Syllabus

For

B. Sc. (Botany)

Choice Based Credit System

(w.e.f. session 2021-2022 onward)

Department of Botany and Microbiology

Gurukul Kangri (Deemed to be University)

Haridwar

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Details of Courses Under Undergraduate Program (B.Sc.)

Course	*Credits	
	Theory+ Practical	Theory+ Tutorials
I. Core Course **(12 Papers)**	12X4= 48	12X5= 60
04 Courses from each of the 03 disciplines of choice		
Core Course Practical/ Tutorial* **(12 Practical/ Tutorials*)**	12X2= 24	12X1= 12
04 Courses from each of the 03 Disciplines of choice		
II. Elective Course **(6 Papers)**	6X4= 24	6X5= 30
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Elective Course Practical / Tutorials* **(6 Practical / Tutorials*)**	6X2= 12	6X1= 6
Two papers from each discipline of choice including paper of interdisciplinary nature.		

- **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester**

III. Ability Enhancement Courses

1.Ability Enhancement Compulsory (2 papers of 2 credits each) Environmental Science **English/MIL Communication**	2X4= 8	2X4= 8
2. Skill Enhancement Course (Skill Based) (4 Papers of 2 credits each)	4X4= 16	4X4= 16
	Total credit= 132	**Total credit= 132**

Institute Should evolve A system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own.

***wherever there is practical there will be no tutorials and vice- versa.**

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Proposed scheme for choice based credit system in B. Sc. Program with Botany

	DISCIPLINE CORE COURSE (12)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective DSE (6)
I	**Discipine-1 Botany** Paper I: Biodiversity (Microbes, Algae, Fungi and Archegoniate)	(English/MIL Communication)/ Environmental Science		
	DSC-2 Paper I			
	DSC-3 Paper I			
II	Discipine-1 Botany Paper II: Plant Ecology and Taxonomy	Environmental Science/ (English/MIL Communication)		
	DSC-2 Paper II			
	DSC-3 Paper II			
III	Discipine-1 Botany Paper III: Plant Anatomy and Embryology		**SEC-1**	
	DSC-2 Paper III			
	DSC-3 Paper III			
IV	Discipine-1 Botany Paper IV: Plant Physiology and Metabolism		**SEC-2**	
	DSC-2 Paper IV			
	DSC-3 Paper IV			
V			**SEC-3**	DSE-Botany Paper I
				DSE-Discipline Paper I
				DSE-Discipline Paper I
VI			**SEC-4**	DSE-Botany Paper II
				DSE-Discipline Paper II
				DSE-Discipline Paper II

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SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	English/MIL communications/ Environmental Science	4
	Core course - Botany Paper I	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	4
	Core Course - Paper I Practical/Tutorial	Biodiversity (Microbes, Algae, Fungi and Archegoniate) Lab	2
	Discipline- 2 Paper I	DSC- 2 Paper I	4
	Discipline- 2 Paper I Practical	DSC- 2 Paper I Practical	2
	Discipline - 3 Paper I	DSC- 3 Paper I	4
	Discipline - 3 Paper I Practical	DSC- 2 Paper I Practical	2
II	Ability Enhancement Compulsory Course-II	English/MIL communications/ Environmental Science	4
	Core course-Botany Paper II	Plant Ecology and Taxonomy	4
	Core Course- Botany Paper II Practical/Tutorial	Plant Ecology and Taxonomy Lab	2
	Discipline - 2 Paper II	DSC- 2 Paper 2	4
	Discipline - 2 Paper II Practical	DSC- 2 Paper 2 Practical	2
	Discipline - 3 Paper II	DSC- 3 Paper 2	4
	Discipline - 3 Paper II Practical	DSC- 3 Paper 2 Practical	2
III	Core course- Botany Paper III	Plant Anatomy and Embryology	4
	Core Course- Botany Paper III Practical/Tutorial	Plant Anatomy and Embryology Practical	2
	Discipline - 2 Paper III	DSC- 2 Paper III	4
	Discipline - 2 Paper III Practical	DSC- 2 Paper III Practical	2
	Discipline - 3 Paper III	DSC- 3 Paper III	4
	Discipline - 3 Paper III Practical	DSC- 3 Paper III Practical	4
	Skill Enhancement Course -1	SEC- 1	4
IV	Core course- Botany Paper IV	Plant Physiology and Metabolism	4
	Course- Botany Paper IV Practical	Plant Physiology and Metabolism Practical	2

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	Discipline - 2 Paper IV	DSC- 2 Paper IV Theory	4
	Discipline - 2 Paper IV Practical	DSC- 2 Paper IV Practical	2
	Discipline - 3 Paper IV	DSC- 3 Paper IV Theory	4
	Discipline - 3 Paper IV Practical	DSC- 3 Paper IV	2
	Skill Enhancement Course -2	SEC -2	4
V	Skill Enhancement Course – 3	SEC -3	4
	Discipline Specific Elective –Botany Paper I	DSE-Botany Paper I	4
	Discipline Specific Elective –Botany Paper I Practical	DSE-Botany Paper I Practical	2
	Discipline Specific Elective – Discipline 2 Paper I	DSE-Discipline 2 Paper I	4
	Discipline Specific Elective – Discipline 2 Paper I Practical	DSE-Discipline 2 Paper I Practical	2
	Discipline Specific Elective – Discipline 3 Paper I	DSE- Discipline 3 Paper I	4
	Discipline Specific Elective – Discipline 3 Paper I Practical	DSE-Discipline 2 Paper I Practical	2
VI	Skill Enhancement Course – 4	SEC -4	4
	Discipline Specific Elective –Botany Paper II	DSE-Botany Paper II	4
	Discipline Specific Elective –Botany Paper II Practical	DSE-Botany Paper II Practical	2
	Discipline Specific Elective – Discipline 2 Paper II	DSE-Discipline 2 Paper II	6
	Discipline Specific Elective – Discipline 2 Paper II Practical	DSE-Discipline 3 Paper II Practical	6
	Discipline Specific Elective – Discipline 3 Paper II	DSE- Discipline 3 Paper II	6
	Discipline Specific Elective – Discipline 3 Paper II Practical	DSE- Discipline 3 Paper II Practical	6
Total Credits			132

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Details of Courses

Core Courses –Botany

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism

Botany

Skill Enhancement Courses (Any four)

1. Biofertilizers
2. Herbal Technology
3. Nursery and Gardening
4. Floriculture
5. Medicinal and Economic Botany
6. Plant Diversity and Human Welfare
7. Ethnobotany
8. Mushroom Culture Technology
9. Intellectual Property Right

