Institute of Science, Nagpur

(An Autonomous Institute of Govt. of Maharashtra)

Department of Botany

B. Sc. Semester V to VI Syllabus as per NEP 2020

To be implemented from 2025-2026

B.Sc. Sem-V (BOTANY -Major, Minor from Basket)

Sr No	Course Category	Name of the course (Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination(Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	DSC	Paper 9:- **Genetics**	B-BO351T	5.5	3	--	--	3	3	60	15	30
		Paper 10:- **Plant physiology**	B-BO352T		3	--	--	3	3	60	15	30
		DSC Lab-5 (Based on Paper 9 + Paper 10)	B-BO353P		--	--	6	3	6	60	15	38
2	DSE	Elective 1:- **Mycology and Industrial Microbiology**	B-BO354T		2	--	--	2	3	40	10	20
		DSE Lab-1 (Based on Elective 1)	B-BO355P		--	--	4	2	4-6	40	10	25
3	Minor	Paper 5:-Refer Minor Basket **Morphology of Angiosperms & Plant Anatomy**	B-BO356T		2	--	--	2	2	40	10	20
		Paper 6:-Refer Minor Basket **Plant Taxonomy**	B-BO357T		2	--	--	2	2	40	10	20
		Minor Lab-3 (Based on Paper 5 + Paper 6)	B-BO358P		--	--	4	2	4 - 6	40	10	25
4	VSEC	Refer VSC Basket **VSC-3: Instrumentation for Botany Laboratory**.	B-BO359P		--	--	4	2	4 - 6	40	10	25
5	CEP	**Community Service**	B-BO360P		--	--	2	1	--		25	25
					12	--	20	22		420	130	--

B. Sc. Semester-V
Discipline Specific Core Course (DSC)
DSC PAPER-9 Genetics
(B-BO351T)

Course objectives: -

1. Identify the basic principles and current trends in classical genetics and plant breeding
2. Recognize the historical process of the evolution of molecular genetics from classical genetics.

Course outcome: -

1. Students will know the Fundamentals of Mendelian and post-Mendelian Genetics.
2. Students will develop their analytical, quantitative and problem solving skills from classical to molecular genetics.
3. Students will be able to understand the knowledge base of plant genetic resources and its conservation

DSC Paper- 1Theory	Hours: 3Hours/Week	Marks: 60(ESE)+15(CIE)=75	Credit: 3

Unit-I	
1. Mendelian, Neo Mendelism, Cytoplasmic Inheritance 2. Concepts of gene, phenotype, genotype, heredity and variation, allele 3. Mendelian inheritance: history, experiments, Law of segregations and Independent assortment.	11.25 Hrs
Unit-II	
1. Neo-mendelian inheritance: codominance, incomplete dominance; epistasis and pleiotropism; lethals and sub-lethals; multiple alleles, 2. Gene interactions: types and suitable examples 3. Cytoplasmic inheritance: genetics of mitochondria and chloroplasts, male sterility in Maize. 4. Genomic imprinting and maternal effect.	11.25 Hrs
Unit-III	
1. Chromosome structure; aberrations; deletion, duplication, inversion, translocation, complex translocation. 2. Chromosomal Numerical aberrations, Euploidy and aneuploidy and their genetic implications 3. Polyploidy: Types, origin and meiotic behavior. 4. Karyotype analysis; method and evolution; banding patterns, applications	11.25 Hrs
Unit-IV	

1. Sex linked, sex-limited and sex-influenced characters, Sex Chromosome and sex determination, dosage compensation of X-linked genes 2. Linkage, recombination and crossing over 3. Detection of linkage in experimental organisms: Tetrad analysis in fungi, mapping in ordered tetrads in Neurospora 4. Gene mapping with two-point and three-point test cross, recombination frequency and genetic map distance, coincidence and interference analysis	11.25 Hrs

Suggested Readings

1. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
2. Benjamin A. Pierce, Genetics: A Conceptual Approach by
3. D. Peter Snustad and Michael J Simmons. Principles of Genetics by
4. Gardner EJ &Snustad DP. 1991. Principles of Genetics. John Wiley & Sons.
5. Klug WS & Cummings MR. 2003. Concepts of Genetics. Peterson Edu.
6. Lewin B. 2008. Genes IX. Jones & Bartlett Publ.
7. Russell PJ. 1998. Genetics. The Benzamin/Cummings Publ. Co.th
8. Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
9. Snustad DP & Simmons MJ. 2006. Genetics. 4 Ed. John Wiley & Sons.
10. Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India
11. Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs.

B. Sc. Semester-V
Discipline Specific Core Course (DSC)
DSC PAPER-10 Plant physiology
(B-BO352T)

Course objectives: -

1. Understand the mechanisms of water and mineral uptake and transport in plants, including hydraulic conductance and aquaporins.
2. Explore the evolutionary dynamics and diversity of photosynthesis across different organisms.
3. Analyze the processes involved in the light reaction and the Calvin cycle, including electron pathways and key enzymes.
4. Investigate the role of light in the activation of dark phase enzymes and the regulation of C4 and CAM photosynthesis.

Course outcome :-

1. Explain the physiological regulation of mineral homeostasis and adaptive strategies under different environmental conditions.
2. Describe the evolution and diversity of photosynthesis, including carbon-concentrating mechanisms and photo-protectant systems.
3. Analyze the light reaction and Calvin cycle, detailing the involvement of reaction centers and electron pathways.
4. Evaluate the regulation of dark phase enzymes and the mechanisms of C4 and CAM photosynthesis.

DSC Paper- 2Theory	Hours: 3Hours/Week	Marks: 60(ESE)+15(CIE)=75	Credit: 3

Unit-I

1. Plant-water relations: Properties of water, diffusion, diffusion pressure deficit and its significance;Osmosis: Concept, types, osmotic potential and its significance; Imbibition: concept and significance 2. Ascent of sap: Definition, Root pressure theory, cohesion-adhesion theory. 3. Transpiration: Definition, types, mechanism of stomatal movements (K+-malate hypothesis) *4.* Phloem transport: Munch hypothesis	11.25 Hrs

Unit-II

1. Evolution and diversity of photosynthesis from bacteria to higher plants, Carbon-concentrating mechanisms in bacteria, algae and plants. 2. Photosynthesis: Definition, significance, photosynthetic pigments and their role, photosystems. 3. Mechanism of Photosynthesis: LightReaction: cyclic and non-cyclic photophosphorylation, Light independent reactions: C3, C4 and CAM pathways and their significance.	11.25 Hrs

Unit-III

1. Overview, historical account, evolution of anaerobic and aerobic respiration. 2. Aerobic respiration: Glycolysis and its regulation, TCA cycle, Pentose phosphate pathway. 3. Plant mitochondrial electron transport and ATP synthesis, alternative oxidase system. 4. Anaerobic respiration: Alcoholic and Lactic acid fermentation 5. Gluconeogenesis, glyoxylate pathway and Hexose monophosphate Shunt.	11.25 Hrs
Unit-IV	
6. Nitrogen metabolism: Definition, Mechanism of biological nitrogen fixation (Symbiotic and non-symbiotic) 7. Plant movements: Definition, outline, Tropic (geotropic, phototropic, thigmotropic) andNastic- seismonastic. 8. Photoperiodism: Definition, classification (short day, long day & day neutral plants) Photoperiodic induction, Florigen hormone. 9. Circadian rhythms and biological clock	11.25 Hrs

Suggested Readings

1. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
2. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biologyof Plants,American Society of Plant Physiologists, USA.
3. Davies P J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rdEdition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
4. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley andSons, U.S.A. 4th Edition.
5. Nelson, D.L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th ed.).W.H.Freeman& Co., New York.
6. Taiz, L., Zeiger, E., (2014). Plant Physiology. Sinauer Associates Inc., U.S.A. 6 Th Edition.

