PG – BOTANY REVISED CURRICULUM 2021-22

M. Sc., BOTANY

OBE REGULATIONS AND SYLLABUS

(With effect from the academic year 2021-22 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 2021-2022. 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. In addition, one industrial oriented paper (Entrepreneurial Botany) has offered to inculcate the opportunities for entrepreneurship from subject.

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 90 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 and Practical	19	76	1900	68

Core course	Project	01	27	200	12
Elective	Elective course (I & II semester)	02	6	200	6
Supportive	Supportive (II & III semester)	02	6	200	6
Special	Special paper (IV semester)	01	3	100	-
SWAYAM		04	-	-	-
	Garden, Library & Field study				
		29	118	2600	96

12. Credit calculation

Method of teaching	**Hours**	**Credits**
Lecture	1	1
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 2021-22 onwards)

SEMESTER-I

Core course	Code	Subject	Hrs /week	credits	CIA	EA	Total
I	21PBOT1CT01	Plant Diversity –I- Phycology and Bryology	4	4	25	75	100
II	21PBOT1CT02	Plant Diversity –II – Mycology, Lichenology and Plant Pathology	4	4	25	75	100
III	21PBOT1CT03	Plant Diversity –III- Pteridophytes, Gymnosperms and Palaeobotany	4	4	25	75	100
IV	21PBOT1CT04	Microbiology and Immunology	4	4	25	75	100
V	21PBOT1CT05	Plant Anatomy and Developmental Botany	5	5	25	75	100
VI	21PBOT1CP01	Practical – 01 (core I, II & III)	3	2	40	60	100
VII	21PBOT1CP02	Practical – 02 (core IV & V)	3	2	40	60	100
	21PBOT1E01	Elective - I	3	3	25	75	100
		SWAYAM (Non credit Course)	-	-	-	-	-
		Sub total	30	28	230	570	800

SEMESTER-II

Core course	Code	Subject	Hrs/ week	credits	CIA	EA	Total
VIII	21PBOT2CT06	Plant Ecology, Phytogeography and Conservation biology	4	4	25	75	100
IX	21PBOT2CT07	Cell biology, Genetics and Molecular Biology	4	4	25	75	100
X	21PBOT2CT08	Plant Physiology and Biochemistry	4	4	25	75	100
XI	21PBOT2CT09	Bioinstruments and Techniques	4	4	25	75	100
XII	21PBOT2CP03	Practical – 03 (core VIII & IX)	3	2	40	60	100
XIII	21PBOT2CP04	Practical – 04 (core X & XI)	3	2	40	60	100
	21PBOT2E02	Elective – II	3	3	25	75	100
	21PBOT2S01	Supportive – I	3	3	25	75	100
		SWAYAM (credit Course)	-	-	-	-	-
		Library	1				
		Garden	1				
		Sub Total	30	26	230	570	800

SEMESTER-III

Core course	Code	Subject	Hrs/ week	Credits	CIA	EA	Total
XIV	21PBOT3CT10	Taxonomy of Angiosperms and Economic Botany	5	5	25	75	100
XV	21PBOT3CT11	Plant Biotechnology and Genetic Engineering	4	4	25	75	100
XVI	21PBOT3CT12	Nanobiotechnology	4	4	25	75	100
XVII	21PBOT3CT13	Research Trends in Botany	4	4	25	75	100
XVIII	21PBOT3CP05	Practical – 05 (core XIV & XV)	5	3	40	60	100
XIX	21PBOT3CP06	Practical – 06 (core XVI & XVII)	5	3	40	60	100
	21PBOT3S02	Supportive-II	3	3	25	75	100
		SWAYAM (credit Course)					
		Sub Total	30	26	205	495	700

SEMESTER-IV

Core course	Code	Subject	Hrs/ week	credits	CIA	EA	Total
XX	21PBOT4PR01	Project work	27	12	50	150	200
	21PBOT4SP1	Entrepreneurial Botany (special paper)	3	2	25	75	100
		SWAYAM (Non credit Course)					
		Sub Total	30	14	75	225	300

Summary of credits

Semester	Hrs/week	credits	CIA	EA	Total
I	30	28	230	570	800
II	28	26	230	570	800
III	30	26	205	495	700
IV	30	14	75	225	300
Total	118	94	740	1860	2600

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

16. Special paper:

The University Department of Botany offers special subject.

- Entrepreneurial Botany

17. 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.

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

18. 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

19. 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)

20. 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 .

21. Classification of successful candidates

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

22. 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

23. 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 - 21PBOT1CT01

Sem.	Paper Code	Name of the Paper	Category	Contact Hrs/ Week	Credits	Maximum Marks	
						CA	SE
I	21PBOT1CT01	Plant Diversity – I – Phycology and Bryology	Core Theory	04	04	25	75

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

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	Provide the students with the knowledge of algae and bryophytes.
CO 2	Get acquainted with the basic understanding about evolution of algae and bryophytes
CO 3	Acquire History and development of Phycology and Bryology.
CO 4	Develop an understanding of Classification, Nomenclature, Occurrence and Distribution, Ultra structure of cell components of algae and bryophytes
CO 5	Understand the life cycle patterns and economic importance of algae and bryophytes.

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

Semester – I

Core Course – II

Plant Diversity –II – Mycology, Lichenology and Plant Pathology- 21PBOT1CT02

Sem	Paper Code	Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
							CA	SE
I	21PBOT1CT02	Plant Diversity –II –Mycology, Lichenology And Plant Pathology	Core Theory	04	04	04	25	75

Course Objectives

Course Outcomes (COs)

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

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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 Ascomycotia: 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 – Defense mechanisms – Principles of plant diseases – Integrated Disease Management (IDM) – Biotechnology in relation to plant pathology.

References.

