SCHEME OF EXAMINATION
AND
COURSE OF STUDY AS PER NATIONAL EDUCATION POLICY (NEP 2022)

IN

BOTANY

B. Sc. I, II, III & IV YEAR
(w.e.f. Session 2022-23 onwards)

DEPARMENT OF BOTANY & MICROBIOLOGY
GURUKULA KANGRI (DEEMED TO BE UNIVERSITY),
HARIDWAR – 249404
AUGUST, 2022

COURSE STRUCTURE

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

Year/ Programme	Semester	Paper Code	Paper title	Credits	Theory /Practical	Total Number of Classes (in hours)
1st/ *Certificate Course In Herbal Technology & Parataxonomy*	I	BBO-C101	DSC-1: Botany Paper I: Biodiversity (Microbes, Algae, Fungi and Archegoniate)	4	Theory	60
		BBO-C151	DSC-1: Lab Course CC-01	2	Practical	60
		BBO-V101	VAC-1	2	-	-
			AECC-1: Environmental Science and Sustainable Development (To be taught by Department of Zoology and Environmental Science)	4	-	-
			Co-Curricular-1: NSS/NCC/Cultural (Music/Arts/Painting/Dance) **Qualifying**	-	-	-
	II	BBO-C201	DSC-2: Taxonomy of Angiosperms & Herbal Technology	4	Theory	60
		BBO-C251	DSC-2: Lab Course CC-02	2	Practical	60
		BBO-V201	VAC-2:	2	-	-
			AECC-2: Environmental Science and Sustainable Development (To be taught by Department of Zoology and Environmental Science)	4	-	-
			Co-Curricular -2: NSS/NCC/Cultural (Music/Arts/Painting/Dance) **Qualifying**	-	-	-
2nd/ **Diploma in** ***Medicinal & Applied Botany***	III	BBO-C301	DSC-3: Plant Anatomy and Embryology	4	Theory	60
		BBO-C351	DSC-3: Lab Course CC-03	2	Practical	60
		BBO-S301	SEC-1: Floriculture	4	Theory	60
		BBO-V301	VAC-3	2	-	-
	IV	BBO-C401	DSC-4: Medicinal and Economic Botany	4	Theory	60
		BBO-C451	DSC-4: Lab Course CC-04	2	Practical	60
		BBO-S401	SEC-2: Biofertilizers	4	Theory	60
		BBO-V401	VAC-4:	2	-	-

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Year/ Programme	Semester	Paper Code	Paper title	Credits	Theory /Practical	Total Number of Classes (in hours)
3rd/ Degree in Bachelor of Science in Botany	V	BBO-E501	DSE-5: Cytogenetics, Plant Breeding and Molecular Biology	4	Theory	60
		BBO-E551	DSE-5: Lab Course - 05	2	Practical	60
		BBO-S501	SEC-3: Indian Traditional Knowledge and Ethnobotany	4	Theory	60
		BBO-V501	VAC-5:	2	-	-
	VI	BBO-E601	DSE-6: Plant Physiology and Metabolism	4	Theory	60
		BBO-E651	DSE-6: Lab Course - 06	2	Practical	60
		BBO-S601	SEC-4: Mushroom Culture Technology	4	Theory	60
		BBO-V601	VAC-6	2	-	-
4th/ Degree in Bachelor of Science in Botany (Honors)	VII	BBO-E701	DSE-7: Plant Biotechnology	4	Theory	60
		BBO-E751	DSE-7: Lab Course CC-07	2	Practical	60
		BBO-E702	DSE-8: Recombinant DNA Technology	4	Theory	60
		BBO-E752	DSE-8: Lab Course CC-08	2	Practical	60
		BBO-E703	DSE-9: Plant Diversity and Human Welfare	4	Theory	60
		BBO-E753	DSE-9: Lab Course CC-09	2	Practical	60
		BBO-T754	Industrial Training/Survey and field work/Dissertation	6	-	
			Vocational Course-1: Communication Skills and Personality Development	2	-	
	VIII	BBO-E801	DSE-10: Applied Microbiology and Plant Pathology	4	Theory	60
		BBO-E851	DSE-10: Lab Course CC-10	2	Practical	60
		BBO-E802	DSE-11: Agricultural Microbiology	4	Theory	60
		BBO-E852	DSE-11: Lab Course CC-11	2	Practical	60
		BBO-E803	DSE-12: Ecology, Environment and Elementary Paleobotany	4	Theory	60
		BBO-E853	DSE-12: Lab Course CC-12	2	Practical	60
		BBO-T854	Industrial Training/Survey and field work/Dissertation	6	-	
			Vocational Course-2: Vedic Botany	2	-	

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B.Sc. I Year **Semester – I**

BBO-C101

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

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total hours: 60

Learning objective:

- To understand the Vedic period plants mentioned in Rigveda and Atharvaveda and their medicinal properties uses and plants used in Yajna.
- To acquire knowledge of different microorganisms like Virus, Bacteria, Algae, Fungi and Archegoniate.
- To acquire an overall knowledge on the morphology, classification and reproduction of Virus, Bacteria, Algae, Fungi and Archegoniate.
- To become familiar with general characteristics and biodiversity components.