Discipline Specific Electives-Botany (Any two)

1. Plant Biotechnology
2. Cell and Molecular Biology
3. Analytical Techniques in Plant Sciences
4. Bioinformatics
5. Research Methodology
6. Dissertation

Ability Enhancement Compulsory Courses

1. Environmental Science
2. English/MIL Communication

NOTE: Questions of theory paper are to be set under two sections i.e., A and B. In section A, the student has to answer any five out of ten **short answer questions** (150 words) uniformly distributed from the entire syllabus. In Section B, the student has to answer any four questions out of Eight **long answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section B. Section A and B will be of 30, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper

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B.Sc. I Year

Semester – I

BBO-C101

DSC-1 Biodiversity (Microbes, Algae, Fungi and Archegoniate)

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- Introduction to Vedic Botany and Vedic period plants mentioned Vedas and their medicinal properties, uses and plants used in Yajna and environmental purification.
- To acquire knowledge of different microorganism like Virus, Bacteria, Algae, Fungi and Archegoniate.
- To become familiar with general characteristic Biodiversity components.

Learning outcomes:

At the end of course student will be able

- The student will be able to understand Vedic culture and Indian Traditional Knowledge (ITK).
- The student will be able to structural and functional components of Biodiversity conservation.
- The student will be able identify key points for ecosystem and ecological importance of various components of Biodiversity and ecological issues and environmental conservation.
- The student will be able take the decisions for carrier point of views in research, industries, academia and Biodiversity conservation.

Unit 1: Vedic Plants and Microbes

(10 Lectures)

Introduction to Veda and Agnihotra, Concept of botany in Vedas; naming of plant in Rigveda, classification of Vedic plants, medicinal properties in plants; plants used in Yajna and environmental purification; Vedic plants used to control the microbial diseases and for the well fare of human beings; Agnihotra as Vedic technology- use of plants; Virus and bacteria- introduction, reproduction and their economic importance.

Unit 2: Algae

(12 Lectures)

General characteristics, ecology, economic importance, and distribution, range of thallus organization, reproduction, and classification of algae, morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*.

Unit 3: Fungi

(12 Lectures)

General characteristics, ecology, range of thallus organization, cell wall composition, nutrition, reproduction and classification, life cycle of *Rhizopus*, *Penicillium*, *Alternaria*, *Puccinia*, *Agaricus*; Symbiotic associations-lichens General account, reproduction and significance of Mycorrhiza: Ectomycorrhiza and Endo-mycorrhiza and their significance.

Unit 4: Bryophytes and Pteridophytes

(18 Lectures)

General characteristics, adaptations to land habit, classification, range of thallus organization of Bryophytes; Classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Marchantia*, and *Funaria*; Ecology and economic importance of Bryophytes; Pteridophytes: General characteristics, classification, early land plants (*Rhynia*), classification(up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*; (Developmental details not to be included); heterospory and seed habit, ecological and economic importance of Pteridophytes.

Unit 5: Gymnosperms

(6 Lectures)

General characteristics, classification. (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*, (developmental details not to be included), ecological and economical importance.

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DSC-1 SEMESTER I BBO-C151(LAB COURSE-CC-01)

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Oedogonium, Vaucheria, Fucus* and Polysiphonia* through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)
5. *Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structures throughpermanent slides.
6. *Alternaria:* Specimens/photographs and tease mounts.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs)
11. ***Marchantia***- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
12. ***Funaria***- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporaryslides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. ***Selaginella***- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
14. ***Equisetum***- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
15. ***Pteris***- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporaryslides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
16. ***Cycas***- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
17. ***Pinus***- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarfshoot, t.s. needle, t.s. stem, ,l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Suggested readings:

1. Dubey, R.C. 2021. *Vedic microbiology- A Scientific Approach* (English Version), Motilal Banarasidas International, Delhi– 110007.
2. Dubey, R.C. A Text Book of Biotechnology. S. Chand & Company Pvt. Ltd. Ram Nagar, New Delhi-110 055.
3. Dubey, R.C. and Maheshwari, D.K. S. Chand & Company Pvt. Ltd. Ram Nagar, New Delhi-110 055
3. Kumar H.D. 1999. Introductory phycology. Affiliated East West Press, New Delhi.
4. Matthews, R.E. 2013 Fundamentals of Plant Virology ELSEVIER India.
5. Sethi I.K and Walia S.K. 2011. Text book of fungi and their allies. Mc Millian Publishers, New Delhi
6. Vashishta, B.R., Sinha A.K. 2012 Botany for degree students: Fungi. S. Chand New Delhi.
7. Vashishta, B.R., Sinha A.K. and Singh, V.P 2012Botany for degree students: Algae,S.Chand New Delhi.
8. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata Mc Graw-Hill Co, New Delhi.
9. Presscott, L. Harley, J. and Klein, D. (2005) Microbiology, 6th edition, Tata Mc Graw- Hill Co. New Delhi.
10. Fritsch F.E. (1935 The Structure & Reproduction of Algae 1945): Cambridge University Press Cambridge, U.K. Vol. I, Vol. II.
11. Smith, G.M (1955) :Cryptogamic Botany(Vol. I Algae, Fungi, & Lichens) McGraw-Hill Book Co., New York .
12. Kumar, H.D. 1999. Introductory Phycology. Aff. East-west Press Pvt ltd., Delhi.

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B.Sc. I Year

Semester – II
BBO-C201
DSC-2 Plant Ecology and Taxonomy

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the importance of natural resources like soil, water and air.
- To acquire knowledge of various ecosystems components and their functioning.
- To acquire an overall knowledge on ecological factors and plant communities.
- To become familiar with plant identification, nomenclature and taxonomy and taxonomic hierarchy, evidences, botanical nomenclature, and classification.

Learning outcomes:

At the end of course student will be able

- The student will be able to understand natural resources importance and functioning for sustainable development.
- The student will be able to structural and functional ecological web.
- The student will be able identify key points for biogeochemical cycling, and various methods used in taxonomy, palynology, cytology, photochemistry and molecular data collection and utilization.
- The student will be able take the decisions for carrier point of views in research, industries and academia.