- Alexopolous, C.J., C.W. Mims and M. Blackwell. Introductory Mycology. 4 th Ed. John Wiley & Sons, New York. 880 pp. 2007.
- Bilgrami, K.S. and R.N.Verma. Physiology of Fungi. 2nd Ed. Vikas Publication House, New Delhi.
- Moore, D., Robson, G.D. and Trinci, A.P.J. 21st Century Guide book of Fungi, Cambridge University Press, N.Y. 2011.
- Webster, C.J. Introduction to Fungi. 3 rd., Cambridge University Press, Cambridge. pp. 2007.
- Sharma, P.D. The Fungi . 2 nd Ed. Rastogi Publications, Meerut. 2004.
- Charles lane, paulBeales, Kevin Hughes. 2012. Fungal plant Pathogens. CABI publing.

Lichenology

- Bryophytes and Lichens in a Changing Environment. Bates, J. W., and A. M. Farmer, eds. Oxford: Clarendon, 1992.

Pathology

- 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,Plant Pathology and Plant Diseases, CABI publing 2020

Semester – I

Core Course – III

Plant Diversity III: Pteridophytes, Gymnosperms and Palaeobotany - 21PBOT1CT03

Sem	Paper Code	Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
							CA	SE
I	21PBOT1CT03	Plant Diversity – III -Pteridophytes, Gymnosperms and Palaeobotany	Core Theory	04	04	04	25	75

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	To understand the Evolution pollination mechanisms and embryogeny of gymnosperms
CO 2	To Study the food, medicine, industry and ornamental plants.
CO 3	To know the Impact of coniferous forest on human life.

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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 – IV

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.

REFERENCES

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.

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.

Semester – I

Core Course – IV

Microbiology and Immunology (21PBOT1CT04)

Sem	Paper Code	Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
							CA	SE
I	21PBOT1CT04	Microbiology and Immunology	Core Theory	04	04	04	25	75

Course Outcomes (COs)

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

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓

CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

References:

- Brock T.D. 2000. Biology of Microorganisms.9th edition, Southern Illinois University, Carbondale.
- Prescott, L.M., Harley, J.P. and Klien, D.A. 1996. Microbiology (3rd ed.), Brown W.C. Publishers, Boston, USA.
- Tortora, G.J., Funke, B.R. and Case, C.L. 1995. Microbiology-an Introduction (5th ed.), The Benjamin/Cummings Publishing Company Inc., Redwood city, California, U.S.A.
- General Microbiology by R.Y. Stanier, JL Ingrahm, ML Wheelis and PR Painter.
- Microbiology: Fundamentals and Applications by RM Atlas.
- Basic Virology by EK Wagner, MJ Hewlett, DC Bloom and D Camerini.
- Introduction to Modern Virology by NJ Dimmock, A J Easton and K N Leppard-2015
- Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.
- Flint SJ, Enquist LW, King RM, Racaniell VR and Shalka AM (2000). Principles of Virology - Molecular Biology, pathogenesis and control, ASM Press, Washington DC.
- Kannan, I. (2007). Immunology. MJP Publishers, Chennai.
- Rajan, S. (2007). Medical microbiology, MJP Publishers, Chennai
- Weir, D.M. (1995). Experimental Techniques in Immunology. Blackwell Scientific Publishers, London.
- T J. Kindt, R A. Goldsby, B A. Osborne, Janis Kuby 2008. CubyImmunology III Edn. Panimabook company limited. New Delhi.
- Medical Microbiology, 8th Edition, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.
- Annadurai, B. (2008). A Textbook of Immunology and Immunotechnology. S. Chand & Co. Ltd., New Delhi
- Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
- Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
- Abigall A. Salyers, Dixie D. Whitt. 2013. Microbiology-Diversity, Disease and the Environment. Panima Distributors, Meerut.
- Dubey, R.C. and D.K. Maheswari, 2010. A Textbookm of Microbiology, S. Chand & Company, New Delhi.
- Rao, C.V. 2008. Immunology. Naraso Publishing House, India.
- Kindt, T.J, R.A. Goldsby, B.A. Osborne, JanisKuby.2008. Cuby immunology IIIedn. Panima book Company limited, New Delhi.

- John P.Harley.2007. Microbiology Lab Manual. 7th Edition. McGraw Hill Medical publication division.
- Yadav A.N. (2020) Plant Microbiomes for Sustainable Agriculture: Current Research and Future Challenges. In: Yadav A., Singh J., Rastegari A., Yadav N. (eds) Plant Microbiomes for Sustainable Agriculture. Sustainable Development and Biodiversity, vol 25. Springer, Cham. https://doi.org/10.1007/978-3-030-38453-1_16
- Chen Dong, Zhengfan Jiang Medical / Immunology, Immunology (2020) ISBN: 9780128178799, 012817879

Semester – I

Core Course – V

Plant Anatomy and Developmental Botany - 21PBOT1CT05

Sem	Paper Code	Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
							CA	SE
I	21PBOT1CT05	Plant Anatomy and Developmental Botany	Core Theory	05	05	05	25	75

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

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	To know the fundamentals of cells, morphology and internal structure of plants
CO 2	To understand the development of secondary growth in plants
CO 3	To know the stages of plant development
CO 4	To study the development of floral parts, palynology and fertilization
CO 5	To acquire knowledge of sexual incompatibility and embryology in plants

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

References

Text books:

- Koelling, C. 2016. Plant Anatomy, Morphology and Physiology. Syrawood publishing house, USA.
- Charles B. Beck. 2010. An Introduction to plant structure and development. Cambridge University Press. New York.
- Pandey, S.N. and Chadha, A. 1996.Plant anatomy and Embryology.Vikas Publications, New Delhi.
- Fitzgerald, L. 2020. Plant Anatomy and Morphology: Structure, Function and Development. Callisto Reference. USA.
- Taylor A. Steeves and Vipen K. Sawhney. 2017. Essentials of Developmental Plant Anatomy. Oxford University Press. USA.
- Maheswari, P. 2020. An introduction to Embryology of Angiosperms, McGraw Hill.