B. Sc. Semester-V
Discipline Specific Core Course (DSC) Laboratory Exercise-5
DSC Lab-3 (B-BO353P)

Based on DSC Paper-9 and Paper-10	**Hours: 6 Hours/Week**	**Marks: 60(ESE)+15(CIE)= 75**	**Credit: 3**

Genetics:

1. Preparations of Stains, Dyes, Preservatives, Fixatives and pre-treatment for the material
2. To prove Mendel's Law of Segregation
3. To prove Mendel's Law of Independent assortment
4. To Solve problems given on gene Interaction
5. To prepare the Karyotype and Idiogram with formula of the given material
6. Study the Meiotic configurations in maize, Alliums', *Rheo, Tradescantia, Aloe* etc.
7. To check the pollen viability and sterility using TTC
8. Study of Human Pedigree and its analysis.
9. Application of Probability to Problems in Genetics

Plant Physiology:

10. To study the permeability of plasma membrane using different concentrations of organic solvents.
11. To study the effect of temperature on permeability of membranes.
12. To determine the osmotic potential of vacuolar sap by plasmolytic method.
13. To determine the water potential of any tuber.
14. To compare the rate of transpiration from two surfaces of leaf- a) bell jar method b) Cobalt chloride method.
15. To determine the path of water (Ascent of sap).
16. To measure rate of photosynthesis by Wilmott's bubbler under variable conditions of light, temperature and CO2.
17. To determine osmotic potential of the cell sap by plasmolytic method.

Suggested activity:

Seminar, Quiz, debate, Assignments, collection of Pteridophytes and Gymnospermsavailable in local area, Field work, Study Projects, Models etc. are Part of Curriculum.

B. Sc. - SEMESTER –V BOTANY PRACTICAL
Based on Discipline Specific Core Course (DSC) Laboratory Exercise-5
DSC Lab-3 (B-BO353P)

Time: 6hrs. **Max. Marks: 60**

1.	To prove Mendels law of Independent Assortment	**10 Marks**
2.	To workout the given gene interaction problem.	**10 Marks**
3.	To determine osmotic potential of the cell sap by plasmolytic method	**10 Marks**
4.	To study the effect of temperature on permeability of membranes.	**10 Marks**
5.	**Spotting:**	**10 Marks**

E. Genetics
F. Genetics
G. Plant Physiology
H. Plant Physiology

6.	Viva-voce, Record and excursion report (submission is compulsory)	**10 Marks**

B. Sc. Semester-V

DSE Elective 1:- Mycology and Industrial Microbiology

(B-BO354T)

Course objectives: -

1. To demonstrate a systematic, extensive and coherent knowledge an understanding of basic and applied mycology.
2. To links to other disciplinary areas of the study; including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of mycology.

Course outcome :-

1. Understand advanced knowledge of structure and diversity of different fungal groups.
2. Analyzed different fungal forms and classify into different groups on the basis of microscopic and macroscopic observations.
3. Apply the knowledge of mycology for research and development.

DSE Paper- 1Theory	Hours: 2Hours/Week	Marks: 40(ESE)+10(CIE)=60	Credit: 2

Unit-I

1. Diversity of Fungi — 7.5 Hrs
2. Habitat- aquatic fungi, soil fungi, root-inhibiting fungi, coprophilous fungi, lignocolous fungi, cellulolytic fungi,keratinophilic fungi, entomogenous fungi, predacious fungi, phylloplane fungi, psychrophilic fungi, thermophilic fungi and ambrosia fungi.
3. Vegetative phase - Thallus and kind of mycelia, Types of septa, structures associated with mycelia and aggregations of mycelia.
4. Reproduction – vegetative, asexual and sexual, types of fructifications
5. Nutrition in fungi- Saprotrophs, Biotrophs,Necrotrophs, Symbiotrophs

Unit-II

Bioprospecting of fungi in Agriculture and Industry — 7.5 Hrs

1. Types of Mycorrhizae and role of AM fungi in agriculture.
2. Mycoinsecticides and mycopesticides
3. *Trichoderma* and other fungal antagonistic as a biocontrol agents.
4. Role of fungi in the production of alcohol, organic acids and enzymes
5. Fermentation methods and biomass production of fungi
6. Principle and production of antibiotics

Unit-III

Methods for studying microorganisms 1. Culture media: preparation and types of defined, differential, selective and enrichment culture, Isolation techniques: Pour plate, spread plate, streak plate. Preservation and maintenance ofculture 2. Methods of sterilization: physical and chemical, media types, Isolation and maintenance of pure cultures of microorganisms, and preservation techniques.	7.5 Hrs
Unit-IV	
1. Introduction Fermentation processes, Microbial culture selection for fermentation processes. Media formulation and optimization; inoculum development; strain improvement 2. Microbial growth Microbial growth kinetics in Batch, fed batch and continuous cultures 3. Design of fermenters Design and operation of Fermenters, Basic concepts for selection of a reactor, Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor.	7.5 Hrs

Suggested Readings

1. Ulloa, M., & Aguirre-Acosta, E. (2019). Illustrated generic names of fungi. APS Press.
2. Ulloa, M., & Hanlin, R. T. (2000). Illustrated dictionary of mycology. Amer Phytopathological Society. ISBN-10: 0890542570; ISBN-13: 978-0890542576.
3. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (2007). Introductory mycology (4th ed.). Wiley. ISBN-10: 8126511087; ISBN-13: 978-8126511082.
4. Aneja, K. R. (2015). An introduction to mycology (2nd ed.). New Age International Private Limited. ISBN-10: 8122437966; ISBN-13: 978-8122437966.
5. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). Introductory mycology (4th ed.). John Wiley & Sons.
6. Arora, D., & Shepherd, G. (2008). Economic botany (Vol. 62, #3). The New York Botanical Garden Press.
7. Ainsworth, G. C., & Sussman, A. S. (Eds.). (n.d.). The fungi: An advance treatise (Vols. I-IV). Academic Press.
8. Alexopoulos, C. J., & Mims, C. W. (1979). Introductory mycology (3rd ed.). John Wiley & Sons.
9. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). Introductory mycology (4th ed.). John Wiley & Sons.
10. Aneja, K. R. (1993). Experimental in microbiology, plant pathology & tissue culture. Wiswa Prakashan.

