

**PG & RESEARCH DEPARTMENT
OF
BOTANY**

PG SYLLABUS

**Proposed Course Structure based on UGC - LOCF and TANSCH
(Choice Based Credit System)**

From the Academic Year 2022-2023



**J.J.COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)
PUDUKKOTTAI – 622 422**

Programme Outcomes - PG

At the End of the Programme, Post Graduates will have

1. Adequate domain **knowledge** and **critical thinking** to enrich it further by self study.
2. Developed discipline **specific skills** in reasoning, analysis and communication.
3. Acquired an aptitude for **research** in mono-disciplinary and multi-disciplinary areas.
4. Become **employable** in specific areas involving expertise.
5. Developed a keen sense of **professional and social ethics**.

Programme Specific Outcomes M.Sc. Botany

On completion of the programme,

1. students will be equipped to be knowledge creators in the field of life sciences, resulting in innovation and entrepreneurship, and employability in a variety of sectors.
2. capable of researching and developing biomolecular systems underlying life processes in health and illness.
3. able to conduct independent research in biology.
4. able to design and execute experiments, as well as assess and explain basic biological and environmental issues.
5. capable of effective conveying biological discoveries in a socio-ethical manner.

J.J. COLLEGE OF ARTS AND SCIENCE (Autonomous)
DEPARTMENT OF BOTANY M.Sc. BOTANY
Proposed Course Structure based on UGC - LOCF and TANSCHÉ
(Choice Based Credit System)

(Applicable for the candidates admitted from academic year 2022-2023 onwards)

Sem .	Sub.Code	Course	Subject Title	Hours/ Week	Credit	Internal	External	Marks
I	P1R2BOCC1	CC1	Plant Diversity I (Phycology, Lichenology & Bryology)	6	5	25	75	100
	P1R2BOCC2	CC2	Plant Diversity II (Pteridophytes, Gymnosperm, Angiosperm & Paleo Botany)	6	5	25	75	100
	P1R2BOCC3	CC3	Microbiology & Plant Pathology	6	5	25	75	100
	P1R2BOCC4P	CC4P	Practical- I (CC1, CC2 & CC3)	6	4	40	60	100
	P1R2BOEC1	DSE1	Discipline Specific Elective-1:1/1:2	6	4	25	75	100
Total				30	23	140	360	500
II	P2R2BOCC5	CC5	Anatomy, Embryology & Microtechniques	6	5	25	75	100
	P2R2BOCC6	CC6	Taxonomy of Angiosperms & Economic Botany	6	5	25	75	100
	P2R2BOCC7	CC7	Cell and Molecular Biology	6	5	25	75	100
	P2R2BOCC8P	CC8P	Practical-II (CC5,CC6 & CC7)	6	5	40	60	100
	P2R2BOEC2	DSE2	Discipline Specific Elective-2:1/2:2	6	4	25	75	100
Total				30	23	140	360	500
III	P3R2BOCC9	CC9	Plant Ecology, Conservation Biology, and Environmental Sustainability	5	5	25	75	100
	P3R2BOCC10	CC10	Genetics, Plant Breeding & Horticulture	5	5	25	75	100
	P3R2BOCC11	CC11	Plant Physiology & Biochemistry	5	5	25	75	100
	P3R2BOCC12	CC12	Plant Biotechnology and Green nanotechnology	5	5	25	75	100
	P3R2BOCC13P	CC13P	Practical – III (CC9, CC10, CC11 & CC12)	5	4	40	60	100
	P3R2BOEC3	SEC1	Skill Enhancement Course1:1/1:2	5	4	25	75	100
Total				30	28	165	435	600
IV	P4R2BOCC14	CC14	Research Methodology and Bioethics	6	5	25	75	100
	P4R2BOCC15P W	CC15	Project Work	18	8	-	-	100
	P4R2BOEC4	GEC1	Generic Elective Course 1	6	3	25	75	100
Total				30	16	50	150	300
Grand Total					90			1900

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DEPARTMENT OF BOTANY M.Sc. BOTANY
Proposed Course Structure based on UGC - LOCF and TANSCH
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(Applicable for the candidates admitted from academic year 2022-2023 onwards)

	Sl.No.	Code	Subject Title – Core Course
Semester-I	1.	P1R2BOCC1	Plant Diversity I (Phycology, Lichenology & Bryology)
	2.	P1R2BOCC2	Plant Diversity II (Pteridophytes, Gymnosperm, Angiosperm & Paleo Botany)
	3.	P1R2BOCC3	Microbiology & Plant Pathology
	4.	P1R2BOCC4P	Practical- I (CC1, CC2 & CC3)
Semester-II	5.	P2R2BOCC5	Anatomy, Embryology & Microtechniques
	6.	P2R2BOCC6	Taxonomy of Angiosperms & Economic Botany
	7.	P2R2BOCC7	Cell and Molecular Biology
	8.	P2R2BOCC8P	Practical-II (CC5,CC6 & CC7)
Semester-III	9.	P3R2BOCC9	Plant Ecology, Conservation Biology, and Environmental Sustainability
	10.	P3R2BOCC10	Genetics, Plant Breeding & Horticulture
	11.	P3R2BOCC11	Plant Physiology & Biochemistry
	12.	P3R2BOCC12	Plant Biotechnology and Green nanotechnology
	13.	P3R2BOCC13P	Practical – III (CC9, CC10, CC11 & CC12)
Sem. IV	14.	P4R2BOCC14	Research Methodology and Bioethics
	15.	P4R2BOCC15PW	Project Work

Sl. No.	Code	Subject Title
1.	P1R2BODSE1:1	Biofertilizers and Agriculture Sustainability
2.	P1R2BODSE1:2	Ethno Botany and Pharmacognosy
3.	P2R2BODSE2:1	Bio-instrumentation
4.	P2R2BODSE2:2	Entrepreneurial Botany
5.	P4R2BOSEC1:1	Organic, Indoor and Terrace Gardening
6.	P4R2BOSEC1:2	Herbal Recipes and Remedies
7.	P4R2BODGEC1	Intellectual Property Rights

SEMESTER I

Title of the Course: PLANT DIVERSITY - I (Phycology, Lichenology & Bryology)

Category of the course: Core Course

Course code: P1R2BOCC1

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To have comprehensive knowledge on lower plants
- To understand the diversity, reproduction and economic importance of lower plants
- To understand the evolutionary significance of lower plants
- To understand the structure of the microbes and their economic values in day to day life
- To know about the diversification in micro-plants

Unit – I: Phycology – Introduction, Classification and Thallus organization (14 hours)

Phycology- Introduction and brief history, Algology in India. Classification of algae (F. E. Fritsch, 1945). Ultra structure of Prokaryotic and Eukaryotic algal cells. Thallus organization and reproduction (vegetative, asexual, sexual); Ultra structure of cell, Flagella, Chloroplast, Pyrenoids and Eye Spot in major groups of algae. Types of Life cycle.

Unit – II: Ecology & Families (14 hours)

Algal Bioinoculant. Ecology of Algae: Freshwater algae, marine algae, terrestrial algae, symbiotic algae and parasitic algae, Comparative study of classes of Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Phylogeny of Fungi. Reduction and sexuality in Fungi.

Unit – III: Fungi – General characters, Classification & Reproduction (15 hours)

Fungi: General features, occurrence and distribution, Mode of nutrition and reproduction in fungi (vegetative, asexual and sexual), Classification of fungi (Ainsworth, 1973; Alexopoulos and Mims, 1979). General characters of major divisions-Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Ecology of fungi, Spore dispersal mechanisms, Economic importance of fungi.

Unit – IV: Lichens - General characters, Classification & Reproduction (15 hours)

Introduction to Lichens, Classification, Distribution, Types, Nature of Mycobionst and Phycobionts, Thallus organization, Reproduction, Biomedical applications, Economic importance, lichens as indicator for air pollution. Identification of lichens using ICT tools: Artificial intelligence, MATLAB software, Image processing techniques. Structure and life cycle of *Parmelia* and *Usnea*.

Unit – V: Bryophytes – General features, Reproduction & Economic importance (15 hours)

General features, distribution, Classification of Bryophytes, Origin of Bryophyta, evolution of gametophytes and sporophytes structural organization of gametophyte and sporophyte in different classes of Bryophytes, Reproduction, life histories of *Marchantia*, *Porella*, *Fossombronia*,

Anthoceros and Polytrichum, Bryophytes as pollution indicators, Economic importance of bryophytes, Fossil bryophytes.

Books for References

1. Hale, Jr. M. E., 1983, Biology of Lichens. Edward Arnold, Mayland.
2. Alexopoulos, C. J. and Mims, C. W. 1979. Introductory Mycology. Wiley Eastern Ltd.,
3. Bessey, E. A. 1979. Morphology and Taxonomy of Fungi. Vikas Publishers. New Delhi.
4. Smith, G.M. Cryptogamic Botany Vol. II
5. Weston, E. V. The Structure and Life of Bryophytes
6. South G.R. and A. Whittick 1987 Introduction to Phycology. Blackwell Scientific Publications, Oxford.
7. Vashista, Sinha B.R., Singh, V.P., 2002, Botany for Degree students, Algae 9th revised edition, S.Chand & Company Ltd., New Delhi.
8. Pandey B.P., 2000 Revised edition, Text Book of Botany Algae, S.Chand & Company, New Delhi.

Web Resources

1. <https://www.biologydiscussion.com/algae/classification-algae/classification-of-algae/49912>
2. <https://archive.bio.org/articles/biotechnology-and-algae>
3. <http://www.nou.ac.in/econtent/Msc%20Botany%20Paper%20IV/MSc%20Botany%20PaperIV%20Unit-1.pdf>

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	acquire the knowledge about structure and classification of algae, fungi, lichen and Bryophytes	K2
CO 2	understand the reproduction and life cycles of algae, fungi, lichen and Bryophytes	K4
CO 3	learn the families and examples of lower plants	K3
CO 4	Obtain the knowledge about digital tools for identification of lichens	K5
CO 5	Identify the economic importance of algae, fungi, lichen and Bryophytes	K4

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	1	2	2	3	1	1	18
CO 2	2	1	1	2	2	2	2	2	2	2	18
CO 3	2	2	1	1	1	2	2	2	2	1	16
CO 4	2	1	2	2	2	2	2	2	2	2	19
CO 5	2	2	1	2	1	1	1	3	1	3	17
											88/50

Mean Overall relationship is **1.76** which is **Medium**

SEMESTER I

Title of the Course: PLANT DIVERSITY - II (Pteridophytes, Gymnosperms and Palaeobotany)

Category of the course: Core Course

Course code: P1R2BOCC2

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To impart the knowledge about the occurrence, distribution, structure and life history of Pteridophytes and Gymnosperms
- To study of evolutionary trends in Pteridophytes
- Geological time scale and types of fossil preservation
- To study of terrestrial plants of the past era
- To learn importance of vascular cryptogams

Unit – I: Pteridophytes – General aspects & Stelar evolution (15 hours)

General characters, Classification by Reimers (1954) and life cycle, Theories of origin of sporophyte, and Telome concept, Sporangium development – eusporangiate and leptosporangiate type, Apogamy and Apospory. Detailed account on Stelar and solar evolution in pteridophytes, Heterospory and seed habit.