Reference books:

- Paula Rudall. 2020. Anatomy of Flowering Plants. Cambridge University Press. USA.
- William C. Dickison 2000. Integrative Plant Anatomy, Academic Press.
- Ana Gonzalez, María Rodriguez, Nihal Gören Sağlam · 2020. Plant Science: Structure, Anatomy and Physiology in Plants. IntechOpen Limited. London.
- Grossniklaus, U. 2019. Plant Development and Evolution. Elsevier.
- Frugis, G.2020.Plant Development and Organogenesis. MDPI, Italy.

Semester - I

Core Course – VI

Practical – 01 (21PBOT1CP01)

Plant Diversity –I- Phycology and Bryology

Plant Diversity –II – Mycology, Lichenology and Plant Pathology

Plant Diversity –III- Pteridophytes, Gymnosperms and Palaeobotany

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*

Semester - I

Core Course – VII

Practical – 02 (21PBOT1CP02)

Microbiology, Immunology, Plant Anatomy and Developmental Botany

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 – VIII

Plant Ecology, Phytogeography and Conservation Biology - 21PBOT2CT06

Sem	Paper Code	Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
							CA	SE
II	21PBOT2CT06	Plant Ecology, Phytogeography and Conservation Biology	Core theory	4	4	4	25	75

Course Objectives

Course Outcomes (COs)

CO. No.	Course Outcomes
CO 1	To understand the basic concepts of ecology
CO 2	To create a vast knowledge about various ecosystem
CO 3	To explain the pioneer and importance processes occurs in environment
CO 4	To be aware of and to take preventive measures during calamity period
CO 5	To create a basic knowledge about phytogeography and conservation biology

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓

CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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

References

Text books:

- Anathakrishnan,T.N. (1982)-Bioresource Ecology-Oxford & IBH Publ.Co.,Inc.,Belmont.
- Ambasht, R.S. (1974) - A text book of plant ecology (3rd Edn.) Students' Friends.& Co., Varanasi, India.
- Agarwal, K.C. (1987) - Environmental biology- Agro-botanical publications, India. Chawla, S. 2011.
- A text book of Environment & Ecology. Tata McGraw-Hill, New Delhi.

Reference books:

- Billings, W.B.(1965)- Plants and the ecosystem - Wardsworth Publ.Co.,Inc., Belmont.
- Conard, H.S. Plant Ecology - Iowa state Press., Iowa.
- Odum E.P. Gray, W. Barrelt 2004.Fundamentals of Ecology.15th edition. Thomas Asia Pvt. Ltd.
- Chapman, J.L. and Reiss, M.J. 1999. Ecology; Principles and Applications.II Ed. Cambridge University Press. New York.
- Putman, R.J. and S.D. Wratten. 1984. Principles of Ecology. University of California Press, Berkeley and Los Angels.
- Schulze, E.D., Beck, E. And K. Muller-Hohenstein. 2005. Plant Ecology. Springer. New York.
- Odum, E.P. 1978. Basic principles of ecology.
- Polunin, N. 1992 Principles of Plant Geography.
- Velentin. 1978. Taxonomy, Phytogeography and Evolution.

Semester II

Core Course – IX

Cell Biology, Genetics and Molecular Biology - 21PBOT2CT07

Sem	Paper Code	Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
							CA	SE
II	21PBOT2CT07	Cell Biology, Genetics and Molecular Biology	Core Theory	04	04	04	25	75

Course Outcomes:

The course will facilitate the adequate knowledge about the cell biology and basic concept of genetics, structure of organisms and advanced molecular techniques.

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓

CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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

- Gupta P.K 2013 Genetics and Cytogenetics. 7th Edition. Rastogi Publications.
- Ahluwalia K.B 2005 (First Edition). Genetics. New Age International Private Ltd. Publishers, New Delhi.
- Sariu C 2004 (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.
- Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai

Reference Books

- Derobertis E.D. and De Robertis E.M.F. 2002. Cell and Molecular Biology 8th Edition. Lee and Fab International edition, Philadelphia.
- Cooper G. 1996. The cell A molecular approach. ASM Press, Washington
- Buchanan B.B. Gruissem W., Jones R.L. (2008). Biochemistry and Molecular Biology. American Society of Plant Physiologist, Maryland, USA.
- Sheeler P and Binachi D 2004. Cell and Moecular Biology, Third edition, Wiley New York, USA.
- Hartk D.L and Jones, E.W 1998 Genetics: Principles and Analysis (Fourth Edition). Jones and Bartlett Publishers, Massachusetts, USA.
- Khush, G.S 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
- Karp, G. 1999. Cell and Molecular Biology : Concept and Experiments. John Wiley and Sons, Inc., USA.
- Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.
- Lewis, R. 1997. Human Genetics: Concepts and Application (Second Edition). WCB McGraw Hill, USA.

- Paul Khurana, S.M and Machiavelli Singh 2015. Biotechnology: Progress & Prospects. Studium Press USA.
- Robert, F and Weaver. 2012. Molecular biology -5th ed. The McGraw-Hill Companies, Inc. New York.
- Kar D.K. 2011. Cell Biology Genetics & Molecular Biology .New Central Book Agency (P) Limited.
- David Clark Nanette Pazdernik 2012.Molecular Biology 2nd Edition. Academic Cell
- David P. Clark, 2009.Molecular Biology. ElsevierMolecular Biology of the Cell, Sixth Edition 2017. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter. Garland Science.

Semester – II

Core Course - X

Plant Physiology and Biochemistry (21PBOT2CT08)

Sem	Paper Code	Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
							CA	SE
II	21PBOT2CT08	Plant Physiology and Biochemistry	Core Theory	04	04	04	25	75

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.

Course Outcomes (COs)

CO. No.	Course Outcomes
CO 1	To understand the basic fundamentals of physiological aspects of plants
CO 2	To know the energy production and its utilization in plants
CO 3	To learn the plant metabolism, photobiology and response to various stress
CO 4	To study the structural and functional properties of plant biomolecules
CO 5	To acquire knowledge of enzymatic action and functions of secondary metabolites

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

References

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.

