, Soxhlet apparatus and Lyophilizers
- Analysis the data from FTIR, XRD, LCMS, NMR, MALDI-TOF – PCR (Thermocycler and Real Time PCR) – ELISA – Flow Cytometry

Semester – III

Core Course – XII

Taxonomy of Angiosperms and Economic Botany

22PBOT3CT10 Credits - 4

COURSE OBJECTIVES

- To learn and understand the classification, Identification and Nomenclature of the Angiosperm plants
- To understand the economic importance of plants and its commercial applications.

UNIT – I

Systems of classification: Artificial system: Linnaeus: Natural system: de Candolle, Bentham & Hooker: Phylogenetic system: Engler and Prantl, Hutchinson and Takhtajan and Dahlgren. ICBN, types and typification – Principles of priority and their limitation– problems in nomenclature, Herbarium and its potential role in teaching and research. Preparation of key, Flora, Monographs – Botanical Gardens, Botanical survey of India- – and it's role, Taxonomical hierarchy.

UNIT – II

Chemotaxonomy – micromolecules - primary and secondary metabolites. Macromolecules – protein, nucleic acids, polysaccharides. Numerical Taxonomy – cladistics.definition and terms: Primitive and Advanced- Homology and Analogy, Parellism and Convergence; Monophyly and polyphyly. Biosystematics - Taxonomy relation to anatomy, embryology, palynology, ecology, cytology and serology. Molecular taxonomy – RFLP – APG.Morphology of Angiosperms- Root, Stem, Leaves,Flower, Fruit and Seed. Phyllotaxy.Types of inflorescence and fruits.Modification of Root, Stem and Leaf.

UNIT – III

Study of diagnostic characters of the following family Magnoliaceae, Menispermaceae, Polygalaceae, Caryophyllaceae, Oxalidaceae, Meliaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae, Lythraceae, Aizoaceae. Portulacaceae and Tiliaceae.

UNIT – IV

Study of diagnostic characters of Oleaceae, Gentianaceae, Boraginaceae, Bignoniaceae, Casuarinaceae, Amaryllidaceae, Podestemaceae, Loranthaceae, Orchidaceae, Liliaceae, Commelinaceae, Musaceae, Arecaceae, Cyperaceae and Poaceae.

UNIT – V

Economic importance of Cereals: Wheat, Rice, Maize, Sorghum, Barley. Legumes: Black gram, Red gram, Chick pea, Pigeon pea. Fruits: Banana, Grapes, Citrus, Mango. Spices and Condiments: Ginger, Pepper, Cardamom, Clove. Beverages from plants: Tea, Coffee and Cocoa. Fibres- Cotton, Jute, Sun hemp. Timber: Teak, Rosewood, Ebony, Sal and Mahogany. Vegetable Oil: Sun flower, Peanut, Palm Oil, Coconut and Sesame. Plants used as avenue trees for shade, pollution control and aesthetics.

TEXT BOOKS:

- Nalk, V.N.., 1984. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company Ltd., New Delhi. 304pp.
- Singh, G 1999. Plant Systematics – Theory and Practice. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi. 35pp.
- Sharma, O.P. 1958. Plant Taxonomy. Tata McGraw Hill Publishing Company Ltd., New Delhi. 482pp.
- Gurucharan Singh. 2008. Plant Sytematics – Theory and Practices. Oxford and IBH Publishing Co. Pvt. Td. New Delhi.
- Michael G. Simpson. 2010. Plant Systematics. Elsevier Academic Press. USA.
- Pandey S.N. and Mishra. S.P. 2009. Taonomy of Angiosperms. Ane Books Pvt. Ltd. New Delhi.
- Pandey, B.P. 2012. Taxonomy of Angiosperms. S.Chand and Company Ltd., New Delhi.
- Rajkumar Gupta. 2006. Text book of Systematic Botany. CBS Publishers. New Delhi.
- Subrahmanyam, N.S. 1995. Modern Plant Taxonomy. Vikas Publishing House Pvt. Ltd. New Delhi.
- Gurucharan Singh. 2010. Plant Sytematics – An Integrated Approach. IIIrd ed. Science Publishers. US.
- Plant Systematics. 2nd Edition. McGraw-Hill Book Company. New York.
- Plant Taxonomy and Biosystematics. Edward Arnold, London. STUESSY, T. F. 2002.
- Pandey.B.P. (1987) – Economic Botany. Verma. V (1984) – Economic Botany.
- Porter.C.L., 1982 – Taxonomy of Flowering Plants, Eurasia Publications House, New Delhi

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- Bensen, 1957. Plant Classification. Oxford & IBH Publishing Co., New Delhi.
- Cronquist, A. 1968. Evolution and Classification of Flowering Plants.
- Thomas & Nelson (Pvt.) Ltd., London. Davis, P.H. and Heywood , V.M.1963.
- Principles of Angiosperm Taxonomy. Oliver & Boyed – London.
- Henry, A.N. and Chandra Bose, 1980 . An aid to the International Code of Botanical Nomenclature, Today & Tomorrow's Printers & Publishers, Delhi.
- Lawerence, G.H.M. 1961, Taxonomy of Vascular Plants. MacMillan and Co., New Delhi.
- Street, H.E., 1978. Essay in Plant Taxonomy, Academic press, London.
- Bentham, G. 1988. Handbook of British Flora. (7th Ed., revised by A.B. Rendle in 1930). Ashford, Kent.
- Cronquist, A. 1988. The Evolution and Classification of Flowering Plants. (2nd Ed.) New Delhi. 482pp.
- Darlington, C.D. and A.P.Wylie. 1955. Chromosome Atlas of Cultivated Plants. Allen and Unwin, London.

COURSE OUTCOMES

On the successful completion of the course students will be able to

CO1	To Understand the basic concepts and classifications of plants	KI, K2	HO
CO2	To understand the branches of taxonomy and its necessity in classification	K3	HO
CO3	To To acquire knowledge about the plants families	K4	HO
CO4	To identify and classify the plants on the basis of natural and phylogenetic system of classification	K5,K2	HO
CO5	To acquire knowledge about economic importance of plants species	K6	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PSO1	PSO2	PSO3	PSO4
CO 1	M	S	L	-
CO 2	S	S	M	-
CO 3	M	S	M	-
CO 4	S	M	-	-
CO 5	S	M	L	-

S- Strong; M-Medium; L-Low

Semester –III

Core Course - XIII

Plant Biotechnology and Genetic Engineering - 22PBOT3CT11 Credits: 4

Course Objectives

- To know and learn the different Plant Tissue Culture techniques
- To study the applications of Tissue culture in Agriculture, forestry,
- To understand GM crops and Organic farming
- To be familiar with IPR and GI
- To learn genetic engineering techniques

Unit I

Biotechnology as Inter and Multidisciplinary approach -Plant Tissue Culture – Introduction - Objectives and Goals – Laboratory organisation – Nutrient medium – Sterilization Techniques – Types of Cultures (seed, embryo, Root, callus, organ, cell, protoplast and axillary bud cultures) – Cell suspension culture, types and in-vitro secondary metabolites production and application - Plant micropropagation - Somatic embryogenesis and organogenesis – Protoplast Isolation and Fusion.

Unit II

Application of tissue culture in agriculture, horticulture, forestry and Conservation of plant genetic resources (Field gene bank, Seed banks, Pollen banks, DNA banks) – Cryopreservation – Application in development of Genetically Modified Crops (Fruits, Vegetables, Crops and Cereals) – Transgenic plants – Ethical, legal and social issues regarding GM crops - recent trends in Genomics and Genetics of *Arabidopsis thaliana*.

Unit III

Intellectual Property (IP) - Definition – Intellectual Property Rights (IPR) – Intellectual Property Protection – Plant Genetic Resources – Patent Systems – Sources of patent Information – Patenting Methods – Patenting of higher plants, genes and DNA sequences – Plant Breeders Rights and Farmers Rights – A brief account on Geographical Indication (GI) – Bioprospecting – Biosafety science.