Learning outcomes:

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

Unit 1: Vedic Plants and Microbes **(10 Lectures)**

Introduction to Veda, naming of plants in Veda, Vedic classification of plants, medicinal plants in Rigveda and Atharvaveda and their medicinal properties and uses. Plants used in Yajna. Viruses– discovery, general structure, replication (general account), DNA virus (T-phage); lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); economic importance.

Unit 2: Algae **(12 Lectures)**

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

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

General characteristics, ecology, cell wall composition, nutrition, reproduction and life cycle of *Rhizopus*, , *Puccinia, Agaricus*; Symbiotic associations- lichens general account, reproduction and significance, 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.

Unit 5: Gymnosperms **(8 Lectures)**

General characteristics, classification. (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*, (developmental details not to be included), ecological and economic 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 through permanent 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 gemmacup, 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 (temporary slides); 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. dwarf shoot, 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. Vedic Microbiology. Publisher: Motilal Banarsidass, New Delhi.
2. Kumar H.D. 1999. Introductory Phycology. Affiliated East West Press, New Delhi.
3. Matthews, R.E. 2013 Fundamentals of Plant Virology ELSEVIER India.
4. Sethi I.K and Walia S.K. 2011. Text book of fungi and their allies. Mc Millian Publishers, New Delhi.
5. Vashishta, B.R., Sinha A.K. 2012 Botany for degree students: Fungi. S.Chand New Delhi.
6. Vashishta, B.R., Sinha A.K. and Singh, V.P 2012 Botany for degree students: Algae, S.Chand New Delhi.
7. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata Mc Graw-Hill Co, New Delhi.
8. Desikachari, T. V. 1959. Cyanophyta, ICAR, New Delhi.
9. Pandey B.P. 2001. College Botany Volume 1, S Chand & Company Pvt.Ltd, New Delhi.
10. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
11. Smith. G. M. 1996. Cryptogamic Botany Volume I, Tata Mc Graw Hill, New Delhi.
12. Plant Taxonomy. Singh, Pandey and Jain. Publisher: Rastogi Publications, Merrut. ISBN: 9789350781708, 9789350781708.
13. Taxonomy of Angiosperms. by V. Singh , D. K. Jain. Rastogi Publication, Meerut.

B.Sc. I Year **Semester – I**

BBO -V101

VAC-1

Credits: 2

B.Sc. I Year **Semester – II**

BBO-C201
DSC-2 Taxonomy of Angiosperms & Herbal Technology

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 30
ESE : 70
Pass Marks : 40

Total Hours: 60

Learning objective:

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

Learning outcomes:

- The student shall be able to familiar with medicinal plants in traditional systems of medicine.
- The student shall be able to understand the systematic position, and medicinal uses of herbal plants.
- The student shall understand the active principles and methods of their testing, identification and utilization of the medicinal herbs.
- The student shall learn about drug adulteration, types, methods of drug evaluation, and biological testing of herbal drugs.
- The students can understand micro propagation of important medicinal herbal plant species.
- The student shall be able to take the decisions for carrier point of views related to research, industries and academia entrepreneurships etc.

Unit I: Introduction to Plant Taxonomy and Identification **(10 Lectures)**

Identification, classification, nomenclature. Functions of herbarium, important herbaria and botanical gardens of the India and world; documentation: flora, Modern trends in Plant taxonomy, APG System of classification, Phenetics and Cladistics.

Unit II: Taxonomic Hierarchy and Evidences, Botanical Nomenclature and Classification (16 Lectures)

Ranks, categories and taxonomic groups. Principles and rules (ICBN); ranks and names; binominal system of nomenclature, typification, author citation, valid publication, rejection of names, principle of priority and its limitations. Types of classification-artificial, natural and phylogenetic. Classification proposed by Bentham and Hooker (up to series) with special reference to Families: Ranunculaceae, Malvaceae, Rosaceae, Cucurbitaceae, Asteraceae, Asclepiadaceae, Convolvulaceae, Solanaceae, Acanthaceae, Verbinaceae, Lamiaceae, Euhorbiaceae and Poaceae.