Unit 1: Introduction to Ecology and Ecological Factors **(12 Lectures)**

Soil: origin, formation, composition, soil profile. Water: states of water in the environment, precipitation types. Light and temperature: variation optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

Unit 2: Plant communities, Ecosystem and Phytogeography **(15 Lectures)**

Characters; Ecotone and edge effect; succession; processes and types. Structure; energy flow trophic organization; food chains and food webs, ecological pyramids production and productivity; biogeochemical cycling; cycling of carbon, nitrogen and phosphorous. Principle bio-geographical zones; endemism.

Unit 3: Introduction to Plant Taxonomy and Identification **(5 Lectures)**

Identification, classification, nomenclature. Functions of herbarium, important herbaria and botanical gardens of the world and India; documentation: flora.

Unit 4: Taxonomic Hierarchy and Evidences **(6 Lecture)**

Ranks, categories and taxonomic groups. Taxonomic evidences from palynology, cytology, Phytochemistry and molecular data.

Unit 5: Botanical Nomenclature and Classification **(10 Lectures)**

Principles and rules (ICBN); binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations. Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (up to series), Engler and Prantal (up to series). Introduction to Angiosperm Phylogeny Group (APG) system of classification.

DSC-2 SEMESTER-II BBO-C251(LAB COURSE-CC-02)

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, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (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)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Brassicaceae -*Brassica,Alyssum / Iberis;* Asteraceae -*Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae - *Solanumnigrum, Withania;*Lamiaceae -*Salvia, Ocimum*; Liliaceae - *Asphodelus / Lilium / Allium.*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested readings: Ecology

1. Singh, J.S., Singh, S.P. and Gupta, S. (2006) Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi
2. Wilkinson, D.M. (2007). Fundamental Processes in Ecology. An Earth System Approach. Oxford.
3. Daubenmier, R.F. (1970). Plants and Environment: A text book of Plant Autoecology, Wiley Eastern Private Limited
4. Daubenmier, R.F. (1970), Plant Communities, Wiley Eastern Private Limited
5. Odum, E. (2008) Ecology. Oxford and IBH Publisher.
6. Sharma, P.D. (2010) Ecology and Environment, (8th Ed.) Rastogi Publications, Meerut.

Taxonomy

1. Porter, C.L. (1969): Taxonomy of flowering Plants, Eurasia Publishing House, New Delhi.
2. Lawrence, G.H.M. (1953): Taxonomy of Vascular Plants, Oxford & IBH Publishers, New Delhi, Calcutta.
3. Jefferey, C.(1968) : An Introduction to Plant Taxonomy J.A. Churchill, London.
4. Mathur, R.C.(1970) : Systematic Botany (Angiosperms) Agra Book Stores-Lucknow, Ajmer, Allahabad, Delhi.

B.Sc. II Year

Semester – III

BBO-C301

DSC-3 Plant Anatomy and Embryology

MM : 100
Time : 3 hrs

Seasonal : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the importance of plant anatomy and embryology.
- To acquire knowledge of meristematic tissues, adaptive and protective systems, secondary growth and histology.
- To become familiar with structural organization of flower, pollination and fertilization, plant embryology.
- To become familiar with general techniques used inplant anatomy and embryology.

Learning outcomes:

At the end of course student will be able

- The student will be able to understand basics of plant anatomy and embryology.
- The student will be able to adaptive and protective systems, secondary growth, structural organization of flower, pollination and fertilization.
- The student will be equipped to understand the various methods and techniques used in plant anatomy and embryology.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Tissue: Meristematic and Permanent Tissues **(12 Lectures)**

Structure of dicot and monocot root, stem and leaf. Root and shoot apical meristems; Distinguish between meristematic, and permanent tissues.

Unit 2: Adaptive and Protective Systems, Secondary Growth **(16 Lectures)**

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes. Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood: distinguish between heartwood and sapwood.

Unit 3: Structural Organization of Flower: Pollination and Fertilization **(8 Lectures)**

Structure of anther and pollen. Structure and types of ovules. Types of embryo sacs, organization and ultrastructure of mature embryo sac. Pollination mechanisms and adaptations; Double fertilization. Seed-structure appendages and dispersal mechanisms.

Unit 4: Embryo and Endosperm **(8 Lectures)**

Endosperm types, structure and functions. Dicot and monocot embryo; Embryo-endosperm relationship.

Unit 5: Apomixis and Poly-embryony **(8 Lectures)**

Definition of Apomixis and Poly-embryony, types, practical applications and economic importance in plant science.

DSC-3 SEMESTER-III BBO-C351(LAB COURSE-CC-03)

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

Suggested readings: Anatomy

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. 1974 Plant Anatomy. PergmonPress, USA and UK.
3. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
5. Taiz, L. &Zeiger, E. 2006 Plant Physiology. (4th edition) Sinauer Associates, Inc. Sunderland,

Embryology

1. Maheswari,P(1963) :Recent Advances in the Embryology of Angiosperms(Ed.) International Society of Plant Morphologists- University of Delhi.
2. Swamy. B.G.L. &Krishnamoorthy. K.V.(1980):From flower to fruit. Tata McGraw Hill Publishing Co., Ltd., New Delhi.
3. Maheswari, P.(1985):An Introduction to the Embryology of Angiosperms Tata McGraw Hill Publishing Co.,Ltd., New Delhi.
4. Bhojwani, S.S. &Bhatnagar, S.P. (2000) : The Embryology of Angiosperms (4th Edition) Vikas Publishing House(P)Ltd., UBS Publisher's Distributors, New Delhi.

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B.Sc. II Year

BBO-S301 **Semester – III**

SEC-1 Nursery and Gardening

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the importance of nursery, gardening nursery planning, and management.
- To acquire an overall knowledge on various types seeds, dormancy and production technologies.
- To become familiar with vegetative propagation techniques and managements.
- To become familiar with general techniques used in nursery, garden designing and managements.

Learning outcomes:

At the end of course student will be able

- The student will be able to understand basics knowledge of nursery and gardening.
- The student will be able to understand the various type's seeds production, dormancy breakdown and production technologies.
- The student will be able to develop able to design and execute their ideas in nursery development and gardeningmanagement and development of different types of gardens, landscaping, home gardening and parks.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Nursery: Planning and Management **(8 Lectures)**

Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - planting - direct seeding and transplants.

Unit 2: Seed: Dormancy and Production Technology **(12 Lectures)**

Structure and types - seed dormancy; causes and methods of breaking dormancy - seed storage: seed banks, factors affecting seed viability, genetic erosion - seed production technology - seed testing and certification.

Unit 3: Vegetative propagation: Techniques and Managements **(12 Lectures)**

Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - hardening of plants - green house - mist chamber, shed root, shade house and glass house.