Unit IV

Tools of Genetic engineering – Restriction Enzymes (Exo and Endo nucleases) –Enzymes used in Genetic engineering (Methylase, SI nuclease, Ligase, Alkaline Phosphatse, Reverse transcriptase, T4 kinase, Terminal transferase, adopters and Linkers) – Vectors and their types – Plasmid (pBR 322, pUC Vectors), *Agrobacterium* based Plasmids, Bacteriophage vectors, Cosmids, Phagemids, YAC, CaMV, Gemini Virus, Shuttle and Expression vectors – Marker genes – Gene silencing – Edible vaccines – Antisense – artificial small RNAs and CRISPRi.

Unit V

Gene transfer methods - Cloning Strategies – rDNA technology – Genomic and cDNA library construction – Hybridization techniques – Labeling methods –Nucleotide sequencing methods – Gene therapy – Human Genome Project -Application of genetic engineering in various fields.

References:

- Dubey, R.C. 2008. A Textbook of Biotechnology. S.Chand Company Pvt. Ltd. New Delhi.
- Singh, B.D. 1998. Biotechnology. Kalyani publishers, Ludhiana.
- Primrose, S, R. Twynman and P.Old. 2005. Principles of gene manipulation. Blackwell Science Ltd., New Delhi.
- Smith, R.H. 2000. Plant tissue Culture – techniques and Experiments. Academic Press, New York.
- Dwivedi, P. 2004. Plant Tissue culture. Scientific publishers, New Delhi.
- Reinert, J, Bajaj, Y.P.S. 1997. Plant Cell and Organ Culture. Narosa publishing House, New Delhi.
- Chawla, H.S. 2000. Introduction to biotechnology. Oxford and IBH publishing Co., New Delhi.

- Harry Levine. 2006. Genetic Engineering: A Reference Hand book. ABC – CLIO, Inc, California.
- Arie altman and Paulmichael hasegawa, 2012. Plant biotechnology and agriculture prospects for the 21 st centuary, Academic Press.
- C.M. Govil, Ashok Aggarwal and Jitender Sharma. 2017. Plant Biotechnology and Genetic Engineering, PHI Learning Pvt. Ltd.
- Suresh Kumar Gahlawat, Raj Kumar Salar, Priyanka Siwach, Joginder Singh Duhan, Suresh Kumar, Pawan Kaur. 2017. Plant Biotechnology: Recent Advancements and Developments Springer.
- C. Neal Stewart, Jr. 2016. Plant Biotechnology and Genetics: Principles, Techniques, and Applications John Wiley & Sons.
- Isil Aksan Kurnaz, 2015. Techniques in Genetic Engineering. CRC Press.
- Huang .P.C., 2012. Genetic Engineering Techniques: Recent Developments. Elsevier.
- Ramawat K.G. and Shaily goyal. 2019. Comprehensive biotechnology. S.Chand and company Ltd, New Delhi.
- Das, H.K. 2010. Textbook of Biotechnology. 4th edition. Wiley, India.

Course Outcomes (COs)

CO 1	obtained wide knowledge about Plant Tissue Culture techniques	K1, K2	LOT
CO 2	recognize the positive approaches of agriculture, forestry, horticulture and conservation of plant genetic resources	K1, K2, K3	LOT
CO 3	identify the problems and rectify methods of GM crops	K3, K4	HOT
CO 4	gathered wide information regarding IPR and GI	K3, K4	HOT
CO 5	get technical skills in genetic engineering	K3, K4	HOT

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate,K6- Create
LOT – Lower Order Thinking (Remember, Understand and Apply)
HOT – Higher Order Thinking (Analyse, Evaluate and Create)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	-	M	-	S
CO 2	S	-	M	-	S
CO 3	S	M	M	-	S
CO 4	S	S	M	-	S
CO 5	S	S	M	-	S

S- Strong: M-Medium: L- LOW

Semester - III

Core Course - XIV

NANOBIOTECHNOLOGY - 22PBOT3CT12 Credit- 4

Course Objectives

- ✓ To understand the basic concepts of field of Nano-biotechnology,
- ✓ To learn the principles behind Nano biotechnology and properties
- ✓ To comprehend the current applications of Nano biotechnology and its relationship in plant science

Unit I

Nano biotechnology: Definition - History, Scope and Recent scenario in nanotechnology -Nanoparticles and its significance – Challenges and Future Prospects of Nanoparticles.

Unit II

Basic introduction of Biomaterials - First, Second and Third generation of Biomaterials - in Tissue and Regenerative Engineering and Nanotechnology – Micro fabrication and Micro technology - Nanofabrication and Nanotechnology.

Unit III

Synthesis routes of Nanomaterials - Synthesis of different Nanoparticles - Unique properties and characterization of Nanoparticles.

Unit IV

Applications of Nanomaterials: Nano electronics - Micro and Nano Electrochemical Systems (MEMS/NEMS) – Nano sensors and Textiles, Paints, Catalysis. Biomedical (Medical Devices: Imaging, implantable sensors, cell specific gene therapy), Nanomaterials and Toxicity Evaluation Cyto-toxicity, Geno-toxicity In vivo tests/assays etc. Food and Agricultural applications of Nano particles - Nano medicine and Novel drug delivery systems - Health and Environmental - Photo catalysis and Photocatalyts.

Unit V

Nanostructured materials with high application potential: Quantum Dots – Carbon Nanotube - GAN Nano wires – Nano crystalline - Zinc Nitrate, Non Crystalline - Titanium Oxide and Multi-layered Films - Role of Nanotechnology in Plant science research.

References:

- Murty BS, Shankar P, Baldev Raj, Rath BB and James Murday. 2013. Textbook of Nanoscience and Nanotechnology. Springer. University Press (India).
- Subbiah Balaji. 2010. Nano biotechnology. MJP Publishers, Chennai.
- Jeremy Ramsden, 2016.Nanotechnology: An Introduction. William Andrew.
- Geoffrey Hunt, Michael Mehta, 2013. Nanotechnology: Risk, Ethics and Law Taylor & Francis.
- Jo Anne Shatkin, 2012. Nanotechnology: Health and Environmental Risks, Second Edition CRC Press.
- Jesus M. de la Fuente, V. Grazu. 2012. Nano biotechnology: Inorganic Nanoparticles Vs Organic Nanoparticles; Elsevier.
- Michael R. Hamblin, Pinar Avci, Tarl Prow, 2016. Nanoscience in Dermatology. Academic Press.
- Waser, 2003. Nano Electronics and Information Technology, John Wiley and son's publication.
- Tuan Vo-Dinh , 2018. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications. CRC Press

- Mark Ratner and Daniel Ratner, 2002. Nanotechnology-A Gentle Introduction to Next Big Idea, Low Price edition, Third Impression, Pearson Education
- William Illsey Atkinson -2008. Nanotechnology- JAICO Publishing House, Bio molecular computation for Bio nanotechnology, Liu and Shimohara, Artech House-London, 2007
- Lee, Young-Chul, Moon, Ju-Young, 2020. Introduction to Bio nanotechnology ; Publisher : Springer

References books

- Chad A Mirkin and Christof M. Niemeyer, 2007 I- Eds, Nano biotechnology - II more concepts and applications. - Wiley VCH
- Monique A. V. Axelos, Marcel Van de Voorde, 2017. Nanotechnology in Agriculture and Food Science, John Wiley & Sons.
- Christ of M. Niemeyer (Editor), Chad A. Mirkin (Editor), 2004. Nano biotechnology: Concepts, Applications and Perspectives , Wiley VCH.
- Makio Naito, Toyokazu Yokoyama, Kouhei Hosokawa, Kiyoshi Nogi 2018. Nanoparticle Technology Handbook, Elsevier.
- Claudia Atavilla, Enrico Ciliberto, 2017. Inorganic Nanoparticles: Synthesis, Applications, and Perspectives CRC Press.