11. Bessey, E. A. (1950). Morphology and taxonomy of fungi. The Blakiston Co.
12. Bilgrami, K. S., & Dube, H. C. (1985). A textbook of modern plant pathology. Vikas Publication House.
13. Butler, E. J., & Jones, S. J. (1949). Plant pathology. Macmillan & Co.
14. Dube, R. C., & Maheshwari, D. K. (2000). Practical microbiology. S. Chand & Co. Ltd.
15. Gupta, V. K., & Behl, M. K. (1994). Indian plant viruses and mycoplasma. Kalyani Publishers.
16. Jha, D. K. (1993). A textbook of seed pathology. Vikas Publication House.
17. Manibhushan Rao, K., & Mahadevan, A. (n.d.). Recent development in biocontrol of plant pathogens. Today and Tomorrow Publishers.
18. Mehrotra, R. S., & Aneja, K. R. (1998). An introduction to mycology. New Age Intermediate Press.
19. Mukadam, D. S., & Gangawane, L. V. (1978). Experimental plant pathology (edited). Marathwada University.
20. Pande, P. B. (1997). Plant pathology. S. Chand & Co.
21. Rangaswamy, G., & Mahadevan, A. (1999). Diseases of crop plants in India. Prentice Hall of India.
22. Singh, R. S. (1994). Plant pathology. Oxford and IBH Publication Co.
23. Thind, T. S. (1998). Diseases of field crops and their management. National Agricultural Technology Information Centre.
24. Manoharachary, C., Tilak, K. V. B. R., Mallaiah, K. V., & Kunwar, I. K. (2016). Mycology and microbiology. Scientific Publishers.
25. Aneja, K. R., & Mehrotra, R. S. (2015). An introduction to mycology. New Age International Private Limited.
26. Dubey, H. C. (2017). Introduction to fungi, bacteria and viruses. Agribios.
27. Gupta, R. C., & Sharma, O. M. P. (2010). Textbook of fungi. Oxford Publication.
28. Sharma, O. M. P. (1989). Textbook of fungi. Tata McGraw-Hill Publishing Company.

B. Sc. Semester-V

DSE Laboratory Exercise-1

DSE Lab-1 (B-BO355P)

Based on DSE	Hours: 4Hours/Week	Marks: 40(ESE)+10(CIE)= 50	Credit: 2

Mycology:

1. Demonstration on Cultivation of Fungi
2. Washing and sterilization of glasswares,
3. PDA preparation, pouring, preparation of slants and sterilization, inoculation, staining techniques Microscopic examination of fungi
4. Isolation of aquatic fungi
5. Isolation Rhizosphere fungi by serial dilution technique
6. Isolation of soil fungi by Warcup method
7. Isolation of Phyllosphere
8. Isolation of Coprophilous fungi
9. Isolation of keratinophilic fungi
10. Study of aeromycoflora from different localities
11. Isolation of mycorrhizal spores from soil
12. Staining of fungi using lactophenol and cotton blue (Rhizopus, Mucor, Aspergillus, Penicillium).

Industrial Microbiology:

13. Microbiology good laboratory practices and biosafety.
14. Neutralization and cleaning of glassware.
15. Measurement of microorganisms (Micrometry).
16. To study the principle of and application of important instruments – Autoclave, Incubator, BOD Incubator, Hot Air Oven, pH Meter, spectrophotometer, Colony Counter, Centrifuge Machine and Laminar Air Flow.
17. Preparation of different culture media- nutrient agar/nutrient broth for bacterial culture, PDA for fungal culture.
18. Isolation of pure culture of bacteria by streak-plate method.
19. Staining of bacteria- Simple staining- methylene blue, Gram's staining, Acid fast staining, ZiehlNeelsen staining, Giemsa staining, Structural staining- capsule, endospore.
20. Sterilization of culture media using autoclave and assessment for sterility.
21. Sterilization of glassware using hot air oven

B. Sc. - SEMESTER –V BOTANY PRACTICAL
Based on DSE Lab- 1 (B-BO355P)

Time: 4hrs. **Max. Marks: 40**

1.	Isolation Rhizosphere fungi by serial dilution technique	**08 Marks**
2.	Isolation of mycorrhizal spores from soil	**06 Marks**
3.	Isolation of pure culture of bacteria by streak-plate method	**08 Marks**
4.	Sterilization of culture media using autoclave.	06 **Marks**
5.	**Spotting:**	**06 Marks**
	I. ….	
	J. …..	
	K. ….	
6.	Viva-voce, Record and excursion report (submission is compulsory)	**06 Marks**

B. Sc. Semester-V
Minor Paper -5
Morphology of Angiosperm and Plant Anatomy
(B-BO356T)

Minor **Paper-5** **Theory**	**Hours: 2Hours/Week**	**Marks: 40(SEE)+10(CIE)=50**	**Credit: 2**

Unit-I

1. **Root Morphology** - Tap root & adventitious roots, Modifications for storage, Respiration & reproduction.
2. **Stem Morphology:** - shape, surface, texture, nature, Branching (Monopodial, Sympodial), modifications (Runner, Rhizome, Tuber, Bulb, cladode).
3. **Leaf Morphology:** --Typical Leaf, Types (Simple, Compound), Phyllotaxy, Venation, and modifications of leaf (Tendril, Phyllode)

7.5 Hrs

Unit-II

1. **Inflorescence: Introduction and definition.**
   Types:
   a) Racemose -Raceme, Spike, Spadix, Corymb, Umbel, Catkin and Capitulum.
   b) Cymose -Solitary, Monochasial- Helicoid and scorpiod; Dichasial and Polychasial.
   c) Special types -Verticillaster, Cyathium and Hypanthodium.
2. **Flower: Introduction and definition**
   Parts of a typical flower: Bract, Pedicel, Thalamus- forms, Perianth- Calyx and Corolla, Androecium and Gynoecium.
   Symmetry: Actinomorphic and zygomorphic, Sexuality- Unisexual and bisexual, Insertion of floral whorls on thalamus- Hypogyny, Epigyny and perigyny, Merous condition-Trimerous, tetrmerous and pentamerous.
3. **Floral whorls:**
   Calyx: Nature- Polysepalous, Gamosepalous; Aestivation- types, Modifications of Calyx- Pappus, Petaloid and Spurred.
   Corolla: Forms of Corolla: Polypetalous- Cruciform and Papilionaceous. Gamopetalous- Infundibuliform, Bilabiate, Tubular and Campanulate.

7.5 Hrs

Unit-III

1. **Aestivation**- types and significance.
   Perianth: Nature- Polytepalous, Gamotepalous.
2. **Androecium:**-Structure of typical stamen, Variations- cohesion and adhesion.
3. **Gynoecium:**—Structure of typical carpel, number, position, cohesion and adhesion; placentation- types and significance.
4. **FRUITS:** Introduction and definition
   Types of fruits:
   a) Simple: Indehiscent - Achene, Cypsela, Nut and Caryopsis. Dehiscent - Legume, Follicle and Capsule,
   b) Fleshy: Drupe, Berry, Hesperidium and Pepo.
   c) Aggregate: Etaerio of Berries and Etaerio of Follicles.
   d) Multiple fruits: Syconus and Sorosis.