Unit – II: Pteridophytes – Morphology & Reproduction (14 hours)

Morphology, anatomy, reproduction and evolution of gametophytes and sporophytes of the following genera: *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Marsilea* and *Alsophila*

Unit – III: Gymnosperms - General aspects & Classification (15 hours)

General characters, Concept of Pro- gymnosperms, Classification of Gymnosperms (Sporne, 1965). Comparative study of Cycadopsida, Coniferopsida, and Gnetopsida. General characters and reproduction of the major groups of gymnosperms: Pteridospermals, Bennettitales, Pentaxylales, Cordaitales, Ginkgoales. Economic importance of Gymnosperms.

Unit – IV: Gymnosperms – Detailed study of major groups (12 hours)

A general account on distribution, morphology, anatomy, reproduction and life cycle of the following genera: Cycadopsida- *Cycas*; Coniferopsida- *Taxus*; Gnetopsida- *Gnetum*.

Unit – V: Palaeobotany – Fossils & Fossil forms (16 hours)

Geological time scale, Fossilization - Preservation of original remains, permineralization, molds and casts, replacement, and compression. Types of fossil, Carbon dating. Indian fossil flora- Rajmahal hill flora and the Deccan Intertrappean flora. Detailed study of the fossil forms: Pteridophytes- *Rhynia*, *Lepidodendron* and *Calamites*; Gymnosperms - *Lyginopteris*, *Williamsonia* and *Cordaite*s.

Books for Reference

1. Sharma, O. P. 2017. Pteridophyta, McGraw Hill Education, New York.
2. Rashid A. 2007. An Introduction to Pteridophyte, Vikaspublications, New Delhi.
3. Vasista PC, Sinha AK and Anilkumar, 2005. Botany for degree students, Gymnosperms, S Chand, New Delhi
4. Sporne K.R. 1972 – The morphology of Gymnosperm - BII Publications, Madras.
5. Vashita P.C. 1990 – Gymnosperms – S. Chand & Co. Ltd., India.
6. Arora, M.P. 1990. Evolutionary biology, Himalaya Publication House, Delhi. C.I.A. Arnold – An Introduction to Paleobotany.
7. Neale, D. B., Wheeler, N. C. (2019). The Conifers: Genomes, Variation and Evolution. Springer. <https://www.springer.com/gp/book/9783319468068>
8. SundaraRajan,S. - Introduction to Pteridophyta - New age International Publishers Ltd., Wiley Eastern Ltd., Madras.
9. Sharma, O.P. (1990) – Text Book of Pteridophyta, , Macmillan Indian Ltd., India

Web Resources

1. https://gurukpo.com/Content/B.SC/Pteridophytes_Gymnosperms_&Palaeobotany.pdf
2. <https://www.easybiologyclass.com/pteriophytes-free-online-study-materials-tutorials-lecturenotes-ppts-mcqs/>
3. <https://www.pteridoportal.org/portal/index.php>

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	Cognize the knowledge on structure and classification of pteridophytes, gymnosperms and palaeobotany	K2
CO 2	Acquire the reproduction and life cycles of vascular cryptogams	K2
CO 3	Realize the importance of vascular cryptogams	K2
CO 4	Understand the evolutionary feature of fossil and fossil forms	K3
CO 5	Attain the knowledge on economic importance of vascular cryptogams	K2

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	1	1	2	2	2	3	2	19
CO 2	1	1	2	2	2	3	3	2	2	2	20
CO 3	2	2	1	1	1	2	2	2	2	1	16
CO 4	1	1	2	2	2	3	2	2	2	2	19
CO 5	2	2	2	1	2	2	2	3	2	3	21
											95/50

Mean Overall relationship is **1.9** which is **Medium**

SEMESTER I

Title of the Course: MICROBIOLOGY & PLANT PATHOLOGY

Category of the course: Core Course

Course code: P1R2BOCC3

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To acquire knowledge on sub-microscopic organisms and their classifications
- To study the plant pathogen's life cycle, symptoms and control measures
- To understand the basic concepts, methods, scopes, characteristics, diseases and economic importance of microbes
- To learn about the pathogenic microorganisms and their mode of entry
- To study the useful microbes in our day today life.

Unit – I: Microbiology – Structure and Organization of Microorganisms (15 hours)

Scope, branches and history. Structure and organization of Bacteria, Actinomycetes. Brief study on Spirochetes, Rickettsias, Chlamydias and Mycoplasmas, Viruses – Structure, organization, replication. Brief account on Viroids, virusoids and prions. Culture of microorganisms: synchronous, batch and continuous culture. Chemostat and turbidostat, Methods of preservation of microbes.

Unit – II: Microbiology – Food & Dairy Microbiology (15 hours)

Food, dairy and environmental microbiology. Source of Microbial contamination of food; food poisoning and food-borne infections. Methods of food preservation. Microbial contamination of milk, milk-borne diseases - preservation of milk and dairy products. Soil microbes and their role in biogeochemical cycling.

Unit – III: Microbiology – Industrial Microbiology (15 hours)

Selection of industrially useful microbes, fermentation processes, recovery of end products; production of alcohol, insulin, lactic acid, single cell oil and single cell protein. Common immunizations, antibiotics and other chemotherapeutic agents and their mode of action. Drug resistance in microbes.

Unit – IV: Plant Pathology – General aspects (15 hours)

Concept of plant disease – definitions of disease, disease cycle and pathogenicity. General symptoms and Classification of plant diseases. History of Plant Pathology with special references to Indian work. Pathogenesis- pathogens and their mode of dissemination, pre-penetration, penetration and post penetration changes. Role of Chemical Weapons (Enzymes, Toxins and Growth regulators) in disease development.

Unit – V: Plant Pathology – Plant Diseases (12 hours)

Plant diseases: causal organisms, symptoms, disease cycle and control measures for the following diseases: White rust of Crucifers, Bacterial blight of paddy, yellow vein Mosaic of Bhindi, covered

smut of Barley, Spike disease in Sandal. Integrated Disease Management (IDM) –Plant diseases control: Cultural, physical, chemical and biological methods.

Books for References

1. Sullia, S.B. and Shantharam, S. 1998. General Microbiology. Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi Unit-II and Unit-III
2. Pelczar, M.J., Reid, R.D. and Chan, E.C.S. 1983. Microbiology, Tata McGraw Hill PublishingCo., New Delhi. Unit I
3. Prescott et al., 2009 7e, Microbiology. W.M.C. Brown Publishers.
4. Singh, RS. 2018. Introduction to Principles of Plant Pathology, 4th ed. Scientific International, Bengaluru, India.
5. Mehrotra, RS. and Aggarwal, A. 2017. Plant Pathology. McGraw Hill Publisher Co. Ltd., New Delhi.
6. Sharma PD. 2001. Microbiology and plant pathology, Rastogi publications, Meerut.
7. Rangasamy G. 1998. Diseases of crop plants in India. Prentice- Hall of India, New Delhi.
8. Mukherjee KG and Jayanti Bhasin, 1986. Plant diseases of India. Tata MacGraw-Hill, New Delhi.

Web Resources

1. <https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/fungi.html>
2. <https://www.apsnet.org/edcenter/disandpath/fungalasco/intro/Pages/IntroFungi.aspx>
3. <https://opentextbc.ca/conceptsofbiologyopenstax/chapter/fungi/>

Course Outcomes (CO)		K Level
After the completion of the course, student will able to		
CO 1	understand the types of microorganisms in an environment and their importance.	K1
CO 2	analyze the role of microorganisms in food processing and spoilage, soil fertility and sewage treatment	K4
CO 3	evaluate the role of microorganisms in industries	K5
CO 4	understand the plant diseases caused by the pathogens.	K3
CO 5	attain basic skills on aetiology and prevention of various plant diseases.	K4

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	2	2	2	3	2	21
CO 2	2	1	1	2	2	3	3	3	3	2	22
CO 3	2	2	2	2	2	2	2	2	2	2	20
CO 4	2	2	2	1	2	2	2	2	2	3	20
CO 5	2	1	2	2	1	2	2	3	2	2	19
											102/50

Mean Overall relationship is **2.04** which is **Medium**

SEMESTER I

Title of the Course: PRACTICAL – I (CC1, CC2 & CC3)

Category of the course: Core Course

Course code: P1R2BOCC4P

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course objectives

- To learn identification of lower and primitive groups of plants
- To learn the identification and description of specimens belonging to higher cryptogams
- To learn slide preparation techniques of stelar plants
- To understand the fossil plants by means of permanent slides
- To identify the plant diseases and causal organisms

Algae

1. Microalgae sample collection, Isolation technique and identification (only microscopic algae)
2. Medium preparation for fresh water algae and marine water algae.
3. Permanent slide preparation.
4. Microscopic observation of algae and their slides included in the syllabus.
5. Sectioning of available algal specimens included in the syllabus.

Fungi

1. *Plasmodiophora*, *Rhizopus*, *Fusarium*, *Pilobolus*, *Xylaria*, *Aspergillus*, *Penicillium*, *Agaricus* and *Peziza*.
2. Microscopic observation of slides of genera include in the syllabus.
3. Isolation of pathogenic microorganisms from infected tissue.

Lichen

Microscopic observations of an anatomical structure of *Usnea*.

Bryophytes

Morphological and anatomical study of representatives of the following: Marchantiales, Jungermanniales, Anthoceretales, Sphagnales, Funariales and Polytrichales.

Pteridophytes

Psilotum, *Lycopodium*, *Selaginella*, *Equisetum*, *Alsophila* and *Marsilea* - A study of the morphology, anatomy of the vegetative and reproductive parts of the sporophytes and gametophytes of living.

Gymnosperms

Cycas, *Cupressus*, *Gnetum* - A study of the morphology, anatomy of the vegetative and reproductive parts of living genera included in the syllabus

Paleobotany

Rhynia, Lepidodendron, Calamites, Lyginopteris, *Williamsonia*, Cordaites.

Observation of slides of fossil forms given in the syllabus.