Unit 4: Gardening: Design and Managements **(16 Lectures)**

Definition, objectives and scope - different types of gardening -landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting

Unit 5: Cultivation **(12 Lectures)**

Sowing of seeds, transplanting of seedlings, cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes and carrots, storage and marketing.

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B.Sc. II Year

Semester – III

BBO-S302
SEC-1 Floriculture

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the importance of Floriculture, and acquire knowledge of importance and scope of floriculture, landscaping gardening.
- To acquire an overall knowledge on Principles of garden designs, and commercial floriculture.
- To acquire an overall knowledge on diseases and pests of ornamental plants.
- To become familiar with general techniques used in Floriculture.

Learning outcomes:

At the end of course student will be able

- The student will be able to understand basics knowledge Floriculture, and understand the sexual and vegetative methods of propagation used in Floriculture.
- The student will be able to develop able to design and execute their ideas in production of lower for commercial, aesthetic and economic purposes.
- The student will be equipped to understand the management and development of different factors affecting flower production; production and packaging.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Introduction **(20 Lectures)**

Importance and scope of floriculture and landscape gardening. Nursery management and routine garden operations: sexual and vegetative methods of propagation; soil sterilization; seed sowing; pricking; planting and transplanting; shading; stopping or pinching; defoliation; wintering; mulching; topiary; role of plant growth regulators.

Unit 2: Ornamental Plants: **(8 Lecturer)**

Flowering annuals; herbaceous perennials; divine vines; shade and ornamental trees; ornamental bulbous and foliage plants; cacti and succulents; palms and cycads; Ferns and Selaginellas; cultivation of plants in pots; indoor gardening; bonsai.

Unit 3: Principles of Garden Designs: **(8 Lecturer)**

English, Italian, French, Persian, Mughal and Japanese gardens; features of a garden (garden wall, fencing, steps, hedge, edging, lawn, flower beds, shrubbery, borders, water garden;some famous gardens of India.

Unit 4: Landscaping and Commercial Floriculture: **(10 Lecturer)**

Landscaping places of public importance: landscaping highways and educational institutions. Factors affecting flower production; production and packaging of cut flowers; flower arrangements; methods to prolong vase life; cultivation of important cut flowers (Carnation, Aster, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids).

Unit 5: Diseases and Pests of Ornamental Plants: **(2 Lecturer)**

Diseases and pests of ornamental plants; leaf spot of Chrysanthemum, tulip mosaic.

17.4.24

B.Sc. II Year

BBO-C401 Semester – IV

DSC-4 Plant Physiology and Metabolism

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the importance of plant physiology and metabolism, plant-water relations and mineral nutrition.
- To acquire an overall translocation of metabolites, photosynthesis, and respiration, enzymes and nitrogen metabolism.
- To become familiar with general techniques used in plant physiology and metabolism.
- To become familiar with various types phyto-hormones and Photoperiodism.

Learning outcomes:

At the end of course student will be able

- The student will be able to understand basics knowledge of plant physiology and metabolism, transpiration, guttation and essential elements required for growth and development.
- The student will be able to understand the structure, function, composition of vascular tissues.
- The student will be to understand the physiology and biochemistry and mechanism of action ofphyto-hormones, pphotosynthesis and respiration.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Plant-Water Relations and Mineral Nutrition **(16 Lectures)**

Importance of water, water potential and its components; transpiration and its significance; factors affecting transpiration; root pressure and guttation. Essential elements, macro and micronutrients; criteria of essentiality of elements; role of essential elements; transport of ions across cell membrane, active and passive transport.

Unit 2: Translocation of Metabolites **(6 Lectures)**

Phloem structure, function, composition of phloem sap, girdling experiment; pressure flow model; phloem loading and unloading.

Unit 3: Photosynthesis and Respiration **(18 Lectures)**

Photosynthetic pigments (Chl. a, b, xanthophylls, carotene); photosystem I and II, reaction center, antenna molecules; electron transport and mechanism of ATP synthesis; C_3, C_4 and CAM pathways of carbon fixation; photorespiration. Glycolysis, anaerobic respiration, TCA cycle; oxidative phosphorylation, oxidative pentose phosphate pathway

Unit 4: Enzymes and Nitrogen Metabolism **(8 Lectures)**

Classification, structure and properties; mechanism of enzyme action and enzyme inhibition. Biological nitrogen fixation (process of nodule formation, *nif*-genes, nitrogenase, mechanism of nitrogen fixation), nitrate and ammonia assimilation.

Unit 5: Plant Growth Regulators and Photoperiodism **(8 Lectures)**

Discovery and physiological roles of Auxins, Gibberellins, Cytokinins, ABA and Ethylene. Photoperiodism (SDP, LDP, day neutral plants); Vernalization.

DSC-4 SEMESTER-IV BBO-C451(LAB COURSE-CC-04)

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

Demonstration experiments (any four)

1. Bolting.
2. Effect of Auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested readings:

1. Steward, F.C (1964): Plants at Work (A summary of Plant Physiology) Addison-Wesley Publishing Co., Inc. Reading, Massachusetts, Palo alto, London.
2. Devlin, R.M. (1969): Plant Physiology, Holt, Rinehart & Winston & Affiliated East West Press (P) Ltd., New Delhi.
3. Noggle, R.& Fritz (1989): Introductory Plant Physiology Prentice Hall of India.
4. Lawlor, D.W. (1989): Photosynthesis, metabolism, Control & PhysiologyELBS/Longmans-London.
5. Mayer, Anderson &Bonning(1965): Introduction to Plant PhysiologyD.VanNostrand . Publishing Co., N.Y.
6. Mukherjee, S. A.K. Ghosh(1998) Plant Physiology, Tata McGraw Hill Publishers(P)Ltd., New Delhi.
7. Salisbury, F.B & C.W. Ross (1999): Plant Physiology CBS Publishers and Printers,New Delhi.
8. Plummer, D.(1989) Biochemistry–the Chemistry of life,McGraw Hill Book Co., London, N.Y. New Delhi, Paris, Singapore, Tokyo.
9. Day, P.M.&Harborne, J.B. (Eds.,) (2000): Plant Biochemistry.Harcourt Asia (P) Ltd., India & Academic Press, Singapore.