Semester – II

Core Course - XI

Bioinstruments and Techniques - 21PBOT2CT09

Sem.	Paper Code	Name of the Paper	Category	Contact Hrs/ Week	Credits	Maximum Marks	
						CA	SE
II	21PBOT2CT09	Bioinstruments and Techniques	Core Theory	04	04	25	75

Course Objectives

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

Course Outcomes (COs)

CO. No.	Course Outcomes
CO 1	gets a deep practical knowledge about biological techniques
CO 2	understand much knowledge about different separation techniques of biomolecules
CO 3	obtained knowledge about structure, function and application of basic and advanced equipments used in biology and molecular biological techniques
CO 4	gathered knowledge about different principles and mechanism of basic and advanced instruments including microscopy
CO 5	capable to operating knowledge of basic and advanced instruments

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

References:

- Jeyaraman, J. 1981. Laboratory Manual in Biochemistry. Wiley Eastern Ltd. Mumbai.
- Plummer, D.T. An Introduction to practical biochemistry. Tata MC Graw Hill Co. New York.
- Keith Wilson and John Walker. 1995. Practical biochemistry. Univ. of Cambridge., New York.
- Chawla, H.S. 2000. Introduction to biotechnology. Oxford and IBH publishing Co., New Delhi.
- Johansen, D.A. 1940. Plant Microtechnique. MC Graw Hill Co., New York.
- Nagarajan, P. and Senthilkumar, N. 2001. Molecular biology principles and methods a practical approach, Sree Narmatha Printers, Coimbatore.
- Sharma, R.K. and S.P.S. Sangha. 2009. Basic Techniques in Biochemistry and Molecular Biology. I.K. International Pvt. Ltd, New Delhi.
- Keith Wilson and John Walker.2010. Principles and Techniques of Biochemistry and Molecular biology. Cambridge University Press, New York.
- Palanichamy, S. and M. Shunmugavelu. 1997. Research methods in Biological Sciences. Palani Paramount Publications, Palani.
- P.R. Yadav and Rajiv tyagi, 2006. Biological Technicques, Discovery Publishing House, New Delhi.
- Susan carson, Heather B. Miller and D. Scottwitherow, 2012. Molecular biology techniques, Elesiver.
- Bajpai P.K. 2006. Biological instrumentation and Methodology. S Chand Publishers, New Delhi.
- Annadurai. B. 2011. A textbook of immunology and immunotechnology. S.Chand Publishers, New Delhi.
- Ananta Swargiary. 2017. Biological tools and Techniques. Kalyani Publishers, New Delhi.
- Sabari Ghosal and Srivastava A. K. 2009. Fundamentals of Biological Techniques and Instrumentation. PHI Learning Private Ltd. New Delhi.

- Gurumani. N. 2006. Research Methodology for biological sciences. MJP Publishers, Chennai.
- Skoog, Holler and Crouch.2007. Instrumental Analysis. Cengage Learning Pvt.Ltd. New Delhi.
- Gurumani N. 2019. Research Methodology for Biological Sciences. MJP Publishers. New Delhi.
- Das, H.K. 2010. Textbook of Biotechnology. 4th edition. Wiley, India.
- Srivastava, M.L. 2008. Bioanalytical Techniques. Narosa Publishing House, New Delhi.

Semester – II

Core Course – XII

Practical – 03 (21PBOT2CP03)

Plant Ecology, Phytogeography, Conservation Biology, Cell biology, Genetics and Molecular Biology

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

Semester – II

Core Course – XIII

Practical – 04 (21PBOT2CP04)

Plant Physiology, Biochemistry, 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.

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 - XIV

Taxonomy of Angiosperms and Economic Botany - 21PBOT3CT10

Sem.	Paper Code	Name of the Paper	Category	Contact Hrs/ Week	Credits	Maximum Marks	
						CA	SE
III	21PBOT3CT10	Taxonomy of Angiosperms and Economic Botany	Core Theory	05	05	25	75

Course Objectives

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	To obtain a basic knowledge about classification of plants
CO 2	To create a better understanding about modern taxonomic tools
CO 3	To explain the basic and importance processes in taxonomy
CO 4	To identify the plants on basis of its general characters
CO 5	To know about economic importance of various groups of plants and its parts

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

References

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

Reference books:

- 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.

Semester –III

Core Course - XV

Plant Biotechnology and Genetic Engineering - 21PBOT3CT11

Sem.	Paper Code	Name of the Paper	Category	Contact Hrs/ Week	Credits	Maximum Marks	
						CA	SE
III	21PBOT3CT11	Plant Biotechnology and Genetic Engineering	Core Theory	04	04	25	75

Course Objectives

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

Course Outcomes (COs)

CO. No.	Course Outcomes
CO 1	obtained wide knowledge about Plant Tissue Culture techniques
CO 2	recognize the positive approaches of agriculture, forestry, horticulture and conservation of plant genetic resources
CO 3	identify the problems and rectify methods of GM crops
CO 4	gathered wide information regarding IPR and GI
CO 5	get technical skills in genetic engineering

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

Semester - III

Core Course - XVI

Nanobiotechnology - 21PBOT3CT12

Sem	Paper Code	Name of the Paper	Category	Contact Hrs/Week	Credits	Maximum Marks	
						CA	SE
I	**(**21PBOT3CT12**)**	Nanobiotechnology	Core Theory	04	04	25	75

Course Objectives

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	The student should be able to on completion of the course:
CO 2	Understand the basic concepts of nanotechnology principles and applications
CO 3	To Know different Biomedical applications of nanoparticles
CO 4	Understand the basic concepts environmental applications
CO 5	To know about nanostructured materials

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

Unit I

Nanobiotechnology: 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 Microtechnology - Nanofabrication and Nanotechnology.

Unit III

Synthesis routes of Nanomaterials – Synthesis of different Nanoparticles - Unique propertiesand characterization of Nanoparticles.

Unit IV

Applications of Nanomaterials: Nanoelectronics – 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 – Nanomedicine and Novel drug delivery systems – Health and Environmental - Photocatalysis and Photocatalyts.