7.5 Hrs

Unit-IV

1. **ANATOMY:** Introduction and definition **TYPES OF TISSUES:** a) Outline with brief description, simple and complex tissues. b) Meristematic tissues: Meristem, characters and types based on origin, position and plane of division, functions. c) Permanent tissues: Simple tissues - parenchyma, collenchyma's, chlorenchyma and sclerenchyma. d) Complex/Vascular tissues: Components of xylem and phloem, types of vascular bundles and functions. e) Epidermal tissues: Epidermis, structure of typical stomata, trichomes. **INTERNAL ORGANIZATION OF PRIMARY PLANT BODY** a) Internal structure of dicotyledon and monocotyledon root. b) Internal structure of dicotyledon and monocotyledon stem. c) Internal structure of dicotyledon and monocotyledon leaf.	7.5 Hrs

Suggested Readings

1. Chandurkar, P.J. (1989). Plant Anatomy. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Dutta, A.C. (2003). Botany for Degree students. Oxford University Press, New Delhi.
3. Eames, J. and Mc. Daniels (1994). An Introduction to Plant Anatomy. Tata McGraw Hill Publishing Comp., New Delhi.
4. Esau, K. (1993). Plant Anatomy. Wiley Eastern Ltd. New Delhi.
5. Esau, K. (2006). Anatomy of seed plants. John Wiley and Sons, New York.
6. Fahn, A. (1974). Plant Anatomy. Pergamum Press Oxford.
7. Gangulee, Das and Dutta (2002). College Botany. Vol. I. New Central Book Agency, Kolkata.
8. Lawrence, G.H.M. (2012). Taxonomy of vascular Plants. Scientific Publishers (India) Jodhpur.
9. Naik, V.N. (1994). Taxonomy of Angiosperms. Tata McGraw Hill Publishing Comp., New Delhi.
10. Pandey, B.P. (2007). Plant Anatomy. S. Chand and Co. Ltd. New Delhi.
11. Pandey, B.P. (2009). A Text Book of Botany- Angiosperms. S. Chand and Co. Ltd. New Delhi.
12. Radford, Albert E. (1986). Fundamentals of Plant Systematics. Publ. Harper and Row, New York.

B. Sc. Semester-V
Minor Paper 6
Plant Taxonomy
(B-BO357T)

Minor Paper-6 Theory	Hours: 2Hours/Week	Marks: 40(ESE)+10(CIE)=50	Credit: 2

Unit-I

1. **Origin of Angiosperms** (Benettitalean theory). Phylogeny of Angiosperm: Homology, monophyly, polyphyly, Clads. — 7.5 Hrs
2. **Fossil Angiosperms:** Flower (*Sahanianthus*), Fruit (*Enigmocarpon*)
3. **Introduction to Angiosperms Taxonomy**: Definition, scope, objectives and importance of taxonomy.
4. Floras, Herbarium, keys (Indented and Bracketed), Botanical Nomenclature: Principles (rank and ending of taxa, principle of priority)
5. Rules and Recommendations; 'Type' specimen and its types (Holotype, Paratype, Isotype, Lectotype, Neotype).
6. Concept of Typification. Ranks and endings of taxa names, Coining of Genus and Species names Single, double and multiple authority citations

Unit-II

1. **Systems of classification** — 7.5 Hrs
   Comparative account of various systems of classification
   a) Artificial system- Carl Linnaeus
   b) Natural system- Bentham and Hooker
   c) Phylogenetic system- Engler and Prantl
   d) APG system- A brief review
2. **Modern trends in Taxonomy:** Cytotaxonomy (Karyotype), Phytochemistry (Proteins, flavonoids, Betalains), Taximetrics to taxonomy

Unit-III

5. **Study of Plant Families** (Dicot) — 7.5 Hrs
   Study of following families with reference to systematic position (As per Bentham and Hooker's system of classification), salient features, floral formula, floral diagram and any two examples with their economic importance-Malvaceae, Brassicaceae, Fabaceae (Papilionoideae, Caesalpinioideae, Mimosoideae)

Unit-IV

6. **Study of Families (Dicot):** Solanaceae, Asteraceae, Asclepiadaceae, Euphorbiaceae — 7.5 Hrs
7. **Study of Families (Monocot):** Poaceae, Liliaceae

Suggested Readings

1. Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
2. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
3. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III (Repr. ed), Botanical Survey of India.
4. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas Nel and Sons Ltd. London.
5. Datta S.C. (1988). Systematic Botany. New Age Publ.
6. Davis P.H and V.H Heywood (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
7. Heywood V.H. (1967). Plant Taxonomy, Hodder & Stoughton Educational, London.
8. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. (2008). Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers.Sunderland, Massachusetts, USA.
9. Lawrence G.H.M. (1955). An Introduction to Plant Taxonomy. McMillan, New York.
10. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. McMillan, New York.
11. Mondol A.K. (2016) Advanced Plant Taxonomy, New Central Book Agency (NCBA)
12. Naik V.N. (1988) Taxonomy of Angiosperms. Oxford and IBH
13. Pande B.P. (2001) Taxonomy of Angiosperms. S. Chand.
14. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
15. Santapau H. (1953). The Flora of Khandala on the Western Ghats of India. BSI
16. Sharma O.P. (2011), Plant Taxonomy, Tata Mc grow Hill
17. Shivrajan V.V. & N.K.P. Robson (1991). Introduction to Principles of Plant Taxonomy. Cambridge Univ. Press
18. Shukla Priti and Shital Mishra (1982). An introduction to Taxonomy of angiosperms. Vikas Publ.
19. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.
20. Singh N.P. (2001) Flora of Maharashtra Volume-II BSI, Kolkatta
21. Singh N.P. (2003) Flora of Maharashtra Volume-III BSI, Kolkatta
22. Singh N.P., S. Karthikeyan (1996) Flora of Maharashtra Volume-I, BSI, Kolkatta

B. Sc. Semester-V
Minor Lab-3 (B-BO358P)

Based on Min. Paper-5 & 6	Hours: 2 Hours/Week	Marks: 40(ESE)+10(CIE)=50	Credit: 2

1. Types and modifications of root.
2. Structure and modifications of stem.
3. Structure, types and modifications of leaf.
4. Study of Inflorescence.

a. Racemose: Raceme, Spike, Spadix, Catkin, Corymb, Umbel and Capitulum

b. Cymose: Solitary cyme, Uniparous cyme: helicoid and scorpiod, Biparous cyme and Multiparous cyme.

c. Special type: Verticillaster, Hypanthodium and Cyathium.