Microbiology

1. Isolation of microbes from soil and water – serial dilution and plating technique
2. Isolation of Rhizobium from root-nodules of legumes
3. Gram staining of bacteria found in curd
4. Microbial analysis of milk by methylene blue reduction test

Plant Pathology

Little leaf of Brinjal, Rice blight, Tikka disease, Wilt of cotton, Ring rot of potato

SEMESTER II

Title of the Course: ANATOMY, EMBRYOLOGY & MICROTECHNIQUES

Category of the course: Core Course

Course code: P2R2BOCC5

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To know all about the primary tissues and anatomical features of plants
- To acquire knowledge about the embryology of Angiosperms
- To understand the primary, secondary and anomalous, anatomical structure of plant parts
- To know the various types of pollination mechanism
- To learn the micro-techniques

Unit – I: Anatomy – Tissue systems & Secondary growth (15 hours)

Meristems – Types (shoot and root). Procambium - Cambium, Vascular cambium - origin, types, structure and etiology. Complex tissues - Secondary xylem - ontogeny, arrangement of vessels in secondary. Xylem, Growth rings. Secondary phloem - structure and function and ontogeny. Periderm formation- lenticels. Anomalous secondary thickening in dicot and monocot stems. *Aristolochia*, *Boerhaavia* and *Dracaena*. Secondary structure and vascular differentiation of root.

Unit – II: Wood Anatomy & Nodal Anatomy (15 hours)

Shoot and root transition – Ontogeny of Dorsi-ventral and Isobilateral leaf. Nodal anatomy- uni, tri and multilacunar nodes. Structure, identification, classification and uses of woods – physical, chemical and mechanical properties of wood – defects in wood – natural defects – knots – reaction wood – compression and tension wood - wood preservation.

Unit – III: Embryology – Development of male & female gametophyte (15 hours)

Microsporogenesis, compatibility, Megasporangium, Megasporeogenesis and female gametophyte, pollen stigma, Sexual Incompatibility, nutrition of embryo-sac, endosperm types, Apomixis, agamospory and apospory – polyembryony and apomixis in plant improvement.

Unit – IV: Embryology – Morphogenesis (15 hours)

Morphogenesis- Definition, morphogenesis and its relation to morphology, Turing's diffusion reaction theory, Morphogenetic factors - growth regulators, genetic and environment, polarity. Molecular basis of morphogenesis, Cellular level morphogenesis, Morphogenesis at tissue level - Differentiation, dedifferentiation and redifferentiation of vascular tissue in vitro and in vivo and in wounds. Plant galls and their importance in morphogenesis.

Unit – V: Micro-techniques and Staining and Fixation (12 hours)

Principle and preparation techniques. Special techniques– Maceration, Squashes, Smears, Whole mount and clearing techniques. Micro techniques – Fixation and fixatives, dehydration, clearing, infiltration, embedding, block making and sectioning.

Books for References

1. Easu K Plant Anatomy, Wiley Eastern Ltd, New Delhi.
2. Kollmann Wood Science and Technology, Vol I & II.
3. Bhojwani SS and Bhatnagar SP, The Embryology of Angiosperms, Vikas publishing house Pvt. Ltd., New Delhi
4. Pattel LR, Bhalachander BL and Jeeraji H An introduction to microtechnique, S. Chand & S. Chand & Co. Pvt. Ltd., New Delhi.
5. Crang, R., Lyons-Sobaski, S., Wise, R. (2018). Plant Anatomy. Springer. <https://www.springer.com/gp/book/9783319772080>.
6. Gutter G Plant Anatomy, Edward Arnold Publications Ltd., London
7. Fahn A Plant Anatomy, Pergamon press, Oxford.
8. Maheswari P An introduction to the Embryology of Angiosperms, Tata McGraw Hill Publishing Co, Ltd., New Delhi

Web Resources

1. <https://www.biology-pages.info/P/PlantTissues.html>
2. https://academic.oup.com/plcell/article/16/suppl_1/S46/6010562
3. <http://mgcub.ac.in/pdf/material/20200501064652545422c4ae.pdf>

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	Obtain knowledge on tissue system of plants	K2
CO 2	Understand the secondary growth and abnormal growth of plants	K4
CO 3	learn the anatomical features of wood and nodal anatomy	K2
CO 4	acquire the knowledge on development of male and female gametophytes and morphogenesis of plants	K4
CO 5	handle the equipment's to using microtechniques	K5

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	3	3	2	2	3	23
CO 2	2	1	2	2	2	3	3	3	3	2	23
CO 3	2	2	2	2	2	2	2	3	1	2	20
CO 4	2	2	2	2	2	2	3	2	3	1	21
CO 5	2	1	2	2	1	2	2	3	3	2	20
											107/50

Mean Overall relationship is **2.14** which is **Medium**

SEMESTER II

Title of the Course: TAXONOMY OF ANGIOSPERMS & ECONOMIC BOTANY

Category of the course: Core Course

Course code: P2R2BOCC6

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To know about the classification and nomenclature
- To learn about plant identification and description
- To understand the molecular taxonomy
- To be aware of the selected families and their characters
- To know about the economic importance of the selected plants

Unit – I: General aspects & Classification system (15 hours)

Taxonomy - Definition and concepts, Scope and importance. History of Plant Classification- Artificial – Linnaeus, Natural – Bentham & Hooker, Cronquist, Phylogenetic – Engler & Prantl, Hutchinson and Angiosperm Phylogeny Group – Outline of APG system – APG IV.

Unit – II: Hierarchy & Botanical Nomenclature (12 hours)

Taxonomic Hierarchy: Ranks of Taxa, Species, Genus, and Family concepts. ICN: Brief history, Principles, Scientific names, Principle of priority, typification, valid and effective publication, conservation and rejection of names.

UNIT – III: Taxonomic tools & Modern trends (15 hours)

Herbarium, Botanical Gardens and their role in teaching, research and conservation; important herbaria and botanical gardens of the world and India, Flora, Monograph and Taxonomic revisions. Important websites for taxonomic literature. Modern trends in Plant Taxonomy: Chemotaxonomy. Numerical Taxonomy, Cladistics - Molecular taxonomy, DNA barcoding in plants.

Unit – IV: Detailed study of Angiosperm families (18 hours)

Salient features, interrelationships, economic importance and classification as per APG-IV of the following groups and families- ANITA grade: Nymphaeaceae, MAGNOLIIDS: Annonaceae, MONOCOTS: Araceae, Commelinaceae, Poaceae, EUDICOTS: Menispermaceae, CORE EUDICOTS: Phyllanthaceae, ROSIDS: Cleomaceae, SUPERASTRIDS: Caryophyllaceae, Amaranthaceae, ASTRIDS: Convolvulaceae, Lamiaceae, Acanthaceae, Asteraceae.

Unit – V: Economic Botany (12 hours)

Economic Botany: Food crops – Cereals (Rice, Wheat), Millets (Sorghum, Pearl), Legumes, Nuts and tropical fruits, Sugar yielding crops – Spices – Beverage plants – Minor forest products – Resins, gums and rubber yielding plants – Oil yielding plants (Castor, Ground nut) – fibre yielding plants (Jute).

Books for References

1. Lawrence GHM. 1967. Taxonomy of Vascular Plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Sambamurthy AVSS. 2005. Taxonomy of Angiosperms. I.K. International Pvt. Ltd., New Delhi.
3. Gupta RK. 2006. Text Book of Systematic Botany. CBS Publishers & Distributors, New Delhi
4. Pandey BP. 1978. Economic Botany. S. Chand & Company Ltd., New Delhi.
5. Turland, N.J. et al. 2018. International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile 159. Glashütten: Koeltz Botanical Books.
6. APG IV 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society, 181,

Web Resources

1. <https://www.biologydiscussion.com › essay › taxonomy>
2. <https://www.wileyindia.com/taxonomy-of-angiosperms.html>
3. <https://www.easybiologyclass.com/angiosperm-systematics-and-taxonomy-free-online-studymaterials-and-lecture-notes/>

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	reminiscence of the System of Classification of Angiosperms.	K2
CO 2	gain the knowledge about different ranks, nomenclature of the plants and Taxonomic judgments.	K4
CO 3	acquire the knowledge on herbarium techniques, management and molecular taxonomy	K6
CO 4	get the knowledge on characters and economic importance of Angiosperm families	K4
CO 5	Understand the importance of food crops and forest products.	K2

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	3	3	2	2	2	22
CO 2	2	1	2	2	2	3	2	3	2	2	21
CO 3	2	2	2	2	2	2	2	2	2	3	21
CO 4	2	2	2	2	1	3	3	2	2	1	20
CO 5	2	2	2	2	1	2	2	3	2	2	20
											104/50

Mean Overall relationship is **2.08** which is **Medium**

SEMESTER II

Title of the Course: CELL & MOLECULAR BIOLOGY

Category of the course: Core Course

Course code: P2R2BOCC7

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Credits: 5

Hrs / Week: 6

Total Inst. Hrs: 72

Course Objectives

- To learn about the structure and function of eukaryotic plant cells
- To acquire knowledge on molecular level of organelles
- To understand the basic ideas on cell cycle
- To learn about the basic interactions of the organelles
- To study the gene regulation and silencing

Unit-I: Cell Biology (15 hours)

Phases and control system of cell cycle, Cell cycle checkpoints - DNA damage, centrosome duplication, spindle assembly. Cyclins and Cyclin-dependent kinases, apoptosis. Cytoskeleton structure and functions: actin filaments (microfilaments), microtubules, and intermediate filaments.

Unit-II: Cell Biology – Cell signaling & Protein receptors (12 hours)

Cell communication: general principles, Signaling molecules and their receptors. Receptors: Cell surface receptors - ion-channel linked receptors, G-protein coupled receptors, and Tyrosine-kinase linked receptors (RTK), Programmed cell death.

Unit-III: Transcription (15 hours)

Transcription: RNA polymerases and their role. Transcription signals - promoters and terminators. Detailed account of transcription in *E. coli* and eukaryotes. Differences between the prokaryotic and the eukaryotic transcription, Post transcriptional modifications of mRNA (5'CAP formation, poly adenylation, spliciosome assembly, splicing editing). Organization of mRNA, RNA editing, mRNA export.

Unit-IV: Translation (15 hours)

Translation: Genetic code – introduction, important features of the genetic code, exceptions to the standard code. Mechanism of translation in prokaryotes and eukaryotes. Differences between prokaryotic and eukaryotic protein synthesis. Protein sorting and translocation: Post-translational modification of proteins, Protein folding-self-assembly and role of chaperones.

Unit-V: Gene regulation (15 hours)

Gene regulation: Operon model - Inducible and repressible systems. Attenuation, positive and negative regulation. *Lac* and *trp* operons of *E. coli*. Regulation of eukaryotic gene expression. Gene families and hormonal control in eukaryotes. Gene silencing: transcriptional and post transcriptional gene silencing

Books for References

1. Verma P.S and V.K. Agarwal- S. Genetics- Chand & Co., Pvt. Ltd., New Delhi (2009).
2. Gardner, Simmons and Snustad. Principles of Genetics-John Wiley and Son (Asia) Pvt, Ltd. (2006).
3. De Robertis, E.D.P. and De Robertis, E.M.F. (2006).Cell and Molecular Biology. VIII Edition. Lippincott.
4. Gupta, P.K. (2015) - A Text Book of Cell & Molecular Biology, Rastogi Publications.
5. Varshney, R. K. (Ed), Pandey, M. K. (Ed), Chitikineni, A. (Ed) (2018). Plant Genetics andMolecular Biology. Springer.
6. Yamaguchi, N. (Ed) (2018). Plant Transcription Factors. Springer.