Unit III: Herbal Medicines: **(10 Lectures)**

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

Unit IV: Introduction to Pharmacognosy: **(10 Lecturers)**

Definitions, history, scope and development of Pharmacognosy. Sources of crude drugs: Plants, and tissue culture. Systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit V: Phytochemistry and Analytical pharmacognosy **(14 Lecturers)**

Organized and unorganized drugs: latex, gums, exudation, resins etc. Drug adulteration - types, methods of drug evaluation -biological testing of herbal drugs. Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds). Introduction to traditional medicines.

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

1. Methods of collection plant specimens,
2. Introduction to advance herbarium techniques.
3. Identification and determination plant names
4. Features used to describe an Angiopermic plant (Habitat, Habit, Root, Stem, Leaf, Inflorescence, Flower and Floral formula.
5. Preparation of Herbal Formulations.
6. Preparation of Herbal Syrup
7. Preparation of Herbal Churna
8. Preparation of Bhasma
9. Preparation of Asava and Aristha
10. Preparation of Vatika and Gutika

Suggested Reading

1. Thapliyal S. and Nautiyal V. (2021) Practical Pharmacognosy and Phytomedicine, P.K. Publishers & Distributors, New Delhi.
2. Anatomy of Crude Drugs by Iyengar,MA and Nayak SCK., 8th edition, 2001, Munipal.
3. Ayurvedic Pharmacopoeia of India, 1990, 1999, 2001, 2004, Ministry of Health and Family Welfare, Govt. of India, New Delhi.
4. Indian Pharmacopoeia 1985, 1996, 2007, Ministry of Health and Family Welfare, Govt. of India, New Delhi.
5. Pharmacognosy by Trease G.E., Brady L.R. robbers J.E. 8th edition, Lea and Febiger, USA.
6. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London.
7. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
8. E.J.Eames . Morphology of Vascular Plants, Standard University Press.
9. Principal Crude Herbal Drugs of India : An Illustrated Guide to Important Largely Used and Traded, By Y.K. Sarin. ISBN 10: 8121106036 / ISBN 13: 9788121106030 Publisher: BSMPS.
10. Herbal Drug Technology By M. Paridhavi S.S. Agrawal Paridhavi Agrawal. ISBN 10: 8173717877 / ISBN 13: 9788173717871 Published by Universities Press (India) Pvt. Ltd., 2021.
11. Plant Taxonomy. Singh, Pandey and Jain. Publisher: Rastogi Publications, Merrut. ISBN: 9789350781708, 9789350781708.
12. Taxonomy of Angiosperms. by V. Singh , D. K. Jain. Rastogi Publication, Meerut.
13. Bridson, D. & L. Forman. eds. 1998. The Herbarium Handbook. 3rd ed. Royal Botanic Gardens, Kew
14. (Reprinted 1999).
15. De Vogel, E.F. 1987. Manual of Herbarium Taxonomy: Theory and Practice. UNESCO, Jakarta.
16. Fosberg, F.R. & M.-H. Sachet. 1965. Manual for tropical herbaria. Int. Bur. Pl. Tax. & Nom. Regnum
17. Vegetabile Vol. 39. Utrecht.
18. Jain, S.K. & R.R. Rao. 1977. A handbook of field and herbarium methods. Today & Tomorrow's Printers
19. and Publishers, New Delhi.
20. Victor, J.E., M. Koekemoer, L. Fish, S.J. Smithies, M. Mossmer. 2004. Herbarium essentials: the Southern
21. African Herbarium user manual. Southern African Botanical Diversity Network Report No. 25. SABONET, Pretoria.
22. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge. London.
23. The useful plant of India, S.P. Ambasta (Eds), NISCAIR, New Delhi.

B.Sc. I Year **Semester – II**

BBO –V201

VAC-2:

Credits: 2

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B.Sc. II Year **Semester – III**

BBO -C301
DSC-3 Plant Anatomy and Embryology

MM : 100
Time : 3 hrs
L Credit
4 4
Total Hours: 60

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

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

Learning outcomes:

- Understand basics of plant anatomy and embryology.
- Adaptive and protective systems, secondary growth..
- Explain structural organization of flower, pollination and fertilization.
- Understand the various methods and techniques used in plant anatomy and embryology.
- Take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Tissue: Meristematic and Permanent Tissues **(14 Lectures)**

Structure of dicot and monocot root, stem and leaf. Root and shoot apical meristems; Simple and complex 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 (heartwood and sapwood).