5. Study of flower with respect to Calyx, Corolla and Perianth, Androecium and Gynoecium.
6. Study of fruits with suitable examples.

a) Simple fruit: Dry: Achene, Cypsella and Legume; Fleshy: Berry and Drupe.

b) Aggregate fruit: Etaerio of follicles and Etaerio of Berries.

c) Multiple fruit: Syconus and Sorosis.

7. Study of simple tissue, complex tissue and secretory tissue from permanent slides
8. Study of types of vascular bundles
9. Study of internal structure of dicot and monocot root using hand section and prepare temporary mounts -Sunflower, Maize
10. Study of internal structure of dicot and monocot stem using hand section and prepare temporary mounts -Sunflower, Maize
11. Study of internal structure of leaves- Nerium, Maize
12. Study of Families covered in the theory portion.
13. Study of fossil Angiosperms specimens: *Sahanianthus, Enigmocarpon*
14. Preparation of Keys.
15. Identification of plant species using flora.

Suggested activity:

Seminar, Quiz, debate, Assignments, Botanical Excursions (Two short or One long out of the state is compulsory).

B. Sc. Semester-V
Minor Lab-3 (B-BO358P)

Time: 4hrs. **Max. Marks: 40**

1. Describe (Calyx, Corolla, Androecium & Gynoecium) of given Flower [A] **4 Marks**

2. Prepare temporary mount of the given material [B](Root) & identify giving diagnostic character **6 Marks**

3. Prepare temporary mount of the given material [C](Leaf) & identify giving diagnostic character **5 Marks**

4. Describe in technical language the given Angiospermic material [D] (dinocot). Classify &Identify the Family giving reasons **5 Marks**

5. Describe in technical language the given Angiospermic material [E](monocot). Classify &Identify the Family giving reasons **5 Marks**

6. Write floral formula and Draw Floral Diagram of the given flower [F] **5 Marks**

7. **Spotting:** **5 Marks**
   D. Type of Fruit.
   E. Root Anatomy
   F. Stem Anatomy
   G. Whole specimen or a permanent slide of Plant disease studied.
   H. Fossil Angiosperm

8. Record and excursion report (submission is compulsory) **5 Marks**

B. Sc. - SEMESTER –V BOTANY PRACTICAL
VOCATIONAL SKILL ENHANCEMENT COURSE
VSC LAB-3 Instrumentation for Botany Laboratory (B-BO359P)

Course objectives: -

1) To provide judicious mix of skills relating to a profession and appropriate content of Laboratory Instrumentation
2) Familiarize students with the sterilization Techniques.

Course outcomes: -

To learn the basic principles of instrumentation
To demonstrate the methods in microbiology sterilization
To gain the Knowledge about laboratory organization for molecular biology

Laboratory Exercise	Hours: 4 Hours/Week	Marks: 40(ESE)+10 (CIE)=50	Credit: 2

1. Neutralization and cleaning of glassware.
2. To study the principle of and application of Autoclave,
3. To study the principle of and application of BOD Incubator
4. To study the principle of and application of Hot Air Oven
5. To study the principle of and application of pH Meter, spectrophotometer, Colony Counter,
6. To study the principle of and application of spectrophotometer
7. To study the principle of and application of Centrifuge Machine
8. To study the principle of and application of Laminar Air Flow.
9. Sterilization of culture media using autoclave and assessment for sterility.
10. Sterilization of glassware using hot air oven.

Suggested activity:

Seminar, Quiz, debate, Assignments, collection of Angiospermic plant and study of higher plants preparation of herbarium and visit to local area, Field work, Study Projects, Models etc. are Part of Curriculum and considered along with attendance for Continuous Internal Evaluation (CIE)

B.Sc. - SEMESTER –V
BOTANY PRACTICAL
VSC LAB-3 Instrumentation for Botany Laboratory (B-BO359P)

Time: 4hrs. **Max. Marks: 40**

1.	Sterilization of Cultute media in an Autoclave.	**08 Marks**
2.	To perform Bacterial culture streaking in laminar air flow.	**08 Marks**
3.	To take absorbance of given sample using spectrophotometer.	**08 Marks**
4.	**Spotting:**	**08 Marks**
	a) ….	
	b) ….	
5.	Viva-voce	**04 Marks**
6.	Practical Record and tour report (submission is compulsory)	**04 Marks**

B. Sc. Semester-V
COMMUNITY ENGAGEMENT & SERVICE (CEP)
(B-BO360P)

Objective: To enable students to:

1. Provide opportunities to understand the different socio-economic contexts.
2. Understand the village/society work ethics, culture, tradition, and conventional methods, giving students exposure to development-related issues in rural and urban areas.
3. Offer hands-on experience in teamwork with sincerity and earnestness about the rural community practices, thereby enhancing professional skills such as communication, work ethics, conflict resolution, etc., with a lasting impact on lifelong learning and professional development.
4. Gain knowledge about botanical resources used by rural community, their conservation, and the structure and components of village ecosystems.

Course Outcomes: After completing the field project, the student will be able to:

1. Practice teamwork skills with sincerity and earnestness in botanical research.
2. Adapt the village/society's botanical work ethics, traditions, and conventional methods in their professional practice.
3. Disseminate knowledge plant resources, their sustainable use, and conservation strategies.
4. Analyse and document the botanical resources of the village ecosystem, identifying and designating its respective components.

Community Services	**Hours: 2 Hours/Week**	**Marks: 25(CIE)=25**	**Credit:1**

A student is required to undergo and successfully complete this 60 hour of Community Services course as mentioned in the teaching and examination scheme under the guidance of a supervisor/mentor assigned by Head of the Department. This course must be corresponding to the 'MAJOR' i.e Botany.

Guidelines:

1. The Field based community engagement and Services is an individual or a group activity with a maximum of three students in a group.
2. The activity shall include participation in the activities related to National Service Scheme (NSS), National Cadet Corps (NCC) literacy initiatives, biodiversity preservation, and mentoring school students with minimum of 60 Hrs. of work either in Institute Campus or above-mentioned activities.
3. The student or the group of students done the work will have to make a final presentation and appear for one Viva-Voce based on the work describing their participation and contribution in the activity at the end of semester as per the schedule given by the Institute.
4. The completed Community Service report should be submitted to the CEP- Coordinator on or before the last day of the semester.
5. The Field based community service draft report as well as the final presentation will be evaluated by an external examiner (as per norms). If an external examiner is not available,

the Head of department may appoint an external examiner from the Department with the prior permission of the Director.

6. **Following activities shall be covered under Community Engagement Program:**

a. Creating environmental awareness among villagers/society in residential areas about flora.
b. Contribute for prevention of nearby biodiversity loss.
c. Communicate residential/commercial areas on importance of biodiversity.
d. Study the ecosystem in the surrounding areas.