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

CO. No.	Course Outcomes		
CO 1	The student should be able to on completion of the course:	K1	LO
CO 2	Understand the basic concepts of nanotechnology principles and applications	K2,K3	LO
CO 3	To Know different Biomedical applications of nanoparticles	K3, K4	HO
CO 4	Understand the basic concepts environmental applications	K4,K5	HO
CO 5	To know about nanostructured materials	K6	HO

K1- Remember, K2- Understand, K3- Apply , K4- Analyse, K5- Evaluate, K6- Create

Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5
CO 1	L	M	M	M	M
CO 2	M	M	M	M	M
CO 3	S	L	M	M	M
CO 4	S	M	M	M	M
CO 5	S	M	M	M	S

STRONG-S, L-LOW, MEDIUM

Semester - III

Practical – 03 (core -XV) - 22PBOT3CP03

(Taxonomy of Angiosperms, Economic Botany, Plant Biotechnology, Genetic Engineering, Nanobiotechnology)

TAXONOMY OF ANGIOSPERMS:

- Study the taxonomical descriptions for all plant parts Root, Stem, Leaves, Flowers, Fruits and seeds.
- Study of the morphological and floral characteristic and economic importance of
  Magnoliaceae, Menispermaceae, Polygalaceae, Caryophyllaceae, Oxalidaceae, Meliaceae, Rhamnaceae, Vitaceae, Sapindaceae, Combretaceae, Lythraceae, Aizoaceae, Rubiaceae, Oleaceae, Gentianaceae, Boraginaceae, Bignoniaceae, Podestemaceae, Loranthaceae,
  Orchidaceae, Liliaceae, Commelinaceae, Musaceae, Arecaceae, Cyperaceae, Poaceae.
- Preparation of Artificial keys
- Herbarium techniques, preparation and submission of 50 herbarium
- Floristic studies of selected area

ECONOMIC BOTANY

- To study the economic importance of Cereals, Legumes, Fruits, Spices and Condiments, Fibres, Timber and Vegetable Oil.

PLANT BIOTECHNOLOGY:

- Preparation of basal media for plant tissue culture
- Sterilization, inoculation and incubation of explants
- Isolation of protoplasts
- Isolation of nitrogen fixing bacteria from soil
- Callus induction
- Preparation of vermicompost/vermiwash
- Study the effect of biofertilizer on different crop cultivation
- Collection and preparation of table regarding different Geological Indication of India

GENETIC ENGINEERING:

- Isolation of DNA from Plants

NANOBIOTECHNOLOGY:

- Synthesis of silver/gold/Zinc/Titanium nanoparticles from plant extract
- Study the characterization of nanoparticles with UV, FTIR, XRD, TEM, SEM, EDAX and ZETA

Semester – IV

Core Course – XVI

Research Trends in Botany - 22PBOT4CT13 credits: 4

Course Objectives

- To study the basic and advanced research developments of plant science
- To learn statistical analysis of research problems
- To equip the students to get a career in Industry/ R&D/ Academic

Unit - I

Plant Genomics and Proteomics – Introduction – Plant Genome - Structural genomics - genome sequencing strategies - Functional genomics – genome annotation, gene expression study using microarrays functional annotation of genes – Introduction to proteomics – Applications to plant biology – General view of proteomics – Analytical tools in proteomics – subcellular proteomics – plant with biotic and abiotic factors interaction with proteomics.

Unit - II

Bioinformatics - Overview – Sequence analysis – Genome annotation – Computational evolutionary biology – Measuring biodiversity – Analysis of gene expression – Analysis of regulation – Analysis of protein expression – Analysis of mutation in cancer – Prediction of protein structure – Comparative genomics – Software tools (Biological data, BLAST, Parellel BLAST) –EBI – NCBI – Phylogenetic analysis (PHYLP, TREE) DNA databank, Nucleotide sequence databank (EMBL Bank) - Sequence alignment.

Unit - III

Phytochemistry– Introduction to Phytochemicals – Antioxidants – Alkaloids – Anthocyanins – carotenoids – flavonoids – Hydroxycinnamic acids – Xanthophylls – plants with phytochemicals – Production of Phyto chemicals from medicinal plants – Extraction of phytochemicals – Developing new drugs from Ethnomedicines - Molecular docking.

Unit - IV

Pharmacognosy – Introduction – history – Indian System of medicine – natural sources of Drugs – Crude drugs – Classification of crude drugs – Collection and Processing of crude drugs – Phytoconstituents of therapeutic value – Histochemical tests for phytochemicals – Drugs containing carbohydrates/glycosides/lipids/Volatile oils/Resin/Alkaloids/Tanninis – Analytical pharmacognosy – Anatomical features of selected medicinal plants (Senna leaf, Datura leaf, Cinchona bark, Nuxvomica seed).

Unit - V

Biostatistics - Methods of collection and classification of data; Primary and secondary data, qualitative and quantitative data. Frequency distribution, graphical representation, normal distribution - Mean - Median and Mode - Mean deviation, Standard deviation, variance (ANOVA), standard error, co-efficient of variation - Linear regression and correlation (simple and multiple) – t-test – X^2 test – Chi-square test. Role of software in Biostatistics (SPSS)

References:

- RanjithaKumari, B.D. 2008. Plant Proteomics. APH Publishers, New Delhi.
- Sanaj.J. and Thelen, J.J. 2007. Plant proteomics. Springer, New York.
- Agarwal, G.K. and Rakwal, R. 2008. Plant Proteomics Technologies; Strategies and Applications. John Wiley & Sons, Inc, USA.
- Balaji, S. 2010. Nanobiotechnology. MJP Publishers, Chennai.
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- Thiagarajan, B. and Rajalakshmi, P.A. 2009. Computational biology. MJP Publishers, Chennai.
- Middha, S.K., Usha, T. And H.P. Prashanth Kumar. 2012. Bioinformatics. College Book House, Bangalore.
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- Harborne, J.B. 1973. Phytochemical methods – A Guide to modern technique of plant analysis. Thomsan Publications Pvt. Ltd. UK.
- Mahajan. B.K. 1997. Methods in Biostatistics. Jay Pee Brothers Medical Publishers (P) Ltd. New Delhi.
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- Agarwal, B.L. 1988. Basic Statistics. New Age International Publishers. New Delhi.
- Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi.
- Arthur Lesk, 2012. Introduction to Genomics, OUP Oxford.
- John M. Archibald, 2018. Genomics: A Very Short Introduction Oxford University Press.
- Dhavendra Kumar, 2012. Genomics and Health in the Developing World.OUP USA.

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- Supratim Choudhuri, 2014. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools, Elsevier.
- Michael Agostino 2012. Practical Bioinformatics, Garland Science.
- Michael Heinrich, Joanne Barnes, Simon Gibbons, Elizabeth M. Williamson 2012. Fundamentals of Pharmacognosy and Phytotherapy. Elsevier Health Sciences.
- Biren Shah, Avinash Seth 2012. Textbook of Pharmacognosy and Phytochemistry - E-Book. Elsevier Health Sciences.
- A.N.M. Alamgir, 2017 Therapeutic Use of Medicinal Plants and Their Extracts: Volume 1: Pharmacognosy, Springer.
- Belavendra Antonisamy, Prasanna S. Premkumar, Solomon Christopher, 2017. Principles and Practice of Biostatistics Elsevier India.
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- Clemens Posten, Christian Walter, 2013. Microalgal Biotechnology: Potential and Production, Walter de Gruyter.
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- Das, H.K. 2010. Textbook of Biotechnology. 4th edition. Wiley, India.
- Raymond Nelson (2022). Genomics proteomics and vaccines. Edition-2022.

Course Outcomes (COs)

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

CO1	Obtained wide knowledge about emerging field of life sciences	**K1**	**HO**
CO2	Acquired scientific information regarding genome and proteome	**K2**	**IO**
CO3	Get computational acquaintance from bioinformatics and biostatistics	**K3**	**HO**
CO4	Gathered practical skills to apply phytochemical and pharmacognostical techniques	**K4**	**HO**
CO5	Ensured career opportunity in Industry/R&D/Academic	**K4, K5**	**HO**

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	M	S	S	M
CO 2	S	L	M	L	M
CO 3	S	S	M	M	L
CO 4	S	M	L	L	M
CO 5	S	M	S	M	L

S- Strong; M-Medium; L-Low

Elective – I

MICROBIAL BIOTECHNOLOGY - 22PBOTE01 **Credits** - 4

Courses Objectives

- To understand life cycle, reproduction, physiology of microorganisms (Bacteria and Fungi).
- The industrial aspect of the field of Fungal Biotechnology and also learn about growth pattern of microbes in different industrial systems.
- Acquire experimental know how of microbial production of various industrial products such as alcohol, antibiotics, enzymes, etc.
- To Develop an understanding aquatic microbiology

Unit-I

Fungi, Molds and Protozoa – importance, characteristics, morphology, reproduction, physiology cultivation & their association with other organisms. Bacteria, and fungi - Types and division -Classification of microbes.