Web Resources

1. <https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article>
2. <https://microbenotes.com/types-of-microscopes/>
3. <https://www.nature.com/scitable/topicpage/mitosis-and-cell-division-205/>

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	obtain the knowledge on cell cycles and cytoskeleton	K2
CO 2	understand the importance of DNA synthesis	K4
CO 3	acquire the knowledge on cell signaling and receptors	K2
CO 4	Understand the protein synthesis in prokaryotic and eukaryotic cells	K3
CO 5	attain the knowledge on operon models and gene silencing	K2

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	2	3	3	1	2	21
CO 2	2	2	2	2	2	2	2	3	3	3	23
CO 3	2	2	2	2	1	2	2	2	2	3	20
CO 4	2	2	2	2	2	2	3	3	2	2	22
CO 5	2	2	2	2	1	2	2	3	2	3	21
											107/50

Mean Overall relationship is **2.14** which is **Medium**

SEMESTER II

Title of the Course: PRACTICAL – II (Covering CC5, CC6 & CC7)

Category of the course: Core Course

Course code: P2R2BOCC8P

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To observe internal organization of plant body
- To understand primary, secondary and anomalous structure of plant parts
- To observe the pollen morphology and types of pollens
- To identify the plants under natural environment
- To get knowledge on preparation of Herbarium

Taxonomy

1. Examination of binomial name using flora.
2. Workout the key preparation.
3. Study of plants belonging to the families given in the theory syllabus.
4. Submission of 5 herbarium sheets of common plants with tour report.

Anatomy

1. Dissection of shoot apex in *Hydrilla* and whole mount
2. Demonstration of primary pit-fields in Onion epidermal peel
3. TS and LS of phloem stained with aniline blue or Lacmoid blue or Coumassie brilliant blue.
4. Identification of different types of stomata – monocot and dicot types

Economic Botany

Study of the following economically important plants: botanical name, family and morphology of useful parts Cereals -Rice, Wheat and Maize, Millets – Sorghum, Ragi and Bajra, Pulses: Black gram and Red gram. Spices: Cinnamon, Cardamom, Clove. Condiments – Chilli, Cinnamon, Pepper. Essential oil: Eucalyptus oil, Lemon grass oil. Edible oil: Palm oil, Ground nut oil. Fibres – Coir, Jute. Resin – Asafoetida. Medicinal - Neem and *Ocimum*. Food additives and colors – Saffron.

Embryology

1. Dissection of endosperm haustoria – Cucurbitaceae – *Cucumis*.
2. Dissection of embryo – *Tridax* / *Crotalaria*.

Ethnobotany

1. Field study (local & outside) – submission of field reports with photographs of ethnobotanical importance.

Cell and molecular biology

1. Squash and smear techniques – onion root tip and Rheo flower buds.
2. DNA isolation from Coconut endosperm and Onion bulb.

Genetics

1. Working out the problems in genetics and drawing of genetic charts.
2. Determination Rh+ Factors.

SEMESTER III

Title of the Course: PLANT ECOLOGY, CONSERVATION BIOLOGY & PHYTOGEOGRAPHY

Category of the course: Core Course

Course code: P3R2BOCC9

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To gain advanced knowledge about plants and their environment
- To study the various plant ecosystems and their impact on society
- To understand the effective measures in biodiversity conservation programmes
- To learn the plant geography distribution in Indian Vegetation.
- To study the Red List categories

Unit-I: Ecology - General aspects & Population studies (15 hours)

Introduction to ecology, Ecosystem structure and dynamics - food chain and food webs, energy flow. Mineral cycling (C, N & P). Plant succession – types and mechanism, Concept of climax vegetation, ecological indicators. Characteristics and dynamics of population- population size, growth, density and age structure.

Unit-II: Ecology – Climate change (12 hours)

Greenhouse effect - global warming, global climatic changes and consequences. Climate change conferences - role of UNFCCC and IPCC. Paris 2015 COP21: legality and respective capabilities, long-term goal, mitigation, carbon markets, transparency, compliance, adaptation. Carbon economy and carbon credits.

Unit-III: Ecology – Biodiversity (15 hours)

Biodiversity: types - species, genetic, ecosystem and habitat. Importance of genetic diversity with reference to crops and farm animals. Preserving the crop genetic resources-germplasm collections and the Svalbard Global Seed Vault. Centres of origin of diversity - Vavilov's and FAO's.

Unit-IV: Conservation Biology (15 hours)

Conservation: approaches - *in situ* and *ex situ* and their evaluation. Biodiversity - importance, assessment, loss and conservation. World organization for conservation of biodiversity, biodiversity act (2002), Red List categories of IUCN, means and ways for conservation.

Unit-V: Phytogeography (15 hours)

Geographical history, continental drift hypothesis, land bridges and shifting of poles. Phytogeographic regions of India. Theory on plant distribution - Age and area theory, Tolerance. Concepts of endemism and hotspots, invasive and exotic species.

References

1. Sharma, P.D. 2010. Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
2. Eugene Odum, 2017. Fundamentals of Ecology 5th Ed. Cengage, Bengaluru.
3. Sharma P.D. 2019. Plant ecology and phytogeography, Rastogi Publications, Meerut.
4. Alexander von Humboldt, Aime Bonpland, and Stephen T. Jackson (eds.) 2013. Essay on the Geography of Plants, University of Chicago Press.

Web Resources

1. <https://nios.ac.in/media/documents/SrSec314NewE/Lesson-25.pdf>
2. [https://dducollegedu.ac.in/Datafiles/cms/ecourse%20content/PK%20\(AECCEVS\)%20Chapter%20-%204%20Biodiversity.pdf](https://dducollegedu.ac.in/Datafiles/cms/ecourse%20content/PK%20(AECCEVS)%20Chapter%20-%204%20Biodiversity.pdf)
3. <https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=79946&printable=1>

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	attain the knowledge on importance of minerals cycles	K2
CO 2	Interpret the community ecology and ensure the vegetation analysis	K4
CO 3	Understand the impact of global warming	K3
CO 4	conserve the biodiversity and IUCN red list species	K5
CO 5	Obtain the knowledge on phytogeography and evolution concepts	K4

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	1	2	2	2	2	2	2	3	2	20
CO 2	1	2	1	2	2	3	3	1	3	3	21
CO 3	2	2	2	1	2	2	2	2	2	2	19
CO 4	1	1	2	2	2	2	2	2	2	2	18
CO 5	2	2	1	2	1	1	1	3	3	2	18
											96/50

Mean Overall relationship is **1.92** which is **Medium**

SEMESTER III

Title of the Course:	GENETICS, PLANT BREEDING & HORTICULTURE	
Category of the course:	Core Course	
Course code:	P3R2BOCC10	
Nature of the course:	Skill Development	
Marks: CIA: 25 + Ext: 75 = 100		Hrs / Week: 6
Credits: 5		Total Inst. Hrs: 72

Course Objectives

- Study the basic principles and applications of genetics
- To study the basic principles and breeding techniques in horticulture crops
- To learn about the as various vegetative propagation techniques
- To understand the concept of garden making
- To learn about landscaping techniques and their implication

Unit-I: Genetics (16 hours)

Mendel and his work: Laws of inheritance. Back cross and Test cross. Gene interaction and Modified Mendelian ratios. Quantitative inheritance and multiple alleles. Problem solving in genetics. Linkage and crossing over, 3-point cross and gene mapping methods. DNA is the genetic material: Griffith's experiment, Avery et al., and Hershy and Chase experiment; RNA as genetic material - Experiment of Fraenkel and Singer.

Unit-II: Genetics – DNA structure & models (12 hours)

Organization of eukaryotic and bacterial genomes- transformation, transduction (generalized and specialized), conjugation (F factor mediated, Hfr and Sexduction). Fine structure of the Gene: Cistron, muton and recon, Watson and Crick model of DNA helix, Semi-conservative replication mechanism of DNA: replication of linear and circular DNA, Replication of RNA genomes.

Unit-III: Genetics – DNA repair mechanism & Genomics (12 hours)

Molecular mechanisms of DNA repair. Mobile genetic elements- IS elements and transposons in maize and bacteria. Beneficial and harmful effects of mutations. Population genetics: gene frequency, gene pool, Hardy–Weinberg equilibrium. Gene frequencies-conservation and changes. Decline of human gene pool and eugenics. Genomics: Arabidopsis genome and rice genome. Gene therapy with reference to Haemophilia, Stem cells- Definition, types & sources.

Unit-IV: Plant Breeding – Breeding methods & Hybridization (17 hours)

Historical aspect of plant breeding and genetic basis. Breeding methods- sexual, asexual and apomitic reproduction. Floral Biology in relation to selfing and crossing techniques. Centres of diversity and origin of cultivated plants. Role of National and International Institutes. Hybridization: Objectives, Choice of parents, problems and causes of failure of hybridization. Incompatibility and sterility, Methods of handling genetic consequence of hybridization, handling segregation material for isolation of superior strains. Role of interspecific and intergeneric hybridization in plant improvement.

Unit – V: Horticulture**(15 hours)**

Importance and scope of horticulture; divisions of horticulture; climate, soil and nutritional needs. Plant propagation methods - Cutting, Grafting, Budding and Layering. Natural horticultural gardening in India. Indoor gardening. Terrarium, Bonsai and topiary plants. Floriculture – cultivation of commercial flower crops. Landscaping principles - planning design for house gardens. Lawns: different grasses, maintenance of lawns and rockeries.

Books for References

1. Manibushan Rao K. 1991. Text book of horticulture. MacMillan Publishing Co., New York.
2. Edmond JB et al., 1977. Fundamentals of horticulture. Tata McGraw Hill Ltd., New Delhi.
3. Rao KM. 2000. Text Book of Horticulture, MacMillan India Ltd., New Delhi.
4. Gopalswamy Iyyangar, 1970. Complete gardening in India, Kalyan Printers, Bangalore
5. Gardner E J, Simmons M J, Snustad D P (1991). Principles of Genetics (III Edn). John Wiley and Sons Inc. 8th Edn., New York.
6. D Peter Snustad and Michael J Simmons (2010). Principles of Genetics. John Wiley & Sons.
7. Verma, P.S. & V.K. Agarwal, 2003, Genetics. S. Chand, New Delhi.
8. Chaudhari, R. C. 2017. Introductory Principles of Plant Breeding, Kindle Edition.
9. Singh, P. 2017. Fundamentals of Plant Breeding, Kalyani Publishers.