17.4.24

B.Sc. II Year

Semester – IV

BBO-S401
SEC-2 Biofertilizers

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the microbes used as biofertilizers, inoculum preparation, maintenance and multiplication
- To acquire basic information on Cyanobacterja, mycorrhiza, and VAM fungi.
- To acquire an overall knowledge on organic farming and vermicomposting.
- To become familiar with general techniques used in commercial production biofertilizers, types biofertilizers used in agriculture.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with the microbes used as biofertilizers, isolation, identification, mass multiplication, carrier based inoculants.
- The student will be able to understand the crop response to biofertilizers inoculums, maintenance and mass multiplication of microbes used as biofertilizers.
- The student will be to understand the symbiotic association of Cyanobacterial and Mycorrhizalassociation with various crops and plants.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Introduction:

(8 Lectures)

General account about the microbes used as biofertilizer; *Rhizobium*, isolation, identification, mass multiplication, carrier based inoculants, actinorrhizal symbiosis.

Unit 2: Inoculum Preparation, Maintenance and Multiplication

(16 Lectures)

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

Unit 3: Cyanobacteria

(8 Lectures)

Cyanobacteria (blue green algae), *Azolla*and *Anabaena* association, nitrogen fixation, factors affecting growth, and *Azolla* in rice cultivation.

Unit 4: Mycorrhizal and VAM Fungi

(16 Lectures)

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5: Organic Farming and Vermicomposting

(12 Lectures)

Green manuring and organic fertilizers, agricultural and industrial wastes: bio-compost making methods, types and method of vermicomposting – field Application.

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B.Sc. II Year **Semester – IV**

BBO-S402
SEC-2 Ethno-botany

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of Ethno-botany, concept, scope and objectives of ethnobotany.
- To acquire information on methodology of ethanobotanical studies. applications of ethnobotany in modern medicine.
- To acquire an overall knowledge on IPR and traditional knowledge, bio-piracy and traditional knowledge.
- To become familiar with major and minor ethnic groups or tribal's of India, and their life styles, plants used by the tribal's for future prospects.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with relevance of ethno-botany in the present and future context, and to understand about field work, herbarium, ancient literature, archaeological findings, temples and Sacred places.
- The student will be able to understand the Medico-ethnobotanical sources in India, and the role of ethnic groups in conservation of plant genetic resources.
- The student will be to learned and understand the Ethnobotany as a tool to protect interests of ethnic groups, IPR, Bio-piracy and traditional knowledge.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Ethno-Botany **(12 Lectures)**

Introduction, concept, scope and objectives; ethnobotanyas an interdisciplinary science; relevance of ethnobotany in the present context; major and minor ethnic groups or tribals of India, and their life styles; plants used by the tribals: a) food plants b) intoxicants and beverages c) resins and oils and miscellaneous uses.

Unit 2: Methodology of Ethnobotanical Studies: **(12 Lectures)**

a) Field work, b) Herbarium, c) Ancient literature, d) Archaeological findings, e) Temples and Sacred places.

Unit 3: Role of Ethnobotany in Modern Medicine: (20 Lectures)

Medico-ethnobotanical sources in India; significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superbae*) *Tribulus terrestris*f) *Pongamia pinnata*g) *Cassia auriculata*h) *Indigofera tinctoria*; role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania.*

Unit 4: IPR and Traditional Knowledge: (16 Lectures)

Role of ethnic groups in conservation of plant genetic resources; endangered taxa and forest management (participatory forest management). Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India; Biopiracy, Intellectual Property Rights (IPR) and traditional knowledge.

B.Sc. III Year **Semester – V**

BBO-E501

DSE-1 Cell and Molecular Biology

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of cell and molecular biology, and techniques in molecular biology.
- To acquire information on cell and cell cycle, structure various cell organelles and their functions.
- To acquire an overall knowledge on cell membrane structure, functions and genetic material.
- To become familiar with transcription and regulation of gene expression.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with various tools and techniques used in cell and molecular biology like Principles of microscopy like light microscopy, phase contrast microscopy; fluorescence microscopy; confocal microscopy etc.
- The student will be able to understand the electron microscopy like scanning EM and scanning Transmission EM (STEM); sample Preparation for electron microscopy; X-ray diffraction analysis.
- The student will be to understand the about the cell structure and functions, cell theory; prokaryotic and eukaryotic cells, various components of cells and their specific functions.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Techniques in Biology: **(8 Lectures)**

Principles of microscopy; light microscopy; phase contrast microscopy; fluorescence microscopy; confocal microscopy; sample preparation for light microscopy; electron microscopy (EM)- scanning EM and scanning Transmission EM (STEM); sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2:Cell and cell Cycle: **(8 Lectures)**

The cell theory; prokaryotic and eukaryotic cells; cell size and shape; eukaryotic cell components.Overview of cell cycle, mitosis and meiosis.

Unit 3: Cell Organelles: **(20 Lectures)**

Mitochondria: structure, marker enzymes, composition; semiautonomous nature; symbiont hypothesis; proteins synthesized within mitochondria; mitochondrial DNA. Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA. Endoplasmic reticulum, Golgi body &Lysosomes: structures and role. Peroxisomes and Glyoxisomes: structures, composition, functions in animals and plants and biogenesis. Nucleus: nuclear envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4: Cell Membrane and Genetic Material: **(12 Lectures)**

Functions of membranes; models of membrane structure; the fluidity of membranes; membrane proteins and their functions; carbohydrates in the membrane; faces of the membranes; selective permeability of the membranes; cell wall .DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (prokaryotes and eukaryotes): bidirectional replication, semi-conservative.

Unit 5: Transcription and Regulation of Gene Expression: **(6 Lectures)**

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerases; translation (prokaryotes and eukaryotes), genetic code. Prokaryotes: lac operon and tryptophan (trp) peron.

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DSE-1 SEMESTER-V BBO-E551 (LAB COURSE-05)

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Study the effect of temperature, organic solvent on semi permeable membrane.
6. Demonstration of dialysis of starch and simple sugar.
7. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
8. Measure the cell size (either length or breadth/diameter) by micrometry.
9. Study the structure of nuclear pore complex by photograph (from Gerald Karp)
10. Study of special chromosomes (Polytene&Lampbrush) either by slides or photographs.
11. Study DNA packaging by micrographs.
12. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Suggested readings:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.
5. Dubey, R.C. A Text Book of Biotechnology. S. Chand & Company Pvt. Ltd. Ram Nagar, New Delhi-110 055.