Unit-II

Fermentation technology – Bioprocess technology – Introduction to bioreactors - Batch and Fed batch bioreactors – Continuous bioreactors – Immobilized cells – Media Design and sterilization – aseptic inoculation – Downstream processing.

Unit-III

Enzymes and their regulation, Microbial metabolism energy production, utilization of energy & biosynthesis, bacterial genetics. Fungi in Medical Biotechnology - Production of antibiotics (Penicillin, Cephalosporin, Streptomycin) Mucormycosis and Biosensors - Other medically useful products – Anti-tumour and antiviral agents. Mode of action, Antibiotic sensitivity assays- Antibiotic resistance in bacteria- factors of development of resistance.

Unit-IV

Microbial cells as food- SCP, mushroom cultivation. Source and applications of microbial enzymes, antioxidants, bio-surfactants, polysaccharides, flavours and colours. Industrial production of Alcohols, Ethanol (Fuel), Butanol, Methane, Organic acids (Lactic acids, Glutamic acid, Amino acids-Lysine) Production of industrial enzymes – Cellulase, Amylase, Vitamins, and fuel cells, coal solubilisation.

Unit-V

Application of microbes in fuel industry; Agriculture, aquatic microbiology - Bioremediation - Fungi as agents of bio deterioration and Biodegradation – Biodegradation of lignin – Biomass – Bio inoculum from fungal sources.

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- Crueger W and Crueger A. 2000. Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
- Stanbury PF, Whitaker A and Hall SJ. 2006. Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

References books

- Yadav A.N.2020. Plant Microbiomes for Sustainable Agriculture: Current Research and Future Challenges. In; Yadav A., Singh J., Rastegari A., Yadav N. 2021. (eds) Plant Microbiomes for Sustainable Agriculture. Sustainable Development and Biodiversity, vol 25. Springer, Cham. doi.org/10.1007/978-3-030-38453-1_16.
- Singh, J., Vyas, A., Wang, S., Prasad, R. 2020 (I-Ed.) Microbial Biotechnology: Basic Research and Applications ; Springer Verlag, Singapore.

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

CO. No.	Course Outcomes		
CO 1	Introduce the students to the role microorganism and play in fermentation process.	**K1,K2**	**LO**
CO 2	Develop an understanding of process control, upstream and downstream process	**K3,K4**	**LO**
CO 3	Know the differences between aerobic and anaerobic fermentation Understand the growth of microorganism and their role in producing foods	**K4,K3**	**LO**
CO 4	Get acquainted with the industrial aspect of the field of Fungi and bacteria Biotechnology and also learnabout growth pattern of microbes in different industrial systems.	**K4,K5**	**HO**
CO 5	Understand the growth of microorganism and their role in producing agriculturalBiotechnology	**K3,K5**	**HO**

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate, K6- Create

Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5
CO 1	L	-	-	-	-
CO 2	S	M	M	-	-
CO 3	S	M	M	-	✓
CO 4	S	M	M	✓	M
CO 5	M	-	-	-	-

STRONG-S, L-LOW, MEDIUM

Elective -II

Algal Biotechnology -22PBOTE02 Credits: 4

Course Objectives

- To encourage research interest by utilizing algae
- To impart the significance of algal biodiversity
- To equip the students to get a career in Industry/ R&D/ Academic

Unit – I

Introduction to algal biotechnology – Scope for research – Significant role of algae in research – recent research trends in algae - Algae as next generation resource – algal based bioeconomy - Nutraceutical, pharmaceutical, biofertilizer, nanotechnology applications of algae.

Unit – II

Role and applications of micro and macro algae in food, feed and nutrition - Biopolymer - Bioplastics – Biofuel- Biosolar cells - Algal Biodegradation of Emerging Contaminants.

Unit – III

Secondary metabolites of algae - Pharmaceutical role and applications of macro and microalgae - current research and development of algal-pharmaceutical and their therapeutic importance - cosmetics products of algae.

Unit – IV

Algae in nanotechnology - Algal farming (Phyco-farming) - Algae as renewable energy resources -Bioremediation -Phycoremediation.

Unit – V

Cultivation of algae – major challenges of algal cultivation - Algal based major industries in world – Algal commercial products.

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- Khattar, J.I.S.., Singh, D.P., and Gurpreet Kaur. 2009. Algal Biology and Biotechnology.I. K. International (Pvt) Ltd. New Delhi.
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- Robert Arthur Anderson. 2005. Algal Culturing techniques. Elsiever. USA.

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Course Outcomes (COs)

CO 1	acquired knowledge about emerging field of algal biotechnology	K1, K2	LOT
CO 2	get research and applications knowledge of algae	K2, K3	LOT
CO 3	gathered skill of algal cultivation and their vast applications	K3, K4	HOT
CO 4	apply the strategies of natural renewable resources	K3, K4	HOT
CO 5	ensured career opportunity in Industry/R&D/Academic	K3, K4	HOT

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate,K6- Create
LOT – Lower Order Thinking (Remember, Understand and Apply)
HOT – Higher Order Thinking (Analyse, Evaluate and Create)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	-	M	-	S
CO 2	S	-	M	-	S
CO 3	S	M	M	M	S
CO 4	S	S	M	M	S
CO 5	S	S	M	S	S

S- Strong: M-Medium: L-Low

Elective – III

Mushroom Technology - 22PBOTE03 Credit-4

COURSE OBJECTIVES

- To create common knowledge about the mushrooms and its nutritional benefits
- To get a basic idea about edible and poisonous mushrooms
- To provide entrepreneurship opportunities through mushroom cultivation

UNIT – I

Introduction – History – Biology of mushrooms, Nutritional value, scope of edible Mushroom cultivation – Types of edible mushroom available in India – Medicinal and other uses, Different parts of a typical mushroom & variations in mushroom morphology. Key to differentiate Edible from Poisonous mushrooms.*Calocybeindica, Volvariellavolvacea, Pleurotuscitrinopileatus, Agaricusbiosporus.*

UNIT – II

Cultivation technology- equipments and substrates in mushroom cultivation. Pure culture – preparation of medium (PDA and Oatmeal Agar medium) Sterilization – preparation of test tube slants- mother spawn in saline bottle – cultivation of white button mushroom (*Agaricus bisporus*). Breeding conditions of mushroom strains: temperate conditions, Isolation of spawn, growth media nuclear behaviour and ultra structural changes during the development of the mushroom fungi.

UNIT – III

Morphological and Microscopically identification of mushrooms.Cultivation of paddy straw mushroom (*Volvariella volvacea*) and oyster mushroom (*Pleurotus spp.)* with details of bed and spawn preparation, cultivation and harvest. Low cost mushroom farm design of production. Diseases of Mushrooms: Brown black disease, yellowing of oyster mushrooms, Bacterial soft root, fungal brown blotch, wet bubble, dry bubble, cob web, green blotch.

UNIT – IV

Storage and nutrition: short-term storages, long term storages, drying, storages in salt solution, Nutrient Profile of Mushroom: Protein, aminoacids, calorific values, carbohydrates, fats, vitamins & minerals. Identification of Mushroom compounds: Antimicrobial, Flavonoids, Pharmaceutical compounds. Separation and Purification of Compounds.TLC analysis of amino acids, UV – spectrophotometric analysis of DNA and protein samples. GC & HPLC analysis

UNIT – V

Insects and pest attacking mushroom – fungal, bacterial, viral diseases.Food preparation from mushroom; soup, cutlet, omelette, somasa, pickles, curry. Cost benefit ration – marketing in India and abroad, export value. Processing and preservation of mushrooms and Economic importance of Mushroom - Pharmaceutical application and in industries.

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- Tripathi, D.P. (2005.) Mushroom Cultivation. Oxford and IBH Publishing Co. Pvt.Ltd,NewDelhi.