Web Resources

1. http://agritech.tnau.ac.in/horticulture/horti_landscaping.html.
2. https://agritech.tnau.ac.in/horticulture/horti_Landscaping_principles.html
3. http://apeda.gov.in/apedawebsite/SubHead_Products/Floriculture.html

Course Outcomes		K Level
After the completion of the course, student will able to		
CO 1	understand the basic principles of genetics	K1
CO 2	learn the DNA structure and principles of genomics	K3
CO 3	Demonstrate the hybridization techniques	K2
CO 4	get employment in agriculture and horticulture centres and plant breeding centre	K4
CO 5	Run nursery gardens	K5

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	2	3	3	3	3	24
CO 2	2	2	2	2	2	3	3	1	3	3	23
CO 3	2	2	2	1	2	2	3	2	2	2	20
CO 4	1	1	2	2	2	2	3	3	3	3	22
CO 5	2	2	1	2	2	1	1	3	3	3	20
											109/50

Mean Overall relationship is **2.18** which is **Medium**

SEMESTER III

Title of the Course: PLANT PHYSIOLOGY & BIOCHEMISTRY

Category of the course: Core Course

Course code: P3R2BOCC11

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Credits: 5

Hrs / Week: 6

Total Inst. Hrs: 72

Course Objectives

- To gain knowledge about plant bio molecules
- To understand different pathways occurring in a cell
- To get an advanced integral knowledge and understanding of topics in Biophysics and Biochemistry
- To acquire basic knowledge about physiological process

Unit-I: Water plant relation

(15 hours)

Plant water relations: diffusion, osmosis, water potential, absorption of water – Ascent of sap. Transpiration, mechanism of stomatal movement. Mineral Nutrition: Passive and active transport, Nutrient uptake and role of cell membrane, ion pump and carrier, salt stress on crop production. Pathway and translocation of phloem.

Unit-II: Photosynthesis

(15 hours)

Photosynthesis: Ultra structure of photosynthetic apparatus, the light reactions, electron transport pathway in chloroplast membrane, photophosphorylations, C₄ carbon cycle, crassulacean acid metabolism, photorespiration. Respiration: Glycolysis, TCA cycle and electron transport in mitochondria, oxidative phosphorylation, pentose phosphate pathway – cyanide resistant respiration.

Unit-III: Nitrogen Metabolism

(12 hours)

Nitrogen metabolism: Biological nitrogen fixation, reduction of nitrogen into ammonia, nif genes, regulation of nitrate reductase and nitrogenase, nitrate and ammonium assimilation. Growth and development: Physiological effect and mode of action of phytohormones – Auxins, ABA, Gibberellins and Ethylene.

Unit-IV: Biomolecules

(15 hours)

Structure of atoms, molecules and chemical bonds. Carbohydrates: General classification, Synthesis and breakdown of carbohydrates (starch, glycogen, pectin, Glucose). Amino acids and proteins: General classification of amino acids and proteins, Structure, synthesis and properties of amino acids, protein structure, Ramachandran plot.

Unit-V: Enzymology

(15 hours)

Properties of Enzymes, General classification, Coenzyme, Isozymes, Prosthetic group. Mode of Enzyme action, Mechanism of Enzyme action. Factors affecting enzyme activity, Enzyme Kinetics, Michaelis – Menton equation, Competitive, uncompetitive, noncompetitive and Allosteric inhibition.

Books for References

1. William G. Hopkins & Norman P.A. Hiuner. 2009. Introduction to Plant Physiology. 4th edition. John Wiley & Sons.
2. Frank B. Salisbury & Cleon W. Ross. 2003. Plant Physiology. 3rd edition. CBS Publishers and Distributors, New Delhi, India
3. S.N. Pandey & B.K. Sinha. 2006. Plant Physiology. 4th edition. Vikas Publishing House PVT Ltd. New Delhi, India
4. R.K. Sinha. 2004. Modern Plant Physiology. Narosa Publishing House, New Delhi, India
5. V.K. Jain. 1974. Fundamental of plant Physiology. S. Chand and Company Limited, New Delhi, India.
6. Stryer Lubert, 2005, Biochemistry, W.H. Freeman & Co., NY.
7. Lehninger, Principles of Biochemistry by Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008), 5th Edition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and Company, New York, p: 677-878.
8. Biochemistry by Donald Voet, Judith G. Voet, Publisher: John Wiley & Sons (2011), Fourth Edition, ISBN-10: 0071737073, ISBN-13: 978-0071737074

Web Resources

1. <http://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf>
2. <http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4>
3. http://employees.csbsju.edu/ssaupe/biol327/Lecture/mineral_nutrition.htm

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	asses the physiological process of higher plants	K2
CO 2	evaluate the nitrogen metabolism and plant growth regulators	K5
CO 3	Understand the principles of photosynthesis in plants	K2
CO 4	evaluate the importance of secondary metabolites to humanity	K5
CO 5	attain the knowledge on role of enzymes in biological systems	K4

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	3	3	3	3	3	25
CO 2	2	2	2	2	2	3	2	3	3	2	23
CO 3	2	2	2	1	2	2	3	2	2	2	20
CO 4	1	2	2	2	2	3	3	3	2	3	23
CO 5	2	2	2	2	2	1	1	3	3	3	21
											112/50

Mean Overall relationship is **2.24** which is **High**

SEMESTER III

Title of the Course: PLANT BIOTECHNOLGY & GREEN NANOTECHNOLOGY

Category of the course: Core Course

Course code: P3R2BOCC12

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To understand the scope and importance application of biotechnology
- To know about the vectors and their mechanisms
- To have basic ideas on plant genome organization
- To gain the principles of r-DNA technology
- To study the importance of Nanotechnology

Unit – I: Plant Tissue Culture

(15 hours)

Definitions, scope, history, importance of plant tissue culture & biotechnology. In vitro culture techniques: Sterilization methods, Culture media - composition, types of medium and role of hormones in in-vitro culture, Initiation, maintenance and acclimatization. Micropropagation, Anther, Embryo, Callus, Suspension culture and its significance. Somatic embryogenesis and synthesis of artificial seeds. Protoplast culture. Plant protoplasmic isolation and fusion in hybrid production. Somaclonal variation.

Unit – II: Gene transformation

(15 hours)

Genetic organization of Ti plasmids - Functions encoded by integrated T- DNA. Molecular mechanism involved in transfer of T- DNA into plants. Gene delivery system: Genetic transformation of plants by *Agrobacterium*. Physical methods: Particle gun bombardment, microinjection, electroporation. Importance of promoter and marker genes in plant transformation. Concerns regarding the use of different promoters and selectable markers.

Unit – III: Gene mapping

(12 hours)

Plant genome mapping: Molecular markers (RFLP, RAPD, SSR& SNP) and its applications. Transgenic plants for resistance to insect and herbicide. Plant Molecular Farming: Production of plantibodies and pharmaceuticals (Golden rice). IPR, Biosafety and bioethics.

Unit – IV: Nanotechnology

(15 hours)

Nanotechnology – definition, origin, scope and importance. Principles: quantization effects - inverse relationship between size and reactive surface area. Properties: surface effects, the effects of size, shape and surface area. Advances made with plant nanobionics-bomb detection, glowing plants, augmented photosynthesis, etc. Essentials of nanostructure generation: top-down vs. bottom-up. Physical, chemical and biogenic synthesis of nanomaterials - biomimetics, green plants and microorganisms. Role of biomolecules - reducing and/or capping agents: proteins, viruses and carbohydrates.

Unit – V: Nanotechnology**(15 hours)**

Interactions between nanoparticles and living systems, interaction with cells, exposure of living systems to nanomaterials - toxicity effects. Mediators of the toxicity of particles. Factors influencing the interaction of nanomaterials over mammalian cells: uptake, transport and biodistribution of nanoparticles in living system, toxicity on cellular processes. Overview of EU regulatory aspects.

Books for References

1. Sharon, M. & Sharon, M 2012. Bio-Nanotechnology- Concepts and Applications, CRC Press.
2. Atkinson WI.2011. Nanotechnology. Jaico Book House, New Delhi.
3. Satyanarayanan, U. 2010. Biotechnology, Books and allied (p) Ltd.,
4. Bhojwani, and Razdan, M.K, 2009. Tissue Culture Theory and Practice.
5. Chawla, H.S. Biotechnology in crop improvement. International Book distributing Company(2007).
6. Guptha, P.K. Elements of Biotechnology. Rastogi and Co. Meerut, (2006).
7. Abdin, M. Z. (Ed), Kiran, U. (Ed), Kamaluddin, M. (Ed), Ali, A. (Ed) (2017). PlantBiotechnology: Principles and Applications. Springer.

Web Resources

1. <https://www.cambridge.org/core/journals/genetics-research/article/principles-of-genemanipulation-and-genomics-7th-edition>
2. <http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3>
3. <http://www.bio-nica.info/biblioteca/OksmanCaldentey2002PlantBiotechnology.pdf>

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	establish the tissue culture technique	K5
CO 2	understand the gene transformation using plasmids	K4
CO 3	obtain the knowledge gene mapping using molecular markers	K3
CO 4	acquire the knowledge on principles and importance of nanotechnology	K4
CO 5	Learn the interaction between nanoparticles and living system	K4

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	1	3	2	3	3	2	22
CO 2	2	2	2	2	2	3	2	2	3	2	22
CO 3	2	1	2	2	2	2	3	2	2	2	20
CO 4	2	2	2	2	2	3	3	3	3	3	25
CO 5	2	2	2	2	2	3	2	3	3	3	24
											113/50

Mean Overall relationship is 2.26 which is **High**

SEMESTER III

Title of the Course: PRACTICAL – III (Covering CC9, CC10, CC11 & CC12)

Category of the course: Core Course

Course code: P3R2BOCC13P

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 5

Total Inst. Hrs: 72

Course Objectives

- To perform double stained permanent slide mounting
- To have a practical exposure on violating the DNA from plant materials
- To perform the experiments on photosynthesis, respiration and growth of plants
- To identify amount of sugar total lipids, free amino acids and total proteins
- To acquire practical knowledge and evaluation the ecological diversity

Plant Breeding, Horticulture and Landscape design

1. Charts display: mass selection, pure line selection, backcross breeding and double cross in Maize
2. Study of different kinds of plant propagation
3. Basic propagation techniques - Cutting, Layering, grafting micro grafting

Plant Ecology, Conservation Biology, Phytogeography and Forestry

1. Analysis of vegetation by quadrat / line transect method Estimation of primary production in the given water sample by the light – dark bottle method
2. Estimation of carbonate, bicarbonate and chloride content in water samples

Plant Physiology Experiments

1. Estimation of water potential in different tissues
2. Estimation of Chlorophyll a, Chlorophyll b and total chlorophyll by Arnon method
3. Determination of carotenoids
4. Estimation of titrable and total acidity
5. Estimation of proteins by Lowry's method
6. Determination of Ascorbic acid content (Titrimetric method)

Biochemistry Experiments

1. Extraction and estimation of starch
2. Extraction and estimation of lipids
3. Determination of reducing sugars in fruits (grapes)
4. Estimation of amino acids by paper chromatography

Plant Biotechnology

1. Preparation of MS medium
2. Plant tissue culture techniques – Direct and Indirect organogenesis
3. Isolation of total genomic DNA from plant tissue.
4. Agarose gel electrophoresis
5. Spotters related to PCR.