B.Sc. III Year **Semester – V**

BBO-E502
DSE-1 Bioinformatics

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of Bioinformatics, scope and research areas of bioinformatics.
- To acquire information on classification format of biological databases and biological database retrieval system.
- To become familiar with National Center for Biotechnology Information (NCBI) and Basic Local Alignment Search Tool (BLAST), EMBL-Bank, DDBJ, Protein Information Resource (PIR) and Swiss-Prot.
- To acquire an overall knowledge on sequence alignments, molecular phylogeny and applications.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with various tools and techniques used in Bioinformatics, and understand the utilization management of biological databases and their retrieval system.
- The student will be able to understand the tools and databases of NCBI and Basic Local Alignment Search Tool (BLAST), nucleotide database, protein database, gene expression database.
- The student will be to understand the about the Concept of Alignment, Multiple Sequence Alignment (MSA) and scoring matrices, PAM; BLOSUM, various techniques of phylogeny, software for phylogenetic analyses, consistency of molecular Phylogenetic prediction.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Introduction: **(5 Lectures)**

Introduction, branches of bioinformatics, aim, scope and research areas of bioinformatics.

Unit 2: Databases: **(5 Lectures)**

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3: Biological Sequence Databases: **(25 Lectures)**

National Center for Biotechnology Information (NCBI): tools and databases of NCBI, database retrieval tool, sequence submission to NCBI, Basic Local Alignment Search Tool (BLAST), nucleotide database, protein database, gene expression database. EMBL nucleotide sequence database (EMBL-Bank): introduction, sequence retrieval, sequence submission to EMBL, sequence analysis tools. DNA Data Bank of Japan (DDBJ): introduction, resources at DDBJ, data submission at DDBJ. Protein Information Resource (PIR): About PIR, resources of PIR, databases of PIR, data retrieval in PIR. Swiss-Prot: introduction and salient features.

Unit 4: Sequence Alignments: **(10 Lectures)**

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, scoring matrices, Percent Accepted Mutation (PAM);Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5: Molecular Phylogeny and Applications: **(8 Lectures)**

Methods of phylogeny, software for phylogenetic analyses, consistency of molecular phylogenetic prediction. Structural bioinformatics in drug discovery, quantitative structure-activity relationship (QSAR) techniques in drug design, microbial genome applications, crop improvement.

17.4.21

Practical

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Suggested readings:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley- Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

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B.Sc. III Year

Semester – V

BBO-E503

DSE-1 Analytical Techniques in Plant Sciences

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of analytical techniques in plant sciences.
- To acquire the basic information about the imaging and related techniques.
- To become familiar with Principles of microscopy, radioisotopes and spectrophotometry, and Chromatography.
- To become familiar with characterization of proteins and nucleic acids, applications of Biostatistics.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with various tools used in analytical techniques in plant sciences, applications of fluorescence microscopy such as Chromosome banding, FISH, chromosome painting and sample preparation for electron microscopy.
- The student will be able to understand the differential and density gradient centrifugation and ultracentrifugation, marker enzymes, Principle of paper chromatography; column chromatography, TLC, GLC, HPLC and Mass spectrometry like X-ray diffraction; X-ray crystallography; characterization of proteins and nucleic acids; electrophoresis: AGE, PAGE, SDS-PAGE etc.
- The student will be to learned and understand the statistics, data, population, samples, parameters; representation of data: tabular, graphical; measures of central tendency: arithmetic mean, mode, median; measures of dispersion.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Imaging and Related Techniques: **(15 Lectures)**

Principles of microscopy; light microscopy; fluorescence microscopy; confocal microscopy; use of fluorochromes: (a) flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; transmission and scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell Fractionation: **(8 Lectures)**

Centrifugation: differential and density gradient centrifugation, sucrose density gradient, CsCl2 gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes and spectrophotometry: **(6 Lectures)**

Use in biological research, auto-radiography, pulse chase experiment. Principle (Beer & Lambert's law). Application in biological research.

Unit 4: Chromatography: **8 Lectures)**

Principle; paper chromatography; column chromatography, TLC, GLC, HPLC, ion-exchange chromatography; molecular sieve chromatography; affinity chromatography.

Unit 5: Characterization of Proteins and Nucleic Acids, Biostatistics: **(20 Lectures)**

Mass spectrometry; X-ray diffraction; X-ray crystallography; characterization of proteins and nucleic acids; electrophoresis: AGE, PAGE, SDS-PAGE. Statistics, data, population, samples, parameters; representation of data: tabular, graphical; measures of central tendency: arithmetic mean, mode, median; measures of dispersion: range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Practical's

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by chromatographic method.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separate DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).
12. Calculation (numerical) of central tendencies (mean, mode & median), standard deviation, standard error.

Suggested readings:

1. Dubey, R.C. A Text Book of Biotechnology. S. Chand & Company Pvt. Ltd. Ram Nagar, New Delhi-110 055.
2. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
3. Smith, R. 2000 Plant Tissue Culture: Techniques and Experiments, 2nd edition, Academic.

17.4.21

B.Sc. III Year

BBO-S501 **Semester – V**

SEC-3 Plant Diversity and Human Welfare

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of plant diversity and human welfare, plant diversity and its scope.
- To acquire an overall knowledge loss of biodiversity and its management.
- To become familiar with Conservation of biodiversity, ethical and aesthetic values.
- To acquire the basic information on role of plants in relation to human welfare.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with genetic, species, plant diversity at the ecosystem level, agro-biodiversity and cultivated plant, basic information on loss of genetic, species, and ecosystem diversity.
- The student will be able to understand the organizations associated with biodiversity management-methodology for execution like IUCN, UNEP, UNESCO, WWF, and NBPGR.
- The student will be to understand the about the biodiversity information management, communication and Conservation of biodiversity, utilization and commercial aspects and important fruit crops for their commercial importance.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Plant Diversity and its Scope: **(16 Lectures)**

Genetic diversity, species diversity, plant diversity at the ecosystem level, agro-biodiversity and cultivated plant taxa, wild taxa; values and uses of biodiversity: ethical and aesthetic values, precautionary principle, methodologies for valuation, uses of plants, uses of microbes.

Unit 2: Loss of Biodiversity and its Management: **(16 Lectures)**

Loss of genetic diversity, loss of species diversity, loss of ecosystem diversity, loss of agro-biodiversity, projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management-methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.

Unit 3: Conservation of Biodiversity: **(16 Lectures)**

Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, social approaches to conservation, biodiversity awareness programmes, sustainable development.

Unit 4: Role of Plants in Relation to Human Welfare: **(12 Lectures)**

Importance of forestry their utilization and commercial aspects, avenue trees, ornamental plants of India. Alcoholic beverages through ages; fruits and nuts: Important fruit crops their commercial importance.