Unit V

Nanostructured materials with high application potential: Quantum Dots – Carbon Nanotube – GAN Nano wires – Nanocrystalline – Zinc Nitrate, Non Crystalline - Titanium Oxide and Multilayered 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) PVT LTD.

- Subbiah Balaji. 2010. Nanobiotechnology. 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.Nanobiotechnology: Inorganic Nanoparticles Vs Organic Nanoparticles Elsevier.

- Michael R. Hamblin, Pinar Avci, Tarl Prow, 2016. Nanoscience in Dermatology. Academic Press.

- Makio Naito, Toyokazu Yokoyama, Kouhei Hosokawa, Kiyoshi Nogi 2018. Nanoparticle Technology Handbook, Elsevier.

- Monique A. V. Axelos, Marcel Van de Voorde, 2017. Nanotechnology in Agriculture and Food Science, John Wiley & Sons.

- Claudia Atavilla, Enrico Ciliberto, 2017. Inorganic Nanoparticles: Synthesis, Applications, and Perspectives CRC Press.

- Rainer Waser, Nano Electronics And Information Technology, John Wiely and sons publication, 2003

- Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.

- Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.

- Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.

- Nanotechnology: A Gentle Introduction to Next Big Idea, Mark Ratner and Daniel Ratner, Low Price edition, Third Impression, Pearson Education

- Nanotechnology, William Illsey Atkinson, JAICO Publishing House, Second Impression-2008.

- Bio molecular computation for Bio nanotechnology, Liu and Shimohara, Artech House-London, 2007

- Lee, Young-Chul, Moon, Ju-Young Introduction to Bionanotechnology (2020)

Semester – III

Core Course – XVII

Research Trends in Botany - 21PBOT3CT13

Sem.	Paper Code	Name of the Paper	Category	Contact Hrs/ Week	Credits	Maximum Marks	
						CA	SE
III	21PBOT3CT13	Research Trends in Botany	Core Theory	04	04	25	75

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

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	obtained wide knowledge about emerging field of life sciences
CO 2	acquired scientific information regarding genome and proteome
CO 3	get computational acquaintance from bioinformatics and biostatistics
CO 4	gathered practical skills to apply phytochemical and pharmacognostical techniques
CO 5	ensured career opportunity in Industry/R&D/Academic

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.
- Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
- 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.
- Shah.B. and Seth.A. 2010. Text book of Pharmacognosy and Phytochemistry. Elsevier India Pvt. Ltd. New Delhi.
- 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.
- Bernard Rosner. 2010. Fundamentals of Biostatistics. Brooks/cole, Boston, USA.
- 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.
- Richard M. Twyman, 2013. Principles of Proteomics, Garland Science.
- Devarajan Thangadurai, Jeyabalan Sangeetha, 2015. Genomics and Proteomics: Principles, Technologies, and Applications, CRC Press.
- 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.
- Merrill, 2012. Fundamentals of Epidemiology and Biostatistics, Jones & Bartlett Publishers.
- Clemens Posten, Christian Walter, 2013. Microalgal Biotechnology: Potential and Production, Walter de Gruyter.
- Peter Castro, Michael Huber, 2015. Marine Biology, McGraw-Hill Higher Education.
- Das, H.K. 2010. Textbook of Biotechnology. 4th edition. Wiley, India.

Semester - III

Practical – 05 (core XIV & XV) - 21PBOT3CP05

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

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

Semester - III

Practical – 06 (core XVI & XVII) - 21PBOT3CP06

Nanobiotechnology and Research Trends in Botany

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

RESEARCH TRENDS IN BOTANY

Genomics and Proteomics

- Observation and explain techniques related Genomics and Proteomics

Bioinformatics

- Phylogenetic analysis
- Protein structure prediction by using tools

Phytochemistry

- Extraction of phytochemicals

Pharmacognosy

- Study of anatomical features of selected medicinal plants (Senna leaf, Datura leaf, Cinchona bark, Nuxvomica seed)

Biostatistics

- Data collection
- Analysis of mean, mode and median
- Analysis of mean deviation, variances, standard deviation and standard error
- Correlation and regression
- Chi-square Test, t-test and ANOVA

Elective – I (code: 21PBOT1E01, 21PBOT2E02)

Microbial Biotechnology

Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
					CA	SE
Microbial Biotechnology	Elective	03	03	03	25	75

Course Objectives

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	Introduce the students to the role microorganism and play in fermentation process.
CO 2	Develop an understanding of process control, upstream and downstream process
CO 3	Know the differences between aerobic and anaerobic fermentation Understand the growth of microorganism and their role in producing foods
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.
CO 5	Understand the growth of microorganism and their role in producing agricultural Biotechnology

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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, flavors and colors. 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 solubilization.

Unit-V

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

REFERENCES

- Michael Shuler and FikretKargi. "Bioprocess Engineering: Basic Concepts", 2nd Edition, Prentice Hall, and Englewood Cliffs, NJ, 2002.

- Pauline Doran. "Bioprocess engineering principles", Academic Press, 1995.

- Colin Ratledge, Bjorn Kristiansen, "Basic Biotechnology", 2nd Edition, CambridgeUniversity Press, 2001.

- Roger Harrison et al., "Bioseparation Science and Engineering", Oxford UniversityPress, 2003

- Industrial Microbiology: An Introduction by Waites, Morgan, Rockey and Higton, Blackwell Science (2001)

- Brock biology of microorganism, 11 th edition, By Madigan,Michael and Martinko,John, (2005)

- Elements of Chemical Reaction and Engineering, 4 th edition, by H. Scott Fogler Pearson Education Inc., (2006).

- Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company

- 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.

- Singh, J., Vyas, A., Wang, S., Prasad, R. (Eds.) Microbial Biotechnology: Basic Research and Applications(2020).