COURSE OUTCOMES
On the successful completion of the course students will be able to

CO1	To understand the common characteristic of Mushroom	KI, K2	HO
CO2	To be able to produce spawn	K2,K3	HO
CO3	To understand the major threats in Mushroom cultivation	K3	HO
CO4	To create basic understanding about storage of Mushroom	K4, K5	HO
CO5	To create entrepreneurship opportunities and marketing values of cultivated mushrooms	K5	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate

Mapping with Programme Outcomes

CO	PSO1	PSO2	PSO3	PSO4
CO 1	M	S	L	-
CO 2	S	S	-	-
CO 3	M	S	M	-
CO 4	S	M	-	-
CO 5	S	M	L	-

S- Strong; M-Medium; L-Low

Elective - IV

Plant Genetics and Plant Breeding Techniques-22PBOTE04 Credits: 4

Course Objectives:

- To provide increased practical knowledge of plant breeding theories and advanced molecular breeding techniques.
- To know about the role of mutations in plant breeding.

Unit - I

Development of genetics, and gene versus allele concepts (Pseudoalleles); Quantitative genetics and multiple factors; Incomplete dominance, polygenic inheritance, multiple alleles; Linkage and crossing over of gene mapping including molecular maps (idea of mapping, function).

Unit - II

Gene pool concept - primary, secondary and tertiary gene pool and gene introgression. Plant genetic resources: importance of plant genetic resource and diversity in plant breeding, collection, evaluation and conservation of germplasm.

Unit - III

Cytogenetics of wheat, Cotton, Tobacco, Triticale (Karyotyping) Incompactibility and male sterility, their types, mechanisms and applications in plant breeding. Biochemical and molecular tools for the analysis of plant genome including protein and DNA based techniques; structural and functional genomics in relation to crop improvement.

Unit - IV

Genetic diversity in plants, importance of genetic diversity in crop improvement and its erosion. Hybridization: inter and intra varietal crosses. Heterosis, Apomixis: types of apoxmies in higher plants, significance in plant breeding.

Unit - V

Concepts, classification of mutation, physical and chemical mutagens, their mechanism of action, molecular of action, molecular basis of gene mutations, Role of mutations in plant breeding.

References

Text books

- George Acquaah 2020. Principles of plant genetics and breeding. Thrid edition, Hobroken , Newyork, Wiley.
- Nina Duran 2019. Principles of Plant Genetics and Breeding published by Callisto Reference. ISBN: 9781641162296, 1641162295
- Ram J.Singh. 2017. Plant Cytogenetics. Third Edition. Traylor and Francis group, CRC Press.

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- Swanson C.P., Merz T and Young J. 1973. Cytogenetics. Prentice Hill of India Private Ltd. New Delhi.

Course Outcomes (COs)

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

CO1	Understanding about the quantitative genetics, Linkage and crossing over	**K1**	**IO**
CO2	Acquired information gene pool concept and plant genetic resources	**K2**	**IO**
CO3	Understand structural and functional genomics in relation to crop improvement	**K2,K3**	**HO**
CO4	Know about Hybridization, Heterosis, Apomixes and its types of apomixes in higher plants	**K4**	**IO**
CO5	Understand about the Concepts, classification and role of mutation	**K4, K5**	**IO**

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	S	S	S	M
CO 2	S	M	M	L	M
CO 3	S	M	L	M	M
CO 4	S	M	S	L	L
CO 5	S	L	S	M	L

S- Strong; M-Medium; L-Low

Elective -V

Biofertilizer and Organic Farming - 22PBOTE05 Credit-4

Course Objectives

- To provide knowledge about different biofertilizer and their applications
- To understand the concept about soil fertility, fermentation, organic farming and organic fertilizer

UNIT I

Biofertilizers – Introduction – Types of Biofertilizers – Applications of Biofertilizers – Action mechanism of biofertilizers - Nitrogen fixation – Nitrogen fixing microorganisms (symbiotic and asymbiotic) – Phosphate solubilising microorganisms – Bacteria, Fungi, Mycorrhizae (AM Fungi).

UNIT II

Application and Evaluation techniques of crop response to biofertilizers – Methods of inoculation and application of biofertilizers – Biofertilizer production system - Simplified anaerobic digester for Biofertilizers – Modified anaerobic Fermenter for Biofertilizer – Operation condition for anaerobic digestion of Biofertilizers.

UNIT III

Soil fertility and fertilizers – Soil Microbiology and Biofertilizers - Biogas production from organic biofertilizers – Biogas from liquid biofertilizers derived from Banana and Coffee processing.

UNIT IV

Vermiculture and Vermitechnology – Introduction – Advantages of vermicomposting – Earthworms – Ecological types of Earthworms – Vermicomposting and their application in organic culture – Compost making.

UNIT V

Organic farming – Organic manures – Methanogenesis – Pest and disease management systems in agriculture – Objectives and components - Biopesticides – Bacterial and Fungal origin - Sustainable agriculture – Production, Quality control and marketing of Biofertilizer.

Text books:

- The Complete technology book on biofertilizers and organic farming. NIIR, New Delhi.
- Meena, V.S., Parihar, M., Singh, A.K. 2021. Biofertilizers Volume 1: Advances in Bio-inoculants. Woodhead Publications, UK.
- The complete technology book on Vermiculture and vermicompost. NIIR, New Delhi.
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Reference books:

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Course Outcomes

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

CO1	To understand the basic fundamentals of biofertilizers and their applications	KI, K2	LO
CO2	To know the fermentation method for biofertilizer production	K3	HO
CO3	To learn the biogas production from organic biofertilizer	K4	HO
CO4	To know the importance of organic biofertilizers	K5, K6	HO
CO5	To acquire knowledge about vermiculture technology	K6	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PSO1	PSO2	PSO3	PSO4
CO 1	S	M	L	M
CO 2	S	M	M	M
CO 3	M	M	M	S
CO 4	S	S	M	S
CO 5	M	S	M	S

S- Strong; M-Medium; L-Low

Supportive – I

Plant and Life - 22PBOT3S01 **Credits: 4**

Course Objectives

- To impart the knowledge of plant science for other subject students
- To understand importance of plants on earth in ecosystem

Unit I

Plant Science – History of Botany - General and salient features and Life cycle of plant kingdom – Importance of plant science.

Unit II

Classification of plant – plants in different ecosystem – Biochemical composition of plants – Reproduction of plants.

Unit III

Structure of plants – Function of plant parts – Metabolism of plants (Photosynthesis) – Growth and Development of plants – Plant and its Environment.

Unit IV

Role of plants in food and medicine – Plant and Industry - plant and doctrine of signature concept – carbon sequestration.

Unit V

Values of plants - Conservation measures of plants – Entrepreneurial perspectives of plant science.

References

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- 2. Bilgrami, K.S. and R.N.Verma. Physiology of Fungi. 2nd Ed. Vikas Publication House, New Delhi.8
- Chopra, R.N. and P. K. Kumar. Biology of Bryophytes. Wiley Eastern Ltd., New Delhi.350 pp.1988.
- 2. Rashid, A. An Introduction to Bryophyta. Ist Ed. Vikas Publishing House Pvt. Ltd., New Delhi. 298 pp. 1998.Sambamurthy, A.V.S.S. 2005. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I.K. International Publishing House. New Delhi.
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- Dubey, R.C. 2008. A Textbook of Biotechnology. S.Chand Company Pvt. Ltd. New Delhi.
- Singh, B.D. 1998. Biotechnology. Kalyani publishers, Ludhiana.

Course Outcomes (COs)

CO 1	acquired knowledge about plant science and its life	K1, K2	LOT
CO 2	obtained basic and applications knowledge of plants	K2, K3	LOT
CO 3	gathered awareness to conserve plant biodiversity	K3, K4	HOT
CO 4	ensured career opportunity in Industry/R&D/Academic	K3, K4	HOT
CO 5	apply knowledge about plant science in skills of entrepreneurship	K3, K4	HOT

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate,K6- Create
LOT – Lower Order Thinking (Remember, Understand and Apply)
HOT – Higher Order Thinking (Analyse, Evaluate and Create)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	-	M	-	S
CO 2	S	-	M	-	S
CO 3	S	M	M	-	S
CO 4	S	S	M	-	S
CO 5	S	S	M	M	S

S- Strong: M-Medium: L-Low

Supportive - II

PHYTOCHEMISTRY - 22PBOT3S02 **Credit**- 4

Course Objectives

- To know Phytochemistry production and uses.
- To Discuss Phyto-pharmacology of these crude drugs and developing.
- Have knowledge about medicinal plants origin and uses.
- Understand concept of marine seaweeds and seagrass phytochemistry.