B.Sc. Sem-VI (BOTANY -Major, Minor from Basket)

Sr No	Course Category	Name of the course(Title of the Paper)	Course code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination(Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 11:- **Plant Ecology Phytogeography & Plant Utilization**	B-BO361T	5.5	3	--	--	3	3	60	15	30
		Paper 12:- **Plant Biotechnology & genetic Engineering**	B-BO362T		3	--	--	3	3	60	15	30
		DSC Lab (Based on Paper 11 +Paper 12)	B-BO363P		--	--	6	3	6	60	15	38
2	DSE	Elective 2:-**Plant Tissue Culture**	B-BO364T		2	--	--	2	2	40	10	20
		DSE Lab-2 (Based on Elective 2)	B-BO365P		--	--	4	2	4-6	40	10	25
3	Minor	Paper 7:- **Angiosperm Systematics & Embryology**	B-BO366T		2	--	--	2	2	40	10	20
		Minor Lab-4 (Based on Paper-7)	B-BO367P		--	--	2	1	4-6	40	10	25
4	VSEC	Refer VSC Basket **VSC-4: Biodiversity and Conservation**	B-BO368P		--	--	4	2	4 - 6	40	10	25
5	OJT	**Internship / Apprenticeship** (Related to DSC)	B-BO369OJT		--	--	8	4	4 – 6	80	20	50
					10	**--**	**24**	**22**		**440**	**110**	**--**

B.Sc Sem VI

Course Code: B-BO361T

DCS Paper-11 Plant Ecology, Phytogeography and Plant Utilization (3 Credits)

Course Objectives: -

1. To introduce the students with environmental factors affecting the plants,
2. To introduce the basic principles of ecology and phytogeography.
3. To make them understand complex community patterns and processes, and ecosystem functioning
4. To make the students familiar with economic importance of diverse plants that offer resources to human life.
5. To emphasize the plants used as- food for man, fodder for cattle, feed for poultry, plants having medicinal value and also plant source of huge economic value etc.

Course Outcome

After studying this course the students will be,

1. Able to understand various ecological factors and their importance.
2. Understand the principles of ecology and phytogeography.
3. Understand components of ecosystem and its function.
4. Would have first hand information of plants used as food, the various kinds of nutrients available in the plants.

DCS Paper-11 **Theory**	**Hours: 3Hours/Week**	**Marks: 60(ESE)+15(CIE)=75**	**Credit: 3**

Unit-I

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. Edaphic factors: Soil; Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development. Ecological factor: Water: Importance; States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. Light, temperature, wind and fire: Variations; adaptations of plants to their	11.25 Hrs

variation	
Unit-II	
Ecosystem and Biotic interactions Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids. Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus. Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; Population ecology: Characteristics and Dynamics .Ecological Speciation , Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.	11.25 Hrs
Unit-III	
Phytogeography Principles; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation. Plant Utilization: Origin of Cultivated Plants : Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.	11.25 Hrs
Unit-IV	
Cereals : Wheat and Rice (origin, evolution, morphology, post-harvest processing & uses); Green revolution; Brief account of millets and pseudocereals. Legumes : General accounts (including chief pulses grown in India); Importance to man and ecosystem. Sugars and Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses Spices : Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper , Beverages: Tea, Coffee (morphology, processing & uses)	11.25 Hrs

Oil and fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses)., Natural Rubber: Para-rubber: tapping, processing and uses. Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses)	

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
6. Shukla and Chandel (2016). A text book of Plant Ecology. S Chand Publication, New Delhi
7. Ambasht R.S. 1995 A text book of plant ecology Student and co. Varanasi-5
8. Anderson JM Ecology for environmental sciences: biosphere ecosystems and man
9. Clements FE 1916 Plant succession, An analysis of the development of vegetation. Carnegie Institute of Washington.
10. Kochhar PL 1986 Plant Ecology Ratan prakashan, Mandi, Agra.
11. Kumar HD 1994 Modern concepts of ecology. Vikas publishing house pvt ltd, New Delhi.
12. Odum EP 1963 Ecology Holt Reinhart and Winston Inc.
13. Odum EP 1983 Basic Ecology, Saunders Publ Philadelphia.
14. Dash MC 1993 Fundamentals of Ecology WB Saunders and co. Philadelphia USA.
15. B. P. Pandey (2017) Economic Botany. S. Chand Publication, New Delhi
16. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India

B.Sc Sem VI

Course code: B-BO362T

DSC Paper-12 Plant Biotechnology and Genetic Engineering (Credit 3)

Course Objectives: -

1. To introduce the students with the various concept of biotechnology.
2. To introduce the aims and objectives of genetic engineering
3. To make them aware of various application of plant biotechnology
4. To explain the process of plant tissue culture

Course Outcome

After studying this course, the students will be,

1. Able to understand the concept of Biotechnology
2. Aware of purpose of genetic engineering
3. Can use methods of plant tissue culture.
4. Aware of various applications of plant biotechnology.

DSC Paper -12 **Theory**	**Hours: 3Hours/Week**	**Marks: 60(ESE)+15(CIE)=75**	**Credit: 3**

Unit-I

1. Recombinant DNA technology: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC). 2. Genetic engineering of plants: Aims, strategies for development of transgenics (with suitable examples); 3. Agrobacterium-the natural genetic engineer	11.25 Hrs

Unit-II

1. Gene Cloning: Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR	11.25 Hrs

Unit-III	
1. Plant tissue culture: Basic concepts; Principles and scope; tissue culture media; callus induction and cell suspension; aspects of morphogenesis; 2. Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).	11.25 Hrs
Unit-IV	
1. Methods of gene transfer: Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; 2. Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP). 3. Applications of Biotechnology : Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations)	11.25 Hrs

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
6. Dubey, R. C. 2014 Advanced Biotechnology. S. Chand & Co. Pvt. Ltd., New Delhi.

B. Sc. Semester-VI

DSC Lab-6

Course Code: B-BO363P

Plant Ecology, Phytogeography and Plant Utilization

Plant Biotechnology and genetic Engineering

DSC Practical	Hours: 6 Hours/Week	Marks: 60(ESE)+15(CIE)=75	Credit: 3

DSC XI Lab work : Plant Ecology, Phytogeography and Plant Utilization

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.

2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)

3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.

4. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.

5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.

6. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each). (b). Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).

8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).

9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.

10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.

11. Field visit to familiarise students with ecology of different sites.

12. Cereals: Wheat (habit sketch, L.S/T.S. grain, starch grains, micro-chemical tests), Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests). Millets and Pseudocereals (specimens / photographs and grains)

13. Legumes: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).

14. Fruits: Mango (habit sketch, L.S. fruit, micro-chemical tests in ripe fruit); Citrus (habit sketch, T.S. hesperidium, W.M. vesicle, micro-chemical tests including test for vitamin C)

15. a. Sugars and starches: Potato. , b. Spices: Black pepper, Fennel and Clove c. Beverages: Tea, Coffee. d. Oils and fats: Coconut, Mustard. e. Rubber f. Fiber-yielding plants: Cotton, Jute

Plant Biotechnology and Genetic Engineering 1. Introduction of Equipments required for Plant Tissue culture: Autoclave, Hot Air Oven, Laminar Flow, Culture racks, Incubation facility. 2. Sterilization of glasswares 3. Preparation of MS medium. 4. Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, Datura, Brassica etc. 5. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs. 6. Isolation of protoplasts. 7. Construction of restriction map of circular and linear DNA from the data provided. 8. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 9. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs. 10. Isolation of plasmid DNA. 11. Restriction digestion and gel electrophoresis of plasmid DNA.	