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B.Sc. III Year

Semester – V

BBO-S502

SEC-3 Medicinal and Economic Botany

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of medicinal and economic botany, introduction and history of Ayurveda.
- To acquire an overall knowledge on conservation of endangered and endemic medicinal plants.
- To become familiar with Ethno-botany and folk medicines.
- To acquire the information on Origin of cultivated plants and beverages, oils, legumes and spices.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with the history, scope and importance of medicinal plants; indigenous medicinal sciences.
- The student will be able to understand about the endemic and endangered medicinal plants, red list criteria; *in-situ* and *ex-situ* conservation strategies, various methods of propagation of medicinal plants.
- The student will be to understand the about the palaeo-ethnobotany, folk medicines of ethno botany, importance of forestry their utilization and commercial aspects and important fruit crops for their commercial importance.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Introduction and History of Ayurveda: **(20 Lectures)**

History, scope and Importance of medicinal plants; indigenous medicinal sciences; definition and scope-Ayurveda: history, origin, saptadhatu and tridosha concepts, Ramayana, plants used in Ayurveda treatments, Siddha: origin of Siddha medicinal systems;basis of Siddha system, plants used in Siddha medicine. Unani: history, concept: Introduction to Polyherbal formulations.

Unit 2: Conservation of Endangered and Endemic Medicinal Plants:(20 Lectures)

Definition: endemic and endangered medicinal plants, red list criteria; in situ conservation: Biosphere reserves, sacred groves, national parks; *Ex situ* conservation: botanic gardens, ethno-medicinal plant gardens. propagation of medicinal plants: objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 3: Ethno-Botany and Folk Medicines: **(20 Lectures)**

Ethnobotany in India: methods to study ethno-botany; applications of ethno botany: national interacts, Palaeo-ethnobotany. Folk medicines of ethno botany, Ethno-medicine, ethno ecology, Ethnic communities of India; application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases.

Unit 4: Origin of Cultivated Plants: **(10 Lectures)**

Concept of centers of origin, their importance with reference to Vavilov's work. Wheat - origin, morphology, uses. General description with special reference to cotton (botanical name, family, part used, morphology and uses).

Unit 5: Beverages, Oils, Legumes and Spices **(14 Lectures)**

Tea (morphology, processing, uses). General description with special reference to groundnut. General account with special reference to Chick-pea and soybean. General account with special reference to clove and black pepper (botanical name, family, part used morphology and uses).

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B.Sc. III Year

Semester – VI

BBO-E601
DSE-2 Plant Biotechnology

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of Plant Biotechnology, global impact and current excitement of plant biotechnology.
- To acquire an overall knowledge on application of plant cell, tissues and organ culture.
- To become familiar with plant tissue culture and cryopreservation.
- To acquire the information on recombinant DNA technology.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with the historical back ground and recent advance in plant biotechnology, global scenario and recent trends in plant biotechnology.
- The student will be able to understand the various methods used for Cryopreservation, various methods of used in tissue culture and micro-propagation.
- The student will be learned various techniques used in DNA fingerprinting and molecular DNA markers, sequencing, PCR, rt-PCR; hybridoma and monoclonal antibodies, ELISA, immune detection, and gene therapy.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Scope and Importance **(4 Lectures)**

Historical back ground and recent advance in plant biotechnology: emergence of modern biotechnology as an interdisciplinary area. Global impact and current excitement of plant biotechnology; Global scenario and recent trends in plant biotechnology; Potential of modern biotechnology for future and sustainable development. Plant biotechnology techniques for conservation of plant genetic resources.

Unit 2: Application of Plant Cell, Tissues and Organ Culture **(8 Lectures)**

Application in agriculture, improvement of hybrid, production of encapsulated seed/artificial seeds, Production of disease and stress free plants. Production of transgenic plants for crop improvements, virus resistant transgenic plants, insect resistant transgenic plants, Herbicide resistant transgenic plants, Molecular farming from transgenic plants, nutritional quality and immunotherapeutic drugs (edible vaccines, edible antibodies and edible interferon); Bioethics in plant genetic engineering.

Unit 3: Cryopreservation **(12 Lectures)**

Introduction and Difficulties in Cryopreservation; Methods for Cryopreservation, Selection of material, addition of cyoprotectors, Storeg in liquid nitrogen, thawing, washing and re-culturing regeneration of plantlets; Plant cell bank; Pollen bank. Stage of cryopreservation and standardization of culture, Achievement through cryopreservation.

Unit 4: Plant Tissue Culture **(10 lecture)**

Totipotency, method of tissue culture. Micro-propagation; haploid production through androgenesis and glycogenesis; brief account of embryo & endosperm culture with their applications.

Unit 5: Recombinant DNA Techniques **(18 Lectures)**

Blotting techniques: Southern and Western Blotting, Northern, DNA fingerprinting; molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and reverse transcriptase- PCR; hybridoma and monoclonal antibodies, ELISA and immune detection; gene therapy.

DSE-2 SEMESTER-VI BBO-E651(LAB COURSE-06)

1. Study of economically important plants: Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2. Familiarization with basic equipment's in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

Suggested readings:

1. Dubey, R.C. A Text Book of Biotechnology. S. Chand & Company Pvt. Ltd. Ram Nagar, New Delhi-110 055.
2. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
3. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
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B.Sc. III Year

Semester – VI

BBO-E602

DSE-2 Research Methodology

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic information and techniques used in research methodology, research-definition and types of research.
- To acquire an overall knowledge on data collection and documentation.
- To become familiar with methods to study plant cell and plant micro techniques.
- To learned technique and acquire the information on scientific writing and presentation.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with the research methodology, literature survey and its consolidation, library research; field research; laboratory research, techniques and common calculations in botanical laboratories.
- The student will be able to understand the various methods used for key biology research areas, model organisms in biology, methods of used in whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; tissue preparation.
- The student will be learned various techniques such asreactive dyes and fluorochromes, scientific writing and ethics, introduction to copyright-academic misconduct/plagiarism.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Basic Concepts: **(22 Lectures)**

Research-definition and types of research (descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vsempirical). Research methods vs methodology; literature-review and its consolidation; Library research; field research; laboratory research. Common calculations in botany laboratories; understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases; preparation of solutions. Dilutions. Percentage solutions; molar and normal solutions; technique of handling micropipettes; knowledge about common toxic chemicals and safety measures in their handling.