SEMESTER IV

Title of the Course: RESEARCH METHODOLOGY & BIOETHICS

Category of the course: Core Course

Course code: P4R2BOCC14

Nature of the course: Skill Development

Marks: CIA: 25 + Ext: 75 = 100

Credits: 5

Hrs / Week: 6

Total Inst. Hrs: 72

Course Objectives

- To impart scientific, statistical and analytical knowledge among the learners
- To carry out research work effectively
- To get knowledge to prepare research documents for publication
- To select the appropriate publish for the research findings
- To write research proposal and apply that to the sponsoring agencies

Unit-I: Research Methodology – Types and data collection (15 hours)

Research - types, objectives and approaches. Census method, Sample -types; Sampling techniques. Hypothesis: definition, characteristics, types, significance. Methods of collecting data: primary and Secondary- merits and demerits, Code of research ethics. Literature collection: Books, Research articles and e-resources.

Unit- II: Research Methodology – Structure and components (12 hours)

Structure of thesis & research article. Journals in Life Sciences, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Software. Manuscript for publication and proof correction. Structure and components of research proposal, National and International funding sources.

Unit-III: Research Methodology – Bibliometrics (15 hours)

Bibliometrics: definition and relevance; Bibliometrics databases, h-index, SNIP, Page Rank, Impact Factor and evaluation. The use of bibliometrics in research: Citation Research, Science Citation Index. The Institute for Scientific Information (ISI), Thomson Reuter's Webmetric and ORCID. Tailored Research and Retraction. Indian Patent Act.

Unit-IV: Bioethics – Principles (15 hours)

Brief history of bioethics - Past and current approaches to bioethics - The Principles Approach to Bioethics (autonomy, justice, beneficence, non- maleficence) - Humans as Moral Agents- Biomedical Research Ethics: Honesty and peer review - Equipoise - Placebo - Ecology and Environmental Ethics.

Unit-V: Bioethics – Ethical committees (15 hours)

Safety and precaution - ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards; Extension: Lab to Field, Extension communication, Extension

tools; Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution.

Books for References

1. Gurumani N Research Methodology for Biological Sciences, MJP Publishers, Chennai
2. Ramakrishnan P Biostatistics, Saras Publication, Nagercoil Arora PN and Malhon PK Biostatistics, Imalaya Publishing House, Mumbai.
3. Palanichami S and Manoharan M Statistical methods for biologists, Paramount publications.
4. P.N. Arora and P.K. Malhan, Biostatistics. Himalaya Publication House, 2006.
5. P.R. Vittal and V. Malini. Statistical and Numerical Methods

Web Resources

1. <https://www.spectroscopyonline.com/>
2. <https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/spectrpy/spectro.htm>
3. <https://www.ltu.edu/engineering/projects/83c24731-ae01-4a41-8875-4248afebf6de/biomedical-engineering/bioinstrumentation-laboratory>

Course Outcomes		K Level
After the completion of the course, students will able to		
CO 1	Get knowledge on basics of research	K2
CO 2	Collect and analyze the data	K5
CO 3	Write the research articles, dissertation and thesis	K6
CO 4	Calculate the bibliometrics like h index, i10 index etc	K5
CO 5	Learn the principles of types of bioethics	K2

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	3	2	3	3	3	24
CO 2	2	1	2	2	2	3	3	3	2	3	23
CO 3	2	2	2	2	2	2	3	3	3	3	24
CO 4	2	2	2	2	1	3	3	2	3	3	23
CO 5	2	2	2	2	2	3	3	3	3	2	24
											118/50

Mean Overall relationship is **2.36** which is **High**

SEMESTER I

Title of the Course: BIOFERTILIZERS AND AGRICULTURE SUSTAINABILITY

Category of the course: SEC

Course code: P1R2BODSEC1:1

Nature of the course: Entrepreneurship

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 4

Total Inst. Hrs: 72

Course Objectives:

- To know about the microbes which are used as Bio-fertilizers
- To have knowledge on technologies for production of Bio-inoculum
- To understand the role of microplants in agriculture
- To gain the basic knowledge on mushroom culture and their economic values
- To understand the values of value added products from mushrooms

Unit- I General aspect and Symbiotic Nitrogen Fixers (14 Hours)

Introduction, Scope, Importance and Classification of Biofertilizers – Microbes used as bio-fertilizer – Isolation, Identification, Field application and Large scale production of following Symbiotic fertilizers - *Rhizobium*, *Anabaena*, *Azolla*

Unit – II Non-Symbiotic Nitrogen and Phosphate Fixers (15 Hours)

Isolation, Identification and large scale production and field application of *Azospirillum*, *Azotobacter*, *Clostridium* and *Klebsiella*. **Phosphate solubilizers:** Isolation, characterization, mass inoculums production, field application of *Bacillus firmus* and *Pseudomonas*- Phosphate solubilization mechanism.

Unit-III Mycorrhizal Biofertilizers (15 Hours)

Introduction, Scope and general account on mycorrhizae – Classification - Method of collection and isolation (Wed sieving and decanting method) – Culture of mycorrhizae in Modified Melin-Norkrans (MMN) - Field application of Ecto and Endo mycorrhizae.

Unit- IV Soil fertility and productivity (14 Hours)

Soil fertility-past and present. Soil fertility and plant growth, soil fertility based growth equations. Soil productivity management. Soil organic matter depletion , causes of organic matter depletion, organic matter replenishment- green manure, farm yard manure and animal manures, compost, crop residues and organic wastes.

Unit- V Nutrient dynamics and availability (14 Hours)

Geochemical distribution- dynamics and availability of N, P, K, S, Mn, Cu, Zn, B and Mo in soil. Soil fertility evaluation: Chemical analysis-soil analysis, plant analysis; biological tests; fertilizer recommendation for crops and cropping patterns.

Books for References

1. Mushroom Cultivation. Tripathi, C.P. (2005). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. The Complete technology book on biofertilizers and organic farming. NIIR, New Delhi.
3. Somani, L.L., P. Shilpkar and D. Shilpkar. 2011. Biofertilizers commercial production technology and Quality control. Agrotech Publishers Academy, Udaipur.
4. Nita Bhahi 1984-1988. Hand book of Mushrooms, II edition, Vol-1 and II.
5. Giri, B. (Ed), Prasad, R. (Ed), Wu, Q. (Ed), Varma, A. (Ed) (2019). Biofertilizers for Sustainable Agriculture and Environment. Springer.

Web Links

1. http://www.fnca.mext.go.jp/english/bf/bfm/pdf/4_4_Phosphate_Solubilizers0403.pdf
2. http://www.fnca.mext.go.jp/english/bf/bfm/pdf/Biofertilizer_Manual.pdf
3. <https://www.springer.com/gp/book/9783030189327>.

Course Outcomes		K Level
After the completion of the course, student will able to		
CO 1	acquired sufficient, academic , practical experiences in the biofertilizer and mushroom culture	K1
CO 2	basic information on biofertilizers and mushroom	K4
CO 3	entrepreneurial skills in the production of mushrooms.	K5
CO 4	Examine the procedures for keeping soil fertility and plant productivity in good shape.	K3
CO 5	analyse plant growth environment in relation with soil, nutrients and fertilizers.	K3

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	1	2	3	3	3	3	2	23
CO 2	2	2	2	2	2	2	3	2	3	3	23
CO 3	2	2	2	2	2	3	2	3	3	2	23
CO 4	2	2	2	1	2	3	2	2	2	2	20
CO 5	3	1	2	2	2	2	3	2	1	2	20
											109/50

Mean Overall relationship is **2.18** which is **Medium**

SEMESTER I

Title of the course: ETHNOBOTANY AND PHARMACOGNOSY

Category of the course: DSE

Course code: P1R2BODSEC1:2

Nature of the course: Skill development

Marks: CIA: 25 + Ext: 75 = 100

Credits: 4

Hrs / Week: 6

Total Inst. Hrs: 72

Course Objectives

- To understand the uses of the plant resources
- To be aware of values of such resources
- To enlighten the students about economic gain because of plant resources
- To learn traditional health care products
- To know about naturopathy treatment and its effectiveness

Unit- I: Ethnobotany- Introduction, history and scope

(14 Hours)

Introduction, history and scope of Ethnobotany Tribes of India – current cultivation, collection of medicinal plants parts and processing of Herbal drugs. Traditional Indian system of Medicine – Ayurveda, Siddha, Unani and Naturopathy. Utilization of medicinal and various systems of medicines aromatic plants in India.

Unit- II: Ethnobotanical techniques

(14 Hours)

Ethnobotanical techniques. Anthropological field methods, linguistic and other symbiotic analysis, plant collection and taxonomy. Archaeobotanical methods of information systems. Traditional botanical knowledge and substances of wild plant resources – the documentation and interpretation. Collection of ethnobotanical evidence, the dynamics and distribution of traditional botanical knowledge.

Unit- III: Ethnobotany and conservation of plants

(15 Hours)

Ethnobotany and conservation of plants with special reference to India - mythology and conservation of ecosystems, conservation of selected plant species: sacred groves, forestry and unique ecosystems and their ethnobiological values, plants and animals in art, tradition and ethnography: Ethnobotanical field methods.

Unit-IV: Herbal preparation methods

(15 Hours)

Herbal preparation methods - bolus, capsules, compresses, creams, decoctions, extracts, infusions, herbal tea, ointments, massage oils, medicinal vinegar, poultice & plasters, powders, salves, syrups, tinctures, tonic, maceration and baths and bathing remedies teas and dry extract (pills or capsules). Application of herbal formulations for the treatment of certain diseases- Jaundice, Fever, Cardiac, Infertility, Diabetics, Blood pressure, Skin care and Respiratory diseases.

Unit-V: Pharmaceutical plant products- Drug adulteration and methods

(14 Hours)

Pharmaceutical plant products- alkaloids, glycosides, terpenoids, tannins, flavonoids, lipids, proteins. Nutraceuticals, cosmeceuticals, pharmaceuticals - fibre, sutures, surgical dressings, adaptogens, rasayana. Drug adulteration and methods of evaluation-physical, chemical and

microscopic. NMPB, CDRI, CIMAP, CIPLA; WHO regulation and Guidelines for quality control and trade of herbal medicine.