Unit - I

Introduction to Phytochemicals – Types – Phytoconstituents and their therapeutic value – Polysaccharides in plants - Secondary metabolites in plants - Pharmaceutical proteins in plants – Plant hormones.

Unit - II

Production of phytochemicals from medicinal plants – Histochemical studies for medicinal plants - Biopharmaceuticals in plants – Extraction, Isolation and purification methods of phytochemicals – Developing new drugs from ethno medicines – Drug industries from India.

Unit - III

Traditional herbal medicine – Natural sources of drugs - Classification of Crude drugs - Qualitycontrol of the crude drugs - Standardizations and Evaluation of herbal drug formulations - Pharmacognosy of medicinal and aromatic plants**.**

Unit - IV

Indian Traditional Medicinal plants and their phytoconstituents; *Aloe vera, Withania Somnifera, Rowolfia serpentina, Emblica officinalis, Saroca asoca, , Tinospora cordifolia, Gloriosa superba, Solanum nigrum, Catharanthus roseus, Tribulus terrestris, Adhatoda vasica, , Andrographis paniculata.*

Unit - V

Marine phytochemistry - Definition – Marine plant products and their phytochemicals – Bioactive compounds – Isolation and purification methods – Seaweed and Seagrasses phytochemicals and their pharmacognosy.

References

Text books

- Jarald E.E. and Jarald S. E. 2009. Text book of Pharmacognosy and Phytochemistry. CBS Publishers & Distributors, New Delhi
- Nitin Suri. 2010. Phytochemical Techniques. Oxford Book Company, Rajasthan. Atul Roy.

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- Gupta, S. D., and Ibaraki, Y. 2006. Plant tissue culture engineering (Vol- 6). Springer Science & Business Media, Germany.

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

Course Outcomes (COs)

CO 1	To knowledge about important of medicinal plants and Phytochemistry production and uses.	K1, K2	LOT
CO 2	obtained basic and applications knowledge of herbal medicinal plants	K2, K3	LOT
CO 3	gathered awareness to conserve plant biodiversity Industry/R&D/Academic	K3, K4	HOT
CO 4	To knowledge about the indian medicinal plants	K3, K4	HOT
CO 5	Understand concept and methods of marine seaweeds and seagrass phytochemistry	K3, K4	HOT

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	M	M	M	M	L
CO 2	S	M	M	M	M
CO 3	S	M	M	M	M
CO 4	S	M	M	M	M
CO 5	S	M	M	M	S

STRONG-S, L-LOW, MEDIUM

Supportive – III

Climate Change and Sustainable Biodiversity-22PBOT3S03 Credits : 4

Course Outcomes

- To understand the facts and issues related to climate change
- To gain knowledge about forest ecology and its conservation.

Unit – I

Global Warming and Climate change—International conventions and global initiatives. Green house, and global warming Reasons, effects and the techniques used to control global warming. Cropping patterns in different agro-climatic zones of the country. Impact of high-yielding and short-duration varieties on shifts in cropping patterns. Concepts of various cropping, and farming systems. Organic and Precision farming. Package of practices for production of important cereals, pulses, oil seeds, fibres, sugar, commercial and fodder crops.

Unit –II

Climate Change and Agriculture: Climate change and its consequences for – sea level, rainfall patter, hydrological systems, extreme events, IPCC models and future scenarios. Expected impacts of climate change on major crop growth, development and their consequences for human livelihoods.Climate of India, different climatic agroclimatic regions of India. Central characters and distribution of the different forest types of India.Climate change and its impacts on agriculture.

Unit – II

Global biodiversity – major biodiversity areas of the world, biodiversity hotspots. Indian Biodiversity – Vegetation Zones, major protected areas and their importance. Forest ecosystem- distribution and types of forests, major tropical forest formations- vegetation dynamics- species richness of tropical forest- covers types. Forest soils: Physical and chemical properties, organic matter, nutrient dynamics, moisture, site index.

Unit – III

Forest environment: Effects of landform position, aspects, climate and hydrology. Strategies and adaptation of forest species; Forest development – natural regeneration: flowering and seed production, dispersal and seed predation, germination patterns, seed dormancy and seed Bank.

Unit – IV

Holistic and Sustainable approach of eco-system management and conservation of biological diversity and its significance. Role of forests in protection of species regulation of climate and production of various produce. Depletion of biodiversity from forest and the world forest conservation policies. Molecular tools for developing disease resistance trees.

Unit – V

Conservation: principles, conservation strategies and legislation – Forest and Environment protection Acts, Wildlife protection Acts (1972), Indian Forest Acts, Biodiversity Act 2002 & 2004, Biosphere reserves, National parks and Wildlife Action Plan, Man and Biosphere programmes, Remote sensing application in measuring biodiversity. Forest genetic resources and gene conservation.

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- University Press. ISBN 978 0190866105. 300pp.
- Bonan, G. (2015). Ecological Climatology: Concepts and Applications. Cambridge UniversityPress. ISBN 9781107339200. 692pp.

Books

- Relevance to Ecosystem Properties and Global Change. Cambridge University Press. ISBN 0 521 56643 6. 371pp.
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- Post, E. (2013). Ecology of Climate Change: The Importance of Biotic Interactions. Princeton University Press. ISBN 978-0-691-14847-2. 376pp.

Course Outcomes (COs)

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

CO1	Obtained wide knowledge about global warming and climate change and cropping patterns in different agro-climatic zones	**K1,K2**	**IO**
CO2	Acquired information about Indian Biodiversity – Vegetation Zones, major protected areas and their importance.	**K2,K3**	**IO**
CO3	get computational acquaintance from bioinformatics and biostatistics	**K3**	**HO**
CO4	Know about the strategies and adaptation of forest species	**K4**	**IO**
CO5	Understand about forest and environment protection acts and remote sensing application in measuring biodiversity, Forest genetic resources and gene conservation.	**K5**	**IO**

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	M	S	S	M
CO 2	S	L	M	L	M
CO 3	S	M	M	M	L
CO 4	S	S	L	L	M
CO 5	S	M	S	M	L

S- Strong; M-Medium; L-Low

Supportive – IV

Horticulture and Gardening - 22PBOT3S04 Credit-4

COURSE OBJECTIVES

- To create a basic knowledge about horticultural crops and gardening methods
- To appreciate and conserve the wild flora and other natural resources along with the Non-governmental organizations of these interest.
- To provide entrepreneurship opportunities.

UNIT – I

Importance and scope of horticulture – Divisions of horticulture – fundamentals of horticulture,climate, soil, nutritional needs – water irrigation – plant propagation method-cutting, layering, grafting , budding, stock-scion relationship. Frame work of marketing management-concept of marketing, management and analysis of marketing.

UNIT – II

Fruit crops – Induction of flowering, flower thinning fruit setting, fruit developments – cultivation of important fruit crops – Mango, lime, and Guava – Veritable crops: classification, cultivation of important vegetable crops: Tomato, Brinjal and Dolichos lablab.Dry land horticulture.

UNIT – III

Storage of fruits and vegetables – preservation of fruits and vegetables nursery – micro propagation – Hardening and translation – Germ palm maintenance of sweet potato. Propagation of bulb plants: Scaling, Scooping, Bulbils, Division, Cutting. Breeding and seed production of medicinal and aromatic plants.

UNIT – IV

Principles and methods of designing a flower garden badges, sedges, fence, tress, climbers – rookeries, terrace garden lawn making and maintenance, water garden – cultivation of water plants. Garden design- scope, objective, types of garden, features, and ornamentation,

UNIT – V

Indoor gardening – house plant, light, humidity, watering, designing Bonsai plants, watering, pruning, dwarfing. Landscaping – principles, types of park. Elements and principles of flower design.Diseases of fruit, plantation, Medicinal and aromatic plants and its control measures.

REFERENCES

TEXT BOOKS:

- Kumar. N. (1986). Introduction to horticulture. Rajalakshmi publication
- Subbha Roa, N.S,1997. Biofertilizers in Agriculture and Forestry. Inda Book House Limited. Trivedy .
- P.P. 1987. Home gardening. ECA Publication. New Delhi.
- Philip Kotler, Marketing Management, Millennium edition, New Delhi, Prentice Hall of India.