- Yadav A.N. (2020) Plant Microbiomes for Sustainable Agriculture: Current Research and Future Challenges. In: Yadav A., Singh J., Rastegari A., Yadav N. (eds) Plant Microbiomes for Sustainable Agriculture. Sustainable Development and Biodiversity, vol 25. Springer, Cham. https://doi.org/10.1007/978-3-030-38453-1_16

Elective -II

Algal Biotechnology

Name of the Paper	Category (Core Theory/Core Practical/Elective/ Supportive	Contact Hrs/ Week	Credits	Maximum Marks	
				CA	SE
Algal Biotechnology	Elective	03	03	25	75

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

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	acquired knowledge about emerging field of algal biotechnology
CO 2	get research and applications knowledge of algae
CO 3	gathered skill of algal cultivation and their vast applications
CO 4	apply the strategies of natural renewable resources
CO 5	ensured career opportunity in Industry/R&D/Academic

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

References

- Trivedi, P.C. 2001. Algal Biotechnology. Printer publishers, Jaipur, India.
- Barsanti, L. and Gualtieri. P. 2006. Algae: Anatomy, Biochemistry and Biotechnology, CRC press, USA.
- Khattar, J.I.S.., Singh, D.P., and Gurpreet Kaur. 2009. Algal Biology and Biotechnology.I. K. International (Pvt) Ltd. New Delhi.
- Vanden Hoek,C., Mann, D.G., and Jahns, H.M. 1995. Algae: an Introduction to phycology, University of Cambridge, New York.

- Linda. E. Graham, james M. Graham and Lee Warren Wilcox. 2009. Algae. Benjamin- Cummings Company.
- Sambamurthy, A.V.S.S. 2005. A text book of Algae. I.K. International Pvt. Ltd. New Delhi.
- Sharma, O.P. 2011. Algae. Tata MC Graw Hill, New Delhi.
- Robert Arthur Anderson. 2005. Algal Culturing techniques. Elsiever. USA.
- Chen, F and Jiang, Y. 2001. Algae and their biotechnological potential. Kluwar Academic Publishers. Netherland.

Elective – III

Mushroom Technology

Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
					CA	SE
Mushroom Technology	Elective	03	03	03	25	75

Course Objectives

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	**To understand the common characteristic of Mushroom**
CO 2	**To be able to produce spawn**
CO 3	**To understand the major threats in Mushroom cultivation**
CO 4	**To create basic understanding about storage of Mushroom**
CO 5	**To create entrepreneurship oppurtunities and marketing values of cultivated mushrooms**

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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 (Agaricusbisporus). 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 (Volvariellavolvacea) 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.

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.
- Nita Bhahi 1984-1988. Hand book of Mushrooms, II editioin, Vol-1 and II. Atkinson G.F. 1961.
- Mushroom, edible, poisonous, et.,Hafner Publishers, New York.
- Pandey, B. P. 1996. A textbook of fungi. Chand and Company New Delhi.
- Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
- Mushroom Production and Processing Technology, PathakYadavGour (2010) Published by Agrobios (India).
- Kannaiyan, S. Ramasamy, K. (1980). A hand book of edible mushroom, Today & Tomorrows Printers &Publishers, New Delhi.
- Tripathi, D.P. (2005.) Mushroom Cultivation. Oxford and IBH Publishing Co. Pvt.Ltd,NewDelhi.

Elective - IV

Plant Genetics and Plant BreedingTechniques

Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
					CA	SE
Plant Genetics and Plant BreedingTechniques	Elective	03	03	03	25	75

Course Outcomes:

The course is to provide increased practical knowledge of plant breeding theories, chromosome techniques, crop improvement and its techniques and advanced molecular breeding techniques.

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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

- Ram J.Singh. 2017. Plant Cytogenetics. Third Edition. Traylor and Francis group, CRC Press.
- Hank W. Bass and James A. Birchler .2012. Plant Cytogenetics, genome structure and chromosome function .Springer New York Dordrecht Heldelberg London. ISBN: 978-0-387-70868-3.
- Mahabal Ram. 2010. Fundamentals of Cytogenetics and Genetics . Published by PHI Learning Private Limited , New Delhi.
- Gupta P.K. 1999. Vytogenetics. Rastogi Publication Meerut.
- Prasad G. 1998. Introduction to cytogenetics. Kalyani Publishers, New Delhi
- Sinha U and Sinha S. 1998. Cytogenetics, Plant Breeding and Evolution . Vikas Publishing house Pvt.Ltd.New Delhi.
- Swaminathan M.S., Gupta P.K and Sinha U 1974. Cytogenetics to Crop Plants . MacMillan Ltd. New Delhi.

Reference books

- Khush G.S. 1973. Cytogenetics of aneuploides. Academic Press New York. USA
- Burnham C.R. 1962. Discussion in Cytogenetics. Burgess Publishing Co.Minnesota.
- Harti D.L and Jones E.W. 1998 Genetics: principles and analysis . 4th Edition . Jones and Barew Publishers Massachusetts. USA.
- Karp G. 1999. Cell and Molecular Biology: Concepts andExperiments, John wiley and Sons inc USA.

- Fikui K. and Nakayama S. 1996. Plant chromosomes: Laboratory Methods . CRC Press Boca Ration Florida.
- Swanson C.P., Merz T and Young J. 1973. Cytogenetics. Prentice Hill of India Private Ltd. New Delhi.

Elective -V

Biofertilizer and Organic Farming

Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
					CA	SE
Biofertilizer and Organic Farming	Elective course	03	03	03	25	75

Course Objectives

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

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	To understand the basic fundamentals of biofertilizers and their applications
CO 2	To know the fermentation method for biofertilizer production
CO 3	To learn the biogas production from organic biofertilizer
CO 4	To know the importance of organic biofertilizers
CO 5	To acquire knowledge about vermiculture technology

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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 Biofertilizers.

References:

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.
- Dar, G.H., Bhat, R.A., Mehmood, M.A., Hakeem, K.R. 2021. Microbiota and Biofertilizers, Vol 2: Ecofriendly Tools for Reclamation of Degraded Soil Environs. Springer, Switzerland.