Question Paper

Course Code: **B-BO363P**

DSC Lab Based on Ecology and Plant biotechnology

Time: 6 Hours Full Marks: 60

1. One Major Experiment from Group A	15
2. One Minor Experiment from Group A	05
3. One Major Experiment from Group B	15
4. One Minor Experiment from Group B	05
5. Identify and comments on given two spots	10
6. Practical record	05
7. Viva-voce	05

B. Sc. Semester-VI
DSE Elective 2: -

Plant Tissue Culture

(B-BO364T)

Course objectives: -

1. Understand the scope, aims, principles, and historical development of plant tissue culture
2. Develop skills in plant tissue culture.

Course outcome: -

1. To learn the basic principles of plant tissue culture
2. To demonstrate themethods in Plant Tissue Culture
3. Understand the applicability of Plant Tissue culture in relation to presentday problems.
4. To gain the Knowledge about laboratory organization for plant tissueculture.
5. Understand various Aseptic techniques for planttissue culture

DSE Elective 2 Theory	**Hours: 2Hours/Week**	**Marks: 40(ESE)+10(CIE)=50**	**Credit: 2**

Unit-I

1. History of plant tissue culture research - basic principles of plant tissue culture. 2. Laboratory organization, design and layout, equipment's (Laminar air flow, autoclave, distillation unit, pH meter, orbital shaker, microscope, deep freezer, growth chamber) and their working principles, laboratory ethics and practices.	7.5 Hrs

Unit-II

1. Nutrient media and their types, importance, Preparation of stocks, pH and Buffers and theirsignificance in media. 2. Media Constituents: Vitamins, Unidentified supplements, (carbohydrate for energy source, Nitrogen source and organic supplements, complex substances, hormones, Activate charcoal)	7.5 Hrs

Unit-III

1. Concept of totipotency, cells differentiation and dedifferentiation. Factors affecting vascular tissue differentiation 2. Callus culture: induction of callus, transfer, subcultures, morphological features and growth kinetics 3. Concepts of Morphogenesis, organogenesis	7.5 Hrs

Unit-IV

1. Micropropagation: steps, advantages, applications andchallenges 2. Meristem culture, organ culture, axillary bud proliferationtechnique and applications 3. Synthetic seed- technique, advantages, applications. 4. Somatic embryogenesis: steps, induction, direct and indirectsomaticembryogenesis, Factors affecting somaticembryogenesis.	7.5 Hrs

Suggested Readings

1. Bhojwani, S. S. (1990). Plant tissue culture: Theory and practical (Revised ed.). New York, NY: Elsevier Science Publishers.

2. Bhojwani, S. S. (1996). Plant tissue culture: Application and limitations. New York, NY: Elsevier Science Publishers.

3. Vasil, I. K., & Thorpe, T. A. (1994). Plant cell and tissue culture. The Netherlands: Kluwer Academic Publishers.

4. Shantharam, S., & Montgomery, J. F. (1999). Biotechnology, biosafety and biodiversity.New Delhi, India: Oxford & IBH Publishing Co. Pvt. Ltd.

5. Glick, B. R., & Thomson, J. E. (1993). Methods in plant molecular biology and biotechnology. Boca Raton, FL: CRC Press.

6. Dubey, R. C. (n.d.). A text book of biotechnology. New Delhi, India: S. Chand Publication.

7. Smith, R. H. (2013). Plant tissue culture: Techniques and experiments (3rd ed.). Boston, MA: Academic Press.

8. Dixon, R. A. (Ed.). (1994). Plant cell culture: A practical approach. Oxford, UK: Oxford University Press.

B. Sc. Semester-VI

DSE Laboratory Exercise-2

DSE Lab-2 (B-BO365P)

Based on DSE	Hours: 4Hours/Week	Marks: 40(ESE)+10(CIE) =50	Credit: 2

1. Handling and Instrumentation of Plant Tissue Culture
2. Principals and applications of- Autoclave, Laminar Airflow, Hot AirOven.
3. Sterilization techniquesfor glassware, tools etc.,
4. MS medium - Preparation of different stock solutions; media preparation
5. Sterilization of seeds for prepration of explant
6. Preparation of Explant and sterilization of explant.
7. Explant preparation, inoculation and initiation of callus.
8. Callus formation, growth measurements.
9. Preparation of mother plants for collection of explants
10. Primary hardening of tissue culture plants for their acclimatization

B. Sc. - SEMESTER –VI BOTANY PRACTICAL

Based on DSE Lab-2 (B-BO365P)

Time: 4hrs. **Max. Marks: 40**

1. To prepare different stock solution and MS media **08 Marks**
2. To sterilize seeds for explant formation **06 Marks**
3. To prepare, sterilize and inoculate explant for callus induction **08 Marks**
4. Sterilization of culture media using autoclave. 06 **Marks**
5. **Spotting:** **06 Marks**

   L. ….

   M. …..

   N. ….

6. Viva-voce, Record and excursion report (submission is compulsory) **06 Marks**

B. Sc. SEM-VI
Minor Paper 7 (B-BO366T)
Angiosperm Systematics and Embryology

Minor Paper 7 Theory	Hours: 2Hours/Week	Marks: 40+10=50	Credit: 2

Course Objectives: -

5. To introduce the students with Principles of classification, nomenclature
6. To introduce the students with morphology of male and female gametophyte.

Course Outcome

After studying this course, the students will be,

5. Able to understand origin and classification of angiosperms
6. Understand reproductive structure of flower.

Unit-I	
Principles of classification, nomenclature: Comparative study of different classifications viz. Linnaeus, Bentham and Hooker, Engler and Prantl, Hutchinson and Cronquist. **Herbaria and Botanical Gardens**: Functions of Herbarium, Important herbaria (World: Kew herbarium; India: Central National Herbarium, Kolkata). Botanic gardens of the world (Royal Botanic Garden, Kew) and India	7.5 Hrs
Unit-II	
Plant Embryology: Introduction. Definition and scope of plant embryology **Microsporangium and male gametophyte**. Structure of tetrasporangiate anther Types of tapetum Sporogenous tissue. Microsporogenesis: process and its types. Types of microspore tetrad. Male gametophyte: structure and development of male gametophyte	7.5 Hrs
Unit-III	
Megasporangium and female gametophyte: Structure. Types of ovules. Types of megaspore tetrads. Female gametophyte: structure of typical embryo sac Types of embryo sacs – monosporic, bisporic and tetrasporic	7.5 Hrs
Unit-IV	
Pollination and Fertilization: Introduction and definition Types of pollination. Germination of pollen grain Entry of pollen tube- porogamy, mesogamy and chalazogamy Double fertilization and its significance. **Endosperm and embryo** Endosperm: Types – nuclear, helobial and cellular. Structure of Dicotyledonous and Monocotyledonous embryo	7.5 Hrs