REFERENCE BOOKS:

- Bose T K and Mukerjee D 1987, Gardening in India, Oxford Book House
- Manibhushan Rao 1991. Text book of Horticulture, Macmillan Publications.

COURSE OUTCOMES

On the successful completion of the course students will be able to

CO1	To understand the importance and scope of horticulture	KI, K2	HO
CO2	To gain a knowledge about fruit plants	K2,K3	HO
CO3	To understand the storage techniques	K3	HO
CO4	To create basic understanding on cultivation of water plants	K4, K5	HO
CO5	To acquire knowledge on garden designing	K5	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate

MAPPING WITH PROGRAMME OUTCOMES

CO	PSO1	PSO2	PSO3	PSO4
CO 1	M	S	L	-
CO 2	S	S	-	-
CO 3	M	S	M	-
CO 4	S	M	-	-
CO 5	S	M	L	-

S- Strong; M-Medium; L-Low

Supportive- V

Commercial Horticulture - 22PBOT3S05 C**redit**-4

Course Objectives

• To learn the basic fundamental principles of floriculture, landscaping, olericulture, production of perfumes and food products.

UNIT- I

Floriculture – History – Definition – Scope and importance of ornamental crops – Classification of flower crops – Production technology and post harvest handling of cut flowers – Dry flower technology – Production – Harvesting - Methods of drying – Economic Importance of dry flower.

UNIT-II

Landscaping – definition – economic value – principles – special types of garden – Terrace garden – Design - major elements - classification of plant and selection of plants for landscaping – minor elements – basic pattern in landscaping – steps involved in landscape gardening and its maintainance.

UNIT-III

Perfumery – History – Economic importance – Aroma chemicals – Essential oils – Nature source of perfumery ingredients – Classification of perfumes – Raw materials, extraction and isolation techniques of essential oils from natural source – Purification of aroma chemicals – Formulation and product development – Marketing.

UNIT-IV

Olericulture – definition – importance of vegetables in human nutrition and national economy- types of vegetable gardens – classification of vegetables – plant parts used as vegetables – cultivation and harvesting of vegetables.

UNIT-V

Jam, jelly and pickles – economic value – selection of fruits and vegetables – preparation and processing – method of preservation – Curing – marketing

REFERENCE:

TEXT BOOKS:

- Anil K. Singh. 2020. Textbook of Floriculture and Landscaping. New India Publishing Agency, India.
- Singh, N. 2018. Basic Concept of Vegetable Science. CBS Publishers, Chennai.

- Arcadi Boix Camps. 2017. Perfumery: Techniques in Evolution. Lulu publisher,USA.
- Singh, N.P. 2007. Fruit and vegetable preservation. Oxford Book Company.
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- Roy Choudhry, N. and Mishra, H.P. (2001). Text book on Floriculture and Landscaping. Raja Infotech Enterprise, India.
- Md Asaduzzaman, Toshiki Asao · 2018. Vegetables: Importance of Quality vegetables to Human Health. IntechOpen. London.
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- Fellows, P. 2015. 3rd ed Food processing technology. Elsevier India.
- Daniel B.-Gagne, Chloe M. 2013. Processed Foods, Jones, Nova Science Publishers, Inc.

Course Outcomes

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

CO1	To understand the basic fundamental of floriculture	KI, K2	LO
CO2	To know the principles of landscaping	K2	HO
CO3	To learn the economic importance of volatile oils	K3	HO
CO4	To study production technology of vegetables	K4, K5	HO
CO5	To acquire knowledge processing of different food products	K6	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PSO1	PSO2	PSO3	PSO4
CO 1	S	S	-	-
CO 2	S	L	M	S
CO 3	M	M	L	-
CO 4	S	S	-	-
CO 5	M	S	-	M

S- Strong; M-Medium; L-Low

Supportive- VI

Siddha Medicine and Disease Ailments - 22PBOT3S06 Credits: 04

Course Objective:

- To acquire knowledge to understand the subject that is available in classical Siddha medicine.

Unit-I History and fundamental of Siddha medicine

History and principle of siddha medicine - Medicinal and aromatic plants - taxonomy - importance in identification and breeding pure lines - Biodiversity - endangered medicinal plants - importance of biodiversity conservation - protection and cultivation - Developing agro techniques for cultivation of important medicinal plants and mass cultivation.

Unit-II Scholars of Siddha Medicines

History of Siddhars:- Agasthiyar - Thirumoolar - Therayar - Yugimuni - Bohar - Sattamuni - Nandhidevar - Raamadevar - Dhanvanthri – Konganavar - Karuvoorar - Kaalanginadhar - Pulippaani - Paampaatti Siddhar - Macchamuni - Romarishi - Koorakkar - Idaikaadar - Sundaraanandhar - Thiruvalluvar - Agappei Siddhar - Kuthambai Siddhar – Sivavaakkiar - Azhuganni Siddhar - Pulathiar.

Unit –III Theories of Siddhaanthic

Three primordial, eternal entities and their siddhaanthic theories, Deekai, Epistemology, Five element theory, Fundamental Principles (96-Thathuvams) and its different concepts. Three humoural theory (Uyir Thaathukkal), Seven Physical constituents (Udal Kattukal), Five basic properties of Drug. Definition and description of the following (Attamaa Sithigal, Thirukkural, (Marunthu Athikaram), Rasavaatham (Alchemy), Muppu, Kaayakalpam (Elixir Science), History of Tamil Nadu including three Tamil Academies & Ancient Religious Traditions of Tamils (Arusamaiyakolgai), Chuvadi Iyal.

Unit –IV – Biochemistry of medicinal herbs

Chemistry and metabolism of Carbohydrates, Lipids, proteins, Biological oxidation, enzymes, Digestion and absorption of carbohydrates, proteins and lipids, hemoglobin, vitamins. Hormones: Biochemical functions and disorders.

Unit V – Pharmacognosy and Phytochemistry

Study of organized raw drugs based on their morphology: Roots, Rhizomes, Woods Barks, Galls Leaves, Flowers, Fruits, Seeds and Whole plant. Study of unorganized raw drugs: Gums, Resins and oils. Phytochemistry – Glycosides, Alkaloids, Tannins and Volatile oils - Obtained from the various plant parts. Adulteration of raw drugs detection, Poisonous plants, Basics of Herbal drug standardization.

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1. Palpandian (2019) Siddhas Masters of Nature. White falcon publisher. ISBN: 9789353510930, 9353510937
2. Ramn Martnez Lopez (2015). Siddha Medicine. Create Space Independent Publishing Platform. ISBN: 9781519376633, 1519376634
3. Neha Tyagi (2021). A Textbook of Pharmacognosy & Phytochemistry – 1, BFC publication. ISBN: 9789355090706, 9355090706
4. Thotrakirama Araichiyum Siddha Maruthuva Varalarum, (Tamil), The Directorate of Indian Medicine and Homoeopathy, Govt. of Tamilnadu, Chennai. (2005), Dr.K.S.Uttamarayan, H.P.I.M.
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6. Siddha Maruthuva Varalaru, (Tamil), International Institute of Tamil Studies, Chennai (2008), Anaivari Aananthan
7. Thenindhiya Maruthuva Varalaru, (Tamil) International Institute of Tamil Studies, Chennai (2008), Ra. Niranjana Devi.
8. Suvatiyiyal (Tamil) International Institute of Tamil Studies, Chennai (1991), Dr. P. Subramanian.
9. Aasivagam Ennum Tamizhar Anuviyam (Tamil) Manitam Pathipagam, Trichy-21 (2013), Neduncheliyan
10. Siddha Dossier, CCRS, Dept. of AYUSH, New Delhi (2013).
11. S.B. Gokhale, C.K. Kokate, A.P. Purohit (2016). Text Book of Pharmacognosy, Thirty Eighth Edition, Nirali Prakashan, Pune.
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14. Somasundaram S. (1997). Maruthuva Thavaraviyal (Medicinal Botany). (Palayamkottai, India: Elangovan Publishers).