Reference books:

- Subba Rao, N.S. (2000). Soil Microbiology. Oxford and IBH Publishing Co.Ltd., New Delhi.
- Kaushik, D. B., Kumar, D., Shamim, Md. 2019. Biofertilizers and Biopesticides in Sustainable Agriculture. Apple Academic Press, Canada.
- Varma, A., Giri, B., Qiang-Sheng Wu, Prasad, R. 2019. Biofertilizers for Sustainable Agriculture and Environment. Springer, Switzerland.

Supportive – I (code : 21PBOT2S01, 21PBOT3S02)

Plant and Life

Name of the Paper	Category	Contact Hrs/ Week	Credits	Maximum Marks	
				CA	SE
Plant and Life	Supportive	03	03	25	75

Course Objectives

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

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	acquired knowledge about plant science and its life
CO 2	obtained basic and applications knowledge of plants
CO 3	gathered awareness to conserve plant biodiversity
CO 4	ensured career opportunity in Industry/R&D/Academic

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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

- Kumar, H.D. Introductory Phycology. 2nd Ed. Affiliated East-West Press, New Delhi.651 pp.1999.
- Lee, R.E. Phycology. 4th Ed. Cambridge University Press, London. 2008.
- Chapman, V.J. and D.J. Chapman. The Algae. ELBS and Macmillan , NY. 1977.

- Alexopolous, C.J., C.W. Mims and M. Blackwell. Introductory Mycology. 4 th Ed. John Wiley & Sons, New York. 880 pp. 2007.
- 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.
- Trivedi P.C. 2002. Advances in Pteridology. Pointer Publishers.
- Vashishta B.R. 2001. Botany for degree students – Pteridophytes. S Chand & Co Ltd; 5th edition.
- Prescott, L.M., Harley, J.P. and Klien, D.A. 1996. Microbiology (3rd ed.), Brown W.C. Publishers, Boston, USA.
- Ray F. Evert. 2006. Esau's Plant anatomy- Meristems, Cells and Tissue of the Plant Body- their structure, Function and development,. John Wiley Edition, Hoboken, New Jersy.
- Pijushroy, (2010).Plant Anatomy, New central Book Agency, Pvt Lit, New Delhi.
- Larry Peterson, R., Peterson, C.A. and Melville, L.H. 2008.Teaching plant anatomy through creative laboratory exercises. NRC, Canada.
- Anathakrishnan,T.N. (1982)-Bioresource Ecology-Oxford & IBH Publ.Co.,Inc.,Belmont.
- Ambasht, R.S. (1974) - A text book of plant ecology (3rd Edn.) Students' Friends. & Co., Varanasi, India. • Agarwal, K.C. (1987) - Environmental biology- Agro-botanical publications, India.
- Jain, V.K. (2007). Fundamentals of Plant Physiology. S. Chand & Co. Ltd., New Delhi.
- Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology.Wadsworth Publishing Company, Belmont, California, USA.
- 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.
- Dubey, R.C. 2008. A Textbook of Biotechnology. S.Chand Company Pvt. Ltd. New Delhi.
- Singh, B.D. 1998. Biotechnology. Kalyani publishers, Ludhiana.

Supportive – II

Climate Change and Sustainable Biodiversity

Name of the Paper	Category	Contact Hrs/ Week	Credits	Maximum Marks	
				CA	SE
Climate Change and Sustainable Biodiversity	Supportive	03	03	25	75

Course Outcomes

The course will enable to understand the facts and issues related to climate change and how it is affecting the ecosystem functions on which the human livelihoods are dependent, its structure, forest ecology and conservation.

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.

References

- Dan Binkley and Richard F.Fisher (2013). Ecology and Management of Forest Soils. Published by John Wiley and sons limited.
- Prabodh K Maiti and Paulami Maiti (2011). Biodiversity- Preception, Peril and Preservation. Published by Asoke K.Ghosh,PHI Learning Private Limited Delhi.
- John M.Fryxell and Anthony R.E. Sinclair (2014). Wildlife Ecology, Conservation and Management. Published by John Wiley and sons limited
- Fred Van Dyke (2008).Conservation Biology – Foundation, Concepts and Applications. Published by Springer Science and Business Media B.V. ISBN: 978-1-4020-6890-4
- Biodiversity conservation in managed and protected areas Katwal/Banerjee Agrobios, India 2002.
- Romm, J. (2018). Climate Change: What Everyone Needs to Know. Second Edition. Oxford
- University Press. ISBN 978 0190866105. 300pp.
- Bonan, G. (2015). Ecological Climatology: Concepts and Applications. Cambridge UniversityPress. ISBN 9781107339200. 692pp.

Books

1. Relevance to Ecosystem Properties and Global Change. Cambridge University Press. ISBN 0 521 56643 6. 371pp.

2. Best, R.J., Stone, M.N. and Stachowicz, J.J. (2015). Predicting Consequences of Climate Change for Ecosystem Functioning: Variation Across Trophic Levels, Species and Individuals. John Wiley & Sons Limited.

3. Post, E. (2013). Ecology of Climate Change: The Importance of Biotic Interactions. Princeton University Press. ISBN 978-0-691-14847-2. 376pp.

4. Smith, T.M., Shugart, H.H. and Woodward, F.I. (Eds.) (1997). Plant Functional Types: TheirRelevance to Ecosystem Properties and Global Change. Cambridge University Press. ISBN 0 521 56643 6. 371pp

Supportive - III

Horticulture and Gardening

Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
					CA	SE
Horticulture and Gardening	Supportive	03	03	03	25	75

Course Objectives

Course Outcomes (COs)

CO. No.	**Course Outcomes**
CO 1	**To understand the importance and scope of horticulture**
CO 2	**To gain a knowledge about fruit plants**
CO 3	**To understand the storage techniques**
CO 4	**To create basic understanding on cultivation of water plants**
CO 5	**To acquire knowledge on garden designing**

Mapping of COs with Pos

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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

Supportive- IV

Commercial Horticulture

Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
					CA	SE
Commercial Horticulture	Supportive	03	03	03	25	75

Course Objectives

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

Course Outcomes (COs)

CO. No.	Course Outcomes
CO 1	To understand the basic fundamentals of floriculture
CO 2	To know the principles of landscaping
CO 3	To learn the economic importance of volatile oils
CO 4	To study the production technology of vegetables
CO 5	To acquire knowledge of processing of different food products

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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.
- Sivasankar,B. 2005. Food processing and preservation. Prentice - Hall of India

REFERENCE BOOKS:

- 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.
- Charles S. Sell.2019. Fundamentals of Fragrance Chemistry. Wiley, New Jersey.
- Fellows, P. 2015. 3rd ed Food processing technology. Elsevier India.
- Daniel B.-Gagne, Chloe M. 2013. Processed Foods, Jones, Nova Science Publishers, Inc.