Books for References

1. Peter B. Kaufman et al., Natural Products from plants. CRC Press (1999).
2. Tyler, V.E., Brady, L.R. and Robbers, J.E, Pharmacognosy. 9th ed. Lea and Fibiger, Philadelphia (1981).
3. Kokate, C.K., Purohit, A.P., and Gokahale, Phamacognosy, NiraliPrakasan, 2002.
4. Dubey, R.C. A Text book of Biotechnology (2006).
5. Natesh, S. 2001. The changing scenario of herbal drugs: Role of Botanists. Phytomorphology. (Golden Jubilee Issue)., Pp.75-97.
6. JonneBernes – Herbal Medicines, Pharmaceutical Press, London.
7. Sushil Kumar – Medicinal Plants in Skin care, CIMAP, Lucknow.
8. Albuquerque, U. P. (Ed), de Lucena, R. F. P. (Ed), Cruz da Cunha, L. V. F. (Ed), Alves, R. R. N. (Ed) (2019). Methods and Techniques in Ethnobiology and Ethnoecology. Springer.

Web Resources

1. <https://thepharmacognosy.com>
2. <http://www.mespharmacy.org>
3. <https://www.ncbi.nlm.nih.gov>

Course Outcomes		K Level
After the completion of the course, student will able to		
CO 1	the basic knowledge on traditional plant based medicinal system	K1
CO 2	understand the valuable herbal products and their preparation methods	K4
CO 3	acquire knowledge on drug marketing	K5
CO 4	get employment in herbal companies	K3
CO 5	create new drug formulations using phytochemical compounds for the healthy life of society.	K3

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	2	2	2	3	2	21
CO 2	2	2	2	2	2	2	3	2	3	2	22
CO 3	2	2	2	2	2	3	2	3	3	2	23
CO 4	2	1	2	2	2	2	2	2	3	1	19
CO 5	3	2	2	2	1	2	3	2	1	2	20
											105/50

Mean Overall relationship is 2.1 which is **Medium**

SEMESTER II

Title of the Course: BIO-INSTRUMENTATION

Category of the course: DSE

Course code: P2R2BODSEC2:1

Nature of the course: Skill development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 4

Total Inst. Hrs: 72

Course Objectives

- To learn the basic principles, procedure and application of biological instruments
- To initiate the students into research activities
- To acquire basic knowledge about the handling methods of biological instruments
- To know about the principles of biological instruments
- To acquire basic knowledge about the handling in Microscope

Unit- I: Bioenergetics- Thermodynamics, Entropy and Enthalpy, (14 Hours)

Bioenergetics, laws of thermodynamics, entropy, enthalpy, ATP bioenergetics. Photobiology – dual nature of light, characteristics of solar radiation, solar energy, absorption spectra in molecules, energy status and de-excitation of atoms.

Unit II: Microscopy- Light, Dark and phase contrast (14 Hours)

Microscopy: Light, Dark and phase contrast microscope – Brief account on Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Sample preparation for electron microscopic study.

Unit III: pH and Centrifugation- Principle and Types (15 Hours)

pH and pH meter : Sorensen's pH scale – Electrolytic dissociation of water – Acid and Bases – Buffers – Phosphate and Tris Buffers. pH meter – Calomel electrode, Glass electrode and combined electrode – Factors affecting pH measurement – Applications. Properties of Centrifugation – Principle – Types of Centrifuges – Types of centrifugation.

Unit IV – Chromatography- Principles, Application and Types (15 Hours)

Chromatography ; Basic principles and Application - Paper Chromatography- Thin layer chromatography–Gas Chromatography– High performance liquid chromatography- Gas Chromatography with Mass spectrum.

Unit V: Bio-Instrumentation- Spectroscopy and Electrophoresis (14 Hours)

Spectroscopy – Colorimeter – UV-Vis spectroscopy – Flame photometry. – Atomic absorption- spectroscopy, FTIR – NMR and ESR. Electrophoresis – Polyacrylamide Gel Electrophoresis – Agarose Gel Electrophoresis – Immuno electrophoresis- Gel documentation system. Blotting technique.

Books for References

1. N. Gurumani. Research methodology for biological Science, MJP, Publishers, Triplicane, Chennai (2011).
2. P.Palanivelu, An introduction to Analytical Biochemistry a practical and theoretical manual.
3. Salmah B. Karman and S. Zaleha M. Diah (2016). Principal And Techniques Of Bioinstrumentation. Intelliz Press.
4. Gupta, S.P, Metrology of Study and Scientific work Research, Narosa Publishing House.Life Science Book House, Madurai (1990).
5. Jayaraman, J., Statistical Methods-Sultan Chand & Sons (1985).
6. Plummer, D.T., An Introduction to Practical Biochemistry, Tata McGraw-Hill Publishing Co. Ltd., New Delhi (1978).
7. Clark, J.N, Hand book of Basic Microtechnique, McGraw Hill Book Co., London, (1964).

Web Resources

1. <https://www.ltu.edu/engineering/projects/83c24731-ae01-4a41-8875-4248afebf6de/biomedical-engineering/bioinstrumentation-laboratory>
2. <https://www.khanacademy.org/>
3. <https://chem.libretexts.org/>

Course Outcomes		K Level
After the completion of the course, student will able to		
CO 1	The students would have understood the principles, procedures and application of certain instruments.	K1
CO 2	They would understand data collection and handling methods.	K2
CO 3	They could get employment in instrumentation laboratory at research industries.	K5
CO 4	evaluate and illustrate the concept of redox potential in biological system.	K4
CO 5	integrate various types of microscopy and their applications.	K6

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	3	3	2	3	3	24
CO 2	2	2	1	2	2	3	3	3	3	3	24
CO 3	2	2	2	2	2	2	2	2	2	2	20
CO 4	2	2	2	2	2	3	3	3	2	1	22
CO 5	2	1	2	2	2	2	2	3	1	3	20
											110/50

Mean Overall relationship is 2.2 which is **High**

SEMESTER II

Title of the Course: ENTREPRENEURIAL BOTANY

Category of the course: DSE

Course code: P2R2BODSEC2:2

Nature of the course: Skill development

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 4

Total Inst. Hrs: 72

Course Objectives

- To provide an understanding the essentials of entrepreneurship.
- To introduce organizations and agencies that can backup entrepreneurial initiatives.
- To expose students to various business opportunities emerging around the study of plants.
- To encourage students to built proposals and projects to become an entrepreneur.
- To study the trademarks and copyright

Unit – I: Entrepreneurial Botany

(14 Hours)

Introduction: Need – definition and concept – Types and characterization – entrepreneurial values – motivation and barriers – entrepreneurship as innovation, risk assessment and solutions.

Unit – II: Bioventure

(14 Hours)

Bioventure: Industry – overview of *Spirulina*, *Pleurotus sajor-caju*, *Ganoderma*, *Lentinusedodes*, drumstick and coconut – Straight Vegetable Oil (SVO) and Plant Oil (PO) - methods and marketing – fresh and dry flowers for aesthetics.

Unit – III: Value added products

(15 Hours)

Value added products: Canning of fruits – process and equipment – fruit and vegetable based products (squash) – ready to serve (RTS) (syrup, pulp, paste, ketchup, soup, vegetable sauces, jam and , jellies) –bio-fuel production – Bamboo and cane based products – virgin coconut oil, jasmine oil production – nutraceuticals – standards and quality management.

Unit – IV: Organizations and agencies

(15 Hours)

Organizations and agencies: TIIC, DIC, NABARD, MICROSTAT, DBT – case study – sarvodaya – SIDCO – Micro Small and Medium Enterprises – support structure for promoting entrepreneurship – various government schemes.

Unit – V: Entrepreneurial opportunities

(14 Hours)

Entrepreneurial opportunities: Understanding a market and assessment – selection of an enterprise – business planning –mobilization of resources – Break Even Analysis – project proposal(guidelines, collection of information and preparation of project report) – steps in filing patents –trademarks and copyright – Intellectual Property Rights – export and import license.

Books for Reference

1. Taneja, S. and Gupta, S.L., 2015. Entrepreneurship development, New venture creation, Galgeha publication company, New Delhi. ISSN: 2321-8916.
2. Desai, V., 2015. Entrepreneurship development, First edition. Himalaya publication house, Mumbai. ISBN: 9789350973837.
3. Khanna, S.S., 2016. Entrepreneurial development. S.Chand Company limited, New Delhi. ISBN: 9788121918015.
4. Manohar, D., 1989. Entrepreneurship of small scale industries, vol.III. Deep and deep publication, New Delhi. ISSN: 09735925.
5. Lal, G., Siddhapa, G.S. and Tandon, G.L., 1988. Preservation of fruits and vegetables. Indian Council of Agricultural Research (ICAR). ISSN: 0101-2061.
6. Ranganna, S., 2001. Hand book of analysis and quality control of fruits and vegetable products, Second edition, Tata mcgraw hill, New Delhi. ISBN: 9780074518519.

Web Resources

1. www.unapcaem.org.
2. <https://apeda.gov.in> > apedawebsite > organic
3. <https://extension.psu.edu/six-steps-to-mushroom-farming>
4. <https://www.mushroomcouncil.com/growing-mushrooms/six-steps-to-mushroom-farming/>

Course Outcomes		K Level
After the completion of the course, student will able to		
CO 1	the knowledge gained in learning Botany for gainful applications by starting own business ventures.	K1
CO 2	feasibility designing projects of their own in the model of the various case studies they have investigated in this course.	K2
CO 3	breakeven of small scale business ventures and evaluate the feasibility of value additions in the project the break grounds for achieving cost effectiveness	K3
CO 4	tap agencies that can possibly provide full or partial support to kick start their projects that stabilize the same for making their livelihood.	K4
CO 5	Assess the market worth of their entrepreneurial exercise and clearly rate the viability considering the opportunities and risks matching it with that of their peers and competitors on real time basis	K5

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	2	2	2	3	2	21
CO 2	2	1	1	2	2	3	3	3	3	2	22
CO 3	2	2	2	2	2	2	2	2	1	2	19
CO 4	2	2	2	1	2	2	2	2	2	1	18
CO 5	2	1	2	2	1	2	2	3	1	2	18
											98/50

Mean Overall relationship is **1.96** which is **Medium**

SEMESTER III

Title of the course: ORGANIC, INDOOR AND TERRACE GARDENING

Category of the course: SEC

Course code: P3R2BOSEC1:1

Nature of the course: Entrepreneurship

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 6

Credits: 3

Total Inst. Hrs: 72

Course Objectives

- To study the basic principles and breeding techniques in horticulture crops
- To learn about the as various vegetative propagation techniques
- To understand the concept of garden making
- To learn about landscaping techniques and their implication
- To learn about the making of Indoor garden

Unit- I: Organic Farming- Concepts, Scope and Requirements

(15 Hours)

Concepts and scope of organic farming, Requirements for organic farming, Farm components for an organic farm. Conversion to organic farming- Process, green card systems and subsidies. Fundamentals of Livestock farming, animal behavior, Poultry management.