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Course Outcomes (COs)

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

CO1	Understanding the knowledge of history and fundamental of Siddha medicine	**K1,K2**	**HO**
CO2	Know the Scholars of Siddha Medicines	**K2,K3**	**IO**
CO3	Study of Siddhaanthic Theories	**K3**	**IO**

CO4	Study the Biochemistry of medicinal herbs	**K3, K4**	**HO**
CO5	Learn the Pharmacognosy and Phytochemistry	**K5**	**HO**

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	M	S	S	M
CO 2	S	L	M	L	M
CO 3	S	M	M	M	L
CO 4	S	S	L	L	M
CO 5	S	M	S	M	L

S- Strong; M-Medium; L-Low

Supportive- VII

Phyconutraceuticals - 22PBOT3S07 Credits: 4

Course Objectives

- To know and learn the different nutritional attributes of algae
- To study uses of algae and their industrial applications

Unit I: Fundamentals of algae

Algae – Introduction – Fundamental study of algae – Ecology of algae – Classification of algae – Structure of algae – Economic importance of algae – harmful algae – Algal blooms.

Unit II: Bio and Phytochemistry of algae

Aquatic autotrophs – Major biochemicals – Algal pigments - Phytochemicals – Macro and micro elements – Vitamins – Fatty acids and other unique bioactive compounds of algae.

Unit III: Nutritional value of algae

Algal food - History - Algal consumption countries – Nutritional and functional properties of algae - Food products of algae – Uses of algal food - Algae as an ideal food for the human diet – Algae against malnutrition.

Unit IV: Algae relation to health

Significance of algae in food supplements - Food ingredients of algae -– Role of algae in health and disease prevention – Concerns associated with consumption of algae - Digestion and Bioavailability – Algal toxins – Quality control – Safety and Regulatory issues.

Unit V: Cultivation methods of algae

Cultivation technology for algae – Algal production Industry – Large scale production – Commercial production - Challenges in production – Trends in Trading and Marketing.

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- Thangadurai et al., Phycobiotechnology , Apple Academic Press, UK, 2021.

Course Outcomes (COs)

CO 1	gets a deep knowledge about nutritional value of algae	K1, K2	LOT
CO 2	understand much knowledge about different nutritional uses of algae	K2, K3	LOT
CO 3	obtained knowledge about present nutritional beneficial from algae	K3, K4	HOT
CO 4	gathered knowledge about different biological compounds of algae and their nutritional applications	K3, K4	HOT
CO 5	capable to develop or produce new nutritional products from algae	K3, K4	HOT

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate,K6- Create
LOT – Lower Order Thinking (Remember, Understand and Apply)
HOT – Higher Order Thinking (Analyse, Evaluate and Create)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5
CO 1	S	-	M	-	S
CO 2	S	-	M	-	S
CO 3	S	M	M	-	S
CO 4	S	S	M	-	S
CO 5	S	S	M	M	S

S- Strong: M-Medium: L-Low

Value added Course

Mushroom Cultivation – 22PGBOTA01 credit-2

COURSE OBJECTIVES

- To create common knowledge about the mushrooms and its nutritional benefits
- To provide entrepreneurship opportunities through mushroom cultivation

UNIT – I

Introduction – History – Biology of mushrooms, Nutritional value, scope of edible Mushroom cultivation – Types of edible mushroom available in India – Medicinal and other uses, Different parts of a typical mushroom & variations in mushroom morphology. Key to differentiate Edible from Poisonous mushrooms., *Pleurotuscitrinopileatus,*

UNIT – II

Cultivation technology- equipments and substrates in mushroom cultivation. Pure culture – preparation of medium (PDA and Oatmeal Agar medium) Sterilization – preparation of test tube slants- mother spawn in saline bottle – cultivation of white button mushroom (Agaricusbisporus).

UNIT – III

Low cost mushroom farm design of production. Diseases of Mushrooms: Brown black disease, yellowing of oyster mushrooms, Bacterial soft root, fungal brown blotch, wet bubble, dry bubble, cob web, green blotch.

UNIT – IV

Storage and nutrition: short-term storages, long term storages, drying, storages in salt solution, Nutrient Profile of Mushroom: Protein, aminoacids, calorific values, carbohydrates, fats, vitamins & minerals. Identification of Mushroom compounds: Antimicrobial, Flavonoids, Pharmaceutical compounds.

UNIT – V

Insects and pest attacking mushroom – fungal, bacterial, viral diseases.Food preparation from mushroom; soup, cutlet, omelette, somasa, pickles, curry. Cost benefit ration – marketing in India and abroad, export value.

REFERENCES

TEXT BOOKS:

- Handbook of cultivation, Processing and packing, published by Engineers India Research Institute, 4449, Nai Sarah, Main Road, Delhi 110006.
- Tewari, PankajKapoor S.C. 1988. Mushroom cultivation. Mittal Publicatiion, New Delhi.
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- Tripathi, D.P. (2005.) Mushroom Cultivation. Oxford and IBH Publishing Co. Pvt.Ltd,NewDelhi.

COURSE OUTCOMES

On the successful completion of the course students will be able to

CO1	To understand the common characteristic of Mushroom	KI, K2	HO
CO2	To be able to produce spawn	K2,K3	HO
CO3	To understand the major threats in Mushroom cultivation	K3	HO
CO4	To create basic understanding about storage of Mushroom	K4, K5	HO
CO5	To create entrepreneurship opportunities and marketing values of cultivated mushrooms	K5	HO

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate

MAPPING WITH PROGRAMME OUTCOMES

CO	PSO1	PSO2	PSO3	PSO4
CO 1	M	S	L	-
CO 2	S	S	-	-
CO 3	M	S	M	-
CO 4	S	M	-	-
CO 5	S	M	L	-

S- Strong; M-Medium; L-Low

Add-on Course

Bonsai Techniques - 22PBOTAOC01 Credits: 2

Course Objectives:

- An understanding of creative composition is essential and an aesthetical appealing bonsai.
- Demonstrate skills of developing bonsai plants for commercial production

Unit –I History and Principal

Introduction: History of Bonsai culture and Terrarium, Scope and importance of Bonsai Culture and terrarium, Nomenclature System of Horticulture Crops used in Bonsai. Classification.

Unit –II – Bonsai Culture

Propagation of horticulture Crops especially for Bonsai culture and terrarium, Selection of Plants for Bonsai culture and terrarium.

Unit –III -Types and styles of Bonsai

Types, styles and classification of the Bonsai plants - Upright (formal and informal) – Winding – Winding – Oblique – Gnarled – Semi-cascadecascade – Clasped to stone etc.

Unit –IV - Bonsai System and Techniques

Bonsai system and techniques, selection of container, tools and accessories for Bonsai and Terrarium, Principle of Bonsai culture and terrarium culture, Bonsai and terrarium culture soil and climate management. Bonsai and terrarium management practices and plant care: Media - Potting and Re-potting -Training - Pruning and Pinching (Shoot, leaf and root) - Watering – maneuring – Defoliation stratigies.

Unit –V - Marketing

Marketing of Bonsai and exhibition of strategies in Bonsai Culture and Terrarium.

References:

- Matthew Puntigam (2021). The Little Book of Bonsai. Published by Quadrille. ISBN: 9781787136489, 1787136485.
- Daiki Sato (2021). Bonsai A Comprehensive Guide to Growing, Pruning, Wiring and Caring for Your Bonsai Trees. Published by Daiki sato publication.
- Dan Barton (2019). The Bonsai Book The Definitive Illustrated Guide. Published by Racehorse publication. ISBN: 9781631583797, 1631583794.
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- Dey.S.C.- Bosnai : An art of miniature plant culture- Ankur publisher
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Course Outcomes (COs)

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

CO1	Understanding knowledge of the history and principal of bonsai	**K1,K2**	**HO**
CO2	Study of Culture of Bonsai plants	**K2,K3**	**IO**
CO3	Understanding the types and styles of Bonsai plants	**K3**	**HO**
CO4	Create the system of Bonsai techniques	**K3, K4**	**HO**
CO5	Acquire knowledge of marketing and exhibition of Bonsai Culture	**K5**	**HO**

K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	S	M	S	S	M
CO 2	S	L	M	L	M
CO 3	S	M	M	M	L
CO 4	S	S	L	L	M
CO 5	S	M	S	M	L

S- Strong; M-Medium; L-Low