Supportive - V

Phytochemistry

Name of the Paper	Category	Contact Hrs/Week	Total Number of hours	Credits	Maximum Marks	
					CA	SE
Phytochemistry	Supportive	03	03	03	25	75

Course Objectives

Course Outcomes (COs)

This supportive course is exposure knowledge about important chemicals of medicinal plants and their significant role in drug discovery

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

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 ethnomedicines – Drug industries from India.

Unit - III

Traditional herbal medicine – Natural sources of drugs – Classification of Crude drugs – Quality control of the crude drugs - Standaridization 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

- Evans W.C. and Trease E. 2009. Pharmacognosy. Elsevier, New York.
- 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. 2012. Herbal Drug Industry. Oxford Book Company, Rajasthan.
- Roseline. A. 2011. Pharmacognosy. MJP Publishers, Chennai.
- Mishra. S.R. 2010. Plant Biochemistry. Discovery Publishing House, New Delhi.

- Gupta, S. D., and Ibaraki, Y. 2006. Plant tissue culture engineering (Vol. 6). Springer Science & Business Media, Germany.
- Altemimi, Ammar, Naoufal Lakhssassi, Azam Baharlouei, Dennis G. Watson, and David A. Lightfoot. "Phytochemicals: Extraction, isolation, and identification of bioactive compounds from plant extracts." Plants 6, no. 4 (2017): 42.
- Avinash Seth Biren Shah (2009) Textbook of Pharmacognosy and Phytochemistry 1st Edition

Special paper

Sem.	Paper Code	Name of the Paper	Category	Contact Hrs/ Week	Credits	Maximum Marks	
						CA	SE
IV	21PBOT4SP1	Entrepreneurial Botany	Special course	03	-	25	75

Course Objectives

- To learn entrepreneurial opportunities for plant science
- To know importance techniques and applications of plant science

Course Outcomes (COs)

CO. No.	Course Outcomes
CO 1	acquired knowledge about entrepreneurship from botany
CO 2	obtained information of commercial applications of plant science
CO 3	gathered marketing strategies of plant products
CO 4	ensured career opportunity in entrepreneurship

Mapping of COs with Pos

CO	PO1	PO2	PO3	PO4	PO5
CO 1	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓
CO 5	✓	✓	✓	✓	✓

Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

Unit I

Entrepreneurial botany – Introduction – Scope – Importance – Challenges.

Unit II

Agriculture based entrepreneurship – organic farming – phyco-farming – biofertilizer – vermicompost – small scale production of *Spirulina* – Preparation of Seaweed Liquid Fertilizer – Hydroponics technology.

Unit III

Algal cultivation – Nutraceutical and pharmaceutical products of algae - Mushroom cultivation – Cultivation of medicinal and aromatic plants – cultivation of traditional crops.

Unit IV

Horticulture and gardening techniques – Storage of seeds - Nursery formation and maintenance – Home garden (Kitchen garden and roof top garden) – Formation of Herbal garden, Zodiac garden, Flower garden – Green house.

Unit V

Strategies of economics and marketing of products (Export strategies) – Opportunities for revenue generation and establish entrepreneurship – Industrial opportunities for entrepreneurship.

References

- Kochhar, S.L. (2016) Economic Botany in the Tropics, (Fifth Edition), Delhi:Cambridge University Press.
- Simpson, B.B., Ogozaly, M.C., (2001) Economic Botany (3rd Edition)Newyork:

- McGraw- Hill.
- Gerrald E. Wickens, (2001) Economic Botany Principles and Practices, Netherlands: Springer.
- Rajkumar Joshi, (2013) Aromatic and Vital Oil Plants. New Delhi:Agrotech Press,
- Singh P. Ornamental, (2008), Medicinal, Aromatic and Tuber Crops, New Delhi: Agrotech Press, Jaipur,.
- Mukund Joshi, (2015), Text Book of Field Crops, Delhi: PHI Learning Private Limited.
- Somasundaram, E. (2019). Principles Of Organic Farming (With Theory And Practicals). New India Publishing Agency- Nipa.
- Prabal MallicK. (2018). Organic Urban Farming, The Indian Way: Comprehensive Guide to Organic Gardening for Urban Spaces in India.
- Tripathi, Bhumi Nath, Kumar, Dhananjay (Eds.). Prospects and Challenges in Algal Biotechnology (2017). Springer.
- Mihir Kumar Das (2010). Algal Biotechnology : New Vistas. Daya.
- Dinabandhu Sahoo and B.D. Kaushik . 2021. Algal Biotechnology and Environment. Wiley.
- Hallmann, Armin, Rampelotto, Pabulo Henrique 2019. Grand Challenges in Algae Biotechnology. Springer.
- Farooqi Sreeramu. (2004). Cultivation of Medicinal & Aromatic Crops. University Press.
- Kumar . 2020. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. 2nd Edition. Oxford Press.
- Deepa Devi, N. (2017). A Text Book of Medicinal and Aromatic Crops. Aavishkar Publishers, Distributors, JAIPUR.
- Mason and John. (2000). Commercial Hydroponics: How To Grow 86 Different Plants In Hydroponics. Kangaroo Press, Australia.
- Lynette Morgan . 2021. Hydroponics and Protected Cultivation: A Practical Guide. CABI, USA.
- Bridwell and Raymond. 1994. Hydroponic Gardening. Woodbridge Press Publishing Company. Santa Barbara, CA