Unit 3: Data Collection and Documentation: **(6 Lectures)**

Maintaining a laboratory record; tabulation and generation of graphs; imaging of tissue specimens and application of scale bars; art of field photography.

Unit 3: Biological Problems **(6 Lectures)**

History; key biology research areas, model organisms in biology (brief overview): genetics, physiology, biochemistry, molecular biology, cell biology, genomics, proteomics-transcriptional regulatory network.

Unit 4: Methods to Study Plant Cell and Plant Micro-techniques: **(18 Lectures)**

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; paraffin and plastic infiltration; preparation of thin and ultrathin sections. Staining procedures, classification and chemistry of stains. staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

Unit 5: Scientific Writing and Presentation: **(8 Lectures)**

Numbers, units, abbreviations and nomenclature used in scientific writing; writing references; power point presentation; poster presentation; scientific writing and ethics, introduction to copyright-academic misconduct/plagiarism.

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Practical

1. Experiments based on chemical calculations.
2. Plant micro-technique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

B.Sc. III Year

Semester – VI

BBO-E603
DSE-2 Dissertation

The students may op dissertation in lieu of one paper

B.Sc. III Year

Semester – VI

BBO-S601
SEC-4 Mushroom Culture Technology

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

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Learning objective:

- To understand the techniques used mushroom culture technology.
- To acquire the information about the mushroom cultivation and management technology, nutritional and medicinal value of edible mushrooms.
- To become familiar with mushrooms storage and nutrition value.
- To learned technique and acquire the information on types of foods prepared from mushrooms.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with history, nutritional and medicinal value of edible mushrooms, and poisonous mushrooms, infrastructure and necessary tools and items required for cultivation, and export value of mushrooms.
- The student will be able to understand the various methods used for pure culture, sterilization, preparation of spawn, multiplication, and mushroom bed preparation, short-term storage and long term storage of mushrooms.
- The student will be learned and understand the various methods of used in whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; tissue preparation.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Introduction:

(10 Lectures)

History; nutritional and medicinal value of edible mushrooms; Poisonous mushrooms; types of edible mushrooms available in India –*Volvariella volvacea,Pleurotus citrinopileatus, Agaricu sbisporus*.

Unit 2: Cultivation Technology:

(24 Lectures)

Infrastructure: substrates (locally available) polythene bag,vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (thatched house) water sprayer, tray, small polythene bag; pure culture: medium, sterilization, preparation of spawn, multiplication; mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves; factors affecting the mushroom bed preparation - low cost technology, composting technology in mushroom production.

Unit 3: Storage and Nutrition:

(16 Lectures)

Short-term storage (refrigeration – up to 24 hours) long term storage (canning, pickels, papads), drying, storage in salt solutions; nutrition – proteins - amino acids, mineral elements nutrition - carbohydrates, crude fiber content - vitamins.

Unit 4: Food Preparation:

(10 Lectures)

Types of foods prepared from mushroom; research centers -national level and regional level; cost benefit ratio - marketing in India and abroad, export value.

B.Sc. III Year

Semester – VI

BBO-S602

SEC-4 Intellectual Property Rights

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the intellectual property rights, IPR, WTO, TRIPS, and WIPO.
- To acquire an overall knowledge on patents, copyrights and trademarks.
- To become familiar with geographical indications and protection of traditional knowledge.
- To learned technique and acquire the information on industrial designs and protection of plant varieties.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar IPR in national and international levels, necessary tools and items required for cultivation.
- The student will be able to understand the various methods procedure of obtaining patents, and working of patents, the concept of traditional knowledge, bio-prospecting and bio-piracy, WTO and traditional knowledge digital library.
- The students can understand about the defenses of design infringement, and plant varieties protection in India and international levels.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Introduction: **(4 lectures)**

Concept and kinds. Economic importance. IPR in India and world: genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Unit 2: Patents, Copyrights and Trademarks: **(18 Lectures)**

Objectives, rights, patent act 1970 and its amendments. Procedure of obtaining patents, working of patents. Introduction, works protected under copyright law, rights, transfer of copyright, infringement. Objectives, types, rights, protection of goodwill, infringement, passing off, defenses, and domain name.

Unit 3: Geographical Indications and Protection of Traditional Knowledge: **(14 Lectures)**

Objectives, justification, international position, multilateral treaties, national level, Indian Position. Objective, concept of traditional knowledge, holders, issues concerning, bio-prospecting and bio-piracy, alternative ways, protect ability, need for a sui-generis regime, traditional knowledge on the international arena, at WTO and at national level, traditional knowledge digital library.

Unit 4: Industrial Designs: **(4 Lectures)**

Objectives, rights, assignments, infringements, defenses of design infringement.

Unit 5: Protection of Plant Varieties: **(20 Lectures)**

Plant varieties protection-objectives, justification, international position, plant varieties protection in India; rights of farmers, breeders and researchers; national gene bank, benefit sharing; protection of plant varieties and farmers' rights act, 2001.Computer software and intellectual property, database and data protection, protection of semi-conductor chips, domain name protection. Patenting biotech inventions: objective, applications, concept of novelty, concept of inventive step, microorganisms, moral issues in patenting biotechnological inventions.

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B.Sc. III Year

Semester – VI

BBO-S603
SEC-4 Herbal Technology

MM : 100
Time : 3 hrs

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the about the medicinal herbs and herbal technology, and Pharmacognosy.
- To acquire an overall knowledge on Phytochemistry.
- To become familiar with Analytical pharmacognosy.
- To learned technique and acquire the information on tissue culture and micro propagation.

Learning outcomes:

At the end of course student will be able

- The student will be able to familiar with the history and role of medicinal plants in traditional systems of medicine, and medicinal uses of herbal plants.
- The student will be learned and understand the active principles and methods of their testing, identification and utilization of the medicinal herbs.
- The student will be learned about drug adulteration, types, methods of drug evaluation, and biological testing of herbal drugs, micro propagation.
- The student will be able take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Herbal medicines:

(12 Lectures)

History and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit 2: Pharmacognosy:

(12 Lecturers)

Systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3: Phytochemistry:

(12 Lecturers)

Active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster)

Unit 4: Analytical Pharmacognosy:

(16 Lectures)

Drug adulteration - types, methods of drug evaluation -biological testing of herbal drugs - phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Unit 5: Tissue Culture and Micro-propagation

(8 Lectures)

Medicinal plant banks, micro propagation of important species, for example *Withania somnifera*; neem and tulsi; herbal foods; future of pharmacognosy).

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