Unit-II: Types of Farming- Organic, Green and Liquid Manure

(15 Hours)

Types of Farming, Concept of different cropping systems in relation to Organic Farming (Inter cropping), nutrient uptake and balanced nutrient supply, organic manure, green and liquid manure, biofertilizers and their method of use, Compost: decomposition, manure – Types vermicompost: Scope and importance, use of vermi castings in organic farming, Potentials and constraints for vermiculture in India.

Unit-III: Gardening- Objectives, Scope and Different Types

(14 Hours)

Gardening: Definition, objectives and scope, different types of gardening. Principles, methods and types of gardens and garden implements, Designing outdoor garden– hedges, edges, fences, trees, climbers, rockeries, arches, Roof garden, Indoor gardening and kitchen garden.

Unit-IV: Indoor Gardening- Terrarium, Bonsai and Topiary plants

(14 Hours)

Indoor gardening - foliage, flowering plants and hanging basket. Terrarium, Bonsai and topiary plants. Floriculture –cultivation of commercial flower crops - rose, orchids and Anthurium. Flower decoration-dry and wet.

Unit-V: Gardening- Water Garden- Types and Cultivation

(14 Hours)

Lawn making and maintenance, water garden – cultivation of water plants, common water plants, glass house, Ornamental pants, hanging basket establishment and plant protection measures. Parks: components, types of parks, Xeriscaping. Field Visit to Horticultural station.

Books for References

1. S.P. Palaniappan and K. Annadurai. 2007 Organic Farming – Theory and Practice. Scientific Publishers (India).
2. Lakshmi, Narasaiah M. 2010. Agriculture and Water Management. Discovery publishing House, New Delhi
3. George Acquaah. 2002. Horticulture Principles and Practices, 2nd Edn. Pearson Edn, Delhi.

Web Resources

1. http://agritech.tnau.ac.in/horticulture/horti_landscaping.html.
2. https://agritech.tnau.ac.in/horticulture/horti_Landscaping_principles.html
3. http://apeda.gov.in/apedawebsite/SubHead_Products/Floriculture.htm

Course Outcomes		K Level
After the completion of the course, student will able to		
CO 1	the techniques in nursery preparation	K1
CO 2	promote these interests to the local society	K2
CO 3	gain knowledge on designing of Gardens.	K3
CO 4	the landscape designing methods	K5
CO 5	get employment in agriculture and horticulture centres and plant breeding centre	K6

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	2	2	2	2	2	3	2	21
CO 2	2	1	2	2	2	3	2	3	2	2	21
CO 3	1	2	2	2	2	3	2	3	2	1	20
CO 4	2	2	2	2	2	2	2	2	3	3	22
CO 5	1	2	1	2	2	2	1	2	3	2	18
											102/50

Mean Overall relationship is **2.04** which is **Medium**

SEMESTER IV

Title of the course: HERBAL RECIPES AND REMEDIES

Category of the course: SEC

Course code: P4R2BOSEC1:2

Nature of the course: Entrepreneurship

Marks: CIA: 25 + Ext: 75 = 100

Credits: 3

Hrs / Week: 6

Total Inst. Hrs: 72

Course Objectives

- To study about the herbalism
- To understand the herbs as a food supplement
- To know about the herbal variety rice and their uses
- To gain basic knowledge on Snacks preparation
- To understand about the herbal Cookies and cakes

Unit-I: Herbalism- History and Traditional Uses

(15 Hours)

Herbalism history, Traditional use of herbal medicine. Health herbal house cleaning and non-toxic home care preparation. Herbal Soup Preparation -Mushroom, Mudakkathan (*Cardiospermum halicacabu*), Thuthuvalai (*Solanum trilobatum* L.), Kurinjakeerai (*Gymnema sylvestre* R. Br.), Pepper (*Piper nigrum* L.), Garlic (*Allium sativum* L.) Tomato (*Lycopersicon esculentum*), Kovakkai (*Coccinia grandis*), Manathakkali (*Solanum nigrum* L.) Neem flower (*Azadirachta indica*) Mode of Preparation and remedies.

Unit-II: Herbal Recipes- Food Supplement and Nutritional Value

(15 Hours)

Beneficial use of herbs as a food supplement, Nutritional value of Herbs, Herbal Paste (Mooligai thovayal) – pirandai *Cissus quadrangularis* (Linn.), Puthina (*Mentha arvensis* L.), Kothamalli (*Coriandrum sativum* L.), Karugapillai *Murraya koenigii* (L.), Nellikkai (*Phyllanthus emblica* L.), Vallarai (*Centella asiatica*), Ginger (*Zingiber officinale* Rosc.)

Unit-III: Herbal Recipes- Variety Rice and Briyani

(14 Hours)

Variety Rice - Mint, coriandum, curry leaves, Toor dal, Ginger, Pepper, carrot, Greens. Ingredients and Mode of Preparation methods. Varaguarisi (Kodo millet) pongal, Thinai (Foxtail millet) Briyani, SamaiArisi (Little millet) Pulao, Kuthiraivali(Barnyard millet) Idiyappm.

Unit-IV: Snacks- Cutlets, kozhukattai and Paniyaram

(14 Hours)

Snacks - Ragi mixture and kozhukattai, vegetables cutlets, wheat, Pearl millet (Kambu) Paniyaram, Ground nut Mittai, cereals rotti, Bengal gram karashev, Mushroom samosa, Keeraivada, Aloe vera juice, citron (Narthangai) Juice.

Unit-V: Cookies and Cakes- History and Preparations

(14 Hours)

Cookies and cakes – History of cookies, Peanut butter Raisin brown cookies, corn flake cookies, wheat cakes, Omla candy, lemongrass and ginger candy, Ginger bread cookies. Mint chocolate.

Books for References

1. Rosemary Gladstar's Herbal Recipes for Vibrant Health: 175 Teas, Tonics, Oils, Salves, Tinctures, and Other Natural Remedies for the Entire Family, Publisher: Storey Publishing, LLC; 2008, Reprint edition.

2. The Essential Guide to Home Herbal Remedies: Easy Recipes Using Medicinal Herbs to Treat More Than 125 Conditions from Sunburns to Sore Throats P, Robert Rose; 1 edition 2014.
3. Herbal Medicine for Beginners: Your Guide to Healing Common Ailments with 35 Medicinal Herbs, 2018. Katja Swift, Ryn Midura
4. Encyclopedia of Herbal Medicine: 550 Herbs and Remedies for Common ailments, 2016. Andrew Chevallier.
5. Herbal Bioactives and Food Fortification: Extraction and Formulation, 2015. D. Suresh Kumar
6. Herbs for Stress and Anxiety, 2018. Rosemary Gladstar

Web Resources

1. <https://www.jacquifernandez.com.au/herbal-medicine.html>.
2. <http://www.herbalremediesinfo.com/herbal-medicine>.
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1071505/>

Course Outcomes		K Level
After the completion of the course, student will able to		
CO 1	understood knowledge on the herbalism	K1
CO 2	understand the herbs as a food supplement	K2
CO 3	the herbal variety rice and their uses	K3
CO 4	gain basic knowledge on Snacks preparation	K4
CO 5	understand about the herbal Cookies and cakes	K4

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	2	2	1	2	2	2	2	3	2	20
CO 2	2	1	2	2	1	3	3	1	3	3	21
CO 3	1	2	2	2	2	2	3	2	2	2	20
CO 4	2	2	1	2	2	2	2	2	2	2	19
CO 5	1	2	1	2	1	2	1	3	3	1	17
											97/50

Mean Overall relationship is **1.94** which is **Medium**

SEMESTER IV

Title of the course: INTELLECTUAL PROPERTY RIGHTS

Category of the course: GEC

Course code: P4R2BOGEC

Nature of the course: Entrepreneurship

Marks: CIA: 25 + Ext: 75 = 100

Hrs / Week: 2

Credits: 2

Total Inst. Hrs: 24

Course Objectives

- To introduce fundamental aspects of Intellectual property Rights
- To students who are going to play a major role in development and management of innovative projects in industries.
- To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
- To disseminate knowledge on copyrights and its related rights and registration aspects

Unit – I: Intellectual Property Right- Introduction and Traditional Knowledge (4 Hours)

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.

Unit – II: Patents- Elements and Industrial Application (4 Hours)

Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board

Unit – III; Copyright- Subject Matter and Ownership (4 Hours)

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights

Unit – IV: Trademarks- Concept and Different Kinds (5 Hours)

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks

- Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board

Unit – V: Intellectual Property Right- Meaning and Concept

(5 Hours)

Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection Geographical Indication (GI) Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection

Books for References

1. Arora JS. 1992. Introductory Ornamental Horticulture, Kalyani Publishers, New Delhi.
2. George Acquaah. 2002. Horticulture Principles and Practices, 2nd Edn. Pearson Edn, Delhi.
3. Manibushan Rao K. 1991. Text book of horticulture. MacMillan Publishing Co., New York.
4. Edmond JB et al., 1977. Fundamentals of horticulture. Tata McGraw Hill Ltd., New Delhi.
5. Rao KM. 2000. Text Book of Horticulture, MacMillan India Ltd., New Delhi.
6. Gopalswamy Iyyangar, 1970. Complete gardening in India, Kalyan Printers, Bangalore.

Web Resources

1. <https://www.ddrpharmacy.com>
2. <https://www.ncbi.nlm.nih.gov>
3. <http://www.igntu.ac.in> 8. <https://ethnobiomed.biomedcentral.com>

Course Outcomes		K Level
After the completion of the course, student will able to		
CO 1	understand the concept and procedure of IPR.	K1
CO 2	know the status of IPR in India.	K2
CO 3	evaluate the difference between patent, copy right and trademark.	K3&K4
CO 4	analyse the benefits of patent, copy right and trademark.	K5
CO 5	prepare applications for patent, copy right and GI.	K6

Relationship matrix for CO, PO & PSO

Course Outcome (CO)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	
CO 1	2	1	2	2	2	2	2	2	3	2	20
CO 2	1	2	1	2	2	3	3	1	3	3	21
CO 3	2	2	2	1	2	2	2	2	2	2	19
CO 4	1	1	2	2	2	2	2	2	2	2	18
CO 5	2	2	1	2	1	1	1	3	3	2	18
											96/50

Mean Overall relationship is **1.92** which is **Medium**