Suggested Reading

1. Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
2. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
3. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III

   (Repr. ed), Botanical Survey of India.
4. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas

   Nel and Sons Ltd. London.
5. Datta S.C. (1988). Systematic Botany. New Age Publ.
6. Plant Anatomy, Chandurkar P J, Plant Anatomy Oxford and IBH publication Co. New

   Delhi 1971
7. B P Pandey, Plant Anatomy. S Chand and Co. Ltd, New Delhi 1978
8. Greulach V A and Adams J E Plant- An introduction to Modern Biology, Toppen Co. Ltd, Tokyo,
9. Eams and Mc Daniel,An Introduction to Plant Anatomy, McGraw –Hill Book Co. Ltd and Kogakusha Co, Tokyo, Japan
10. Adriance S Foster Practical Plant Anatomy, D Van Nostrand Co. INC, New York
11. Esau, Plant Anatomy, Wiley Toppan Co. California, USA
12. Pijush Roy, Plant Anatomy. New Central Book Agency Ltd, Kolkata
13. Pandey S N and Ajanta Chadha, Plant Anatomy and Embryology, Vikas Publishing House,Pvt, Ltd, New Delhi
14. Bhojwani S S and Bhatnagar S P, An Embryology of Angiosperms
15. Maheshwari P, An introduction to Embryology of Angiosperm

B. Sc. Semester-VI
Minor Laboratory Exercise-4 (B-BO368P)

Based on Minor Paper 7	Hours: 2 Hours/Week	Marks: 20(ESE)+05(CIE)=25	Credit: 1

1. Study of dicot and monocot embryo with the help of permanent slide
2. Study of tetrasporangiate anther and types of ovules with the help of permanent slides
3. Study of types of pollen grains, adaptations for pollination
4. To calculate the percent pollen germination in the given specimen
5. Identification of plant family by using key
6. Preparation and submission of Herbarium.
7. Botanical Excursions (One short tour is compulsory)

B. Sc. Semester-VI
BOTANY MINOR PRACTICAL-4
Based on Minor Paper 7 (B-BO368P)

Time: 4hrs. **Max. Marks: 20**

1. Identify the given plant material [A] up to family level using provided key **5 Marks**

2. Prepare temporary mount of the given pollen material [B] & Calculate percent germination in the given pollen grains 4 **Marks**

3. Herbarium submission [C] 3 **Marks**

4. **Spotting:** **3 Marks**
   D. Embryology
   E. Anther
   F. Pollination

5. Record and excursion report (submission is compulsory) 2 **Marks**
6. **Viva Voce** **3 Marks**

B. Sc. Semester-VI
VSC Laboratory Exercise-4 (B-BO369P)
Biodiversity and Conservation

Laboratory Exercise	Hours: 4 Hours/Week	Marks: 40(ESE)+10(CIE)=50	Credit: 2

Objective:

1. Understanding Biodiversity of India and World.
2. Understanding need of plant conservation;
3. Understanding importance of National parks, Biospheres, botanical gardens etc.
4. Understand the vegetation types around them.

Outcome:

1. Learn and apply the knowledge of Biodiversity and conservation methods.
2. Learn and apply the knowledge of conservation methods.
3. Learn and apply techniques of Botanical gardens etc.

1. A trip to the grass land/ forest/ water body to get acquainted with their plant species.
2. Demonstration of different types of vegetation sampling methods – transects and quadrats.
3. To determine minimum size and number of quadrats required to study grassland.
4. To determine minimum size and number of quadrats required to study Forest area.
5. Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover, dominance, Abundance and IVI.
6. To determine the homogeneity of vegetation by Raunkier's frequency diagram.
7. To determine diversity indices (Shannon-Weiner, species richness, B-diversity) from given data.
8. Population structure study of dominant tree species of the locality.
9. To study ecological adaptations of the given plants.
10. To study the various methods of conservation- In-situ and Ex-situ.

Based on Biostatistics

1. Calculate mean, variance, standard deviation and coefficient of variation for comparing two means related to given ecological data.
2. Calculate mean, variance, and to use t-test for comparing two means related to given ecological data.
3. To find out association between important grassland species from the given data using chi- square test.

B. Sc. Semester-VI
VSC Laboratory Exercise- 4 (B-BO369P)
Biodiversity and Conservation

Time: 4-6hrs. **Max. Marks: 40**

1.	To perform given major Experiment [A] & report the findings	**10 Marks**
2.	To perform the minor Experiment [B] & report the findings	**5 Marks**
3.	To solve the given statistical problem B	**5 Marks**
4.	To study morphological and anatomical characteristics of the given plant material with reference to ecological adaptations.	**5 Marks**
5.	Spotting	**5 Marks**
6.	Viva-voce	**5 Marks**
7.	Practical Record and Excursion report	**5 Marks**

Suggested activity: Study of locally available vegetation, Study of tree species, Field visit, Field diary, Practical record, Data analysis.

B. Sc. Semester-VI

Internship / Apprenticeship (Related to DSC) (OJT)

(B- BO369OJT)

Objective: To enable students to:

1. **Core Competency Development**: Enhancing knowledge of plant biology, classification, and physiological processes.
2. **Hands-on Training**: Providing exposure to modern biological techniques and laboratory practices.
3. **Analytical & Research Skills**: Developing the ability to conduct experiments, analyze data, and solve scientific problems.
4. **Digital Proficiency**: Integrating traditional botanical knowledge with modern digital tools and techniques.
5. **Environmental Awareness**: Understanding biodiversity conservation, sustainable practices, and ecological interactions.
6. **Entrepreneurship & Career Readiness**: Preparing students for careers in botany-related fields, including agriculture, environmental science, and biotechnology.

Course Outcomes: After completing the OJT, the student will be able to:

1. **Practical Skills**: Students gain hands-on experience in laboratory techniques, plant identification, and ecological assessments.
2. **Research & Analytical Abilities**: They develop skills in data collection, analysis, and scientific reporting.
3. **Industry Readiness**: The training prepares students for careers in agriculture, environmental science, biotechnology, and related fields.
4. **Sustainability & Conservation**: Students learn about biodiversity conservation, sustainable agricultural practices, and ecological interactions.
5. **Technological Integration**: Exposure to modern tools like bioinformatics, tissue culture, and genetic engineering enhances their technical proficiency.
6. **Entrepreneurial & Career Development**: The program fosters skills for startups, research projects, and employment opportunities in botany-related industries.

OJT	**Hours: 8 Hours/Week**	**Marks: 100(CIE)=100**	**Credit:4**

A student is required to undergo and successfully complete this 120 hour of **Internship / Apprenticeship** (Related to DSC) course as mentioned in the teaching and examination scheme under the guidance of a supervisor/mentor assigned by Head of the Department. This course must be corresponding to the 'MAJOR' i.e Botany.