Unit 3: Structural Organization of Flower: Pollination and Fertilization **(10 Lectures)**

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

Unit 4: Embryo and Endosperm **(10 Lectures)**

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

Unit 5: Apomixis and Polyembryony **(10 Lectures)**

Definition, types and practical applications.

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); Maccrated 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. Pergmon Press, 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. Plant Anatomy By Pandey B. P. Publisher: S Chand & Co Ltd. ISBN: 9788121901451.
6. An Introduction to Plant Structure and Development. Charles B. Beck, University of Michigan, Ann Arbor.

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.

B.Sc. II Year **Semester – III**

BBO -S301

SEC-1 Floriculture

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

Learning objective:

- To acquire knowledge importance and scope of floriculture, landscaping gardening.
- To acquire an overall knowledge of the principles of garden designs.
- To become familiar with landscaping 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:

- The student shall be able to understand basic knowledge of floriculture and its propagation.
- The student shall be able to develop design and execute their ideas in production of flower 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 to Floriculture **(18 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: **(12 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: **(12 Lecturer)**

Introduction to the principles of garden designs, 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: **(12 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, Chrysanthemum, Dahelia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids).

Unit 5: Diseases and Pests of Ornamental Plants: **(6 Lecturer)**

Diseases and pests of ornamental plants (Aster, Dahelia, Gerbera, Marigold, Rose); leaf spot of *Chrysanthemum*, tulip mosaic,

B.Sc. II Year **Semester – III**

BBO –V301

VAC-3

Credits: 2

B.Sc. II Year **Semester – IV**

BBO -C401
DSC-4 Medicinal and Economic Botany

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 30
ESE : 70
Pass Marks : 40

Total Hours: 60

Learning objectives:

- To understand the basic knowledge of medicinal and economic botany.
- To acquire the basic information about the 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.

Learning outcomes:

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

Unit 1: Introduction and History of Ayurveda: **(18 Lectures)**

History, scope and Importance of medicinal plants; indigenous medicinal sciences; definition and scope-Ayurveda: history, origin, saptadhatu and tridosha concepts, Plants used in Ayurveda treatments, Siddha system of medicines: Introduction, origin and Basis of Siddha system, Unani System of Medicine: Introduction, history, and concept; Polyherbal formulations.

Unit 2: Conservation of Endangered and Endemic Medicinal Plants: **(12 Lectures)**

Definition: endemic and endangered medicinal plants, red list criteria; *in-situ* conservation: Biosphere reserves, sacred groves, national parks; *Ex-situ* and *in-situ* germplasm conservation: Botanical gardens, Ethno-medicinal plants. Cultivation, conservation and propagation of medicinal plants.

Unit 3: Ethnobotany and Folk Medicines: **(10 Lectures)**

Ethnobotany definition and concept: methods to study the ethnobotany; applications of ethnobotany: Palaeoethnobotany. Folk medicines and ethno-medicine, ethnoecology, ethnic communities of India; application of natural products to certain diseases: Jaundice, 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 **(10 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).

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

1. Cultivation and conservation techniques of medicinal and economic plants .
2. Factors affecting cultivation of medicinal plants.
3. Plants of medicinal importance: Tulsi, Giloy, Rauvolfia, Aswagandha, Bhang, Dhatura, Bhrangraj, Punarnava, Mint etc.
4. Plants of economic importance: Wheat, Rice, Maize
5. Plants of protein sources: Chana, Soybean, Black gram, Green gram, Chick pea.
6. Plants of beverages sources: Tea and Coffee.
7. Plants of oil sources: Sesame, Ground nut and Sarso.
8. Plants of spices sources: Cardamom, Pepper and Coriander.
9. Plants of Fiber sources: Jute and Sunn Hepm.
10. Plants of sugar and starch sources: Sugarcane and Potato.

Suggested Reading

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
5. Amit Deogirikar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture. Rajlaxmi Prakashan, Aurangabad, India.
6. Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.
7. Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
8. Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
9. Krishnamurthy, K.V. (2004). An Advanced Text rbook of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
10. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today& Tomorrow's printers and publishers, New Delhi.
11. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.

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B.Sc. II Year **Semester – IV**

BBO -S401
SEC-2 BIOFERTILIZERS

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4

Total Hours: 60

Learning objectives:

- To understand the beneficial plant-microbes interaction and their role as biofertilizer.
- To understand the symbiotic and non-symbiotic nitrogen fixation.

Learning outcomes:

At the end of course students will be able to

- Explain the role of microorganisms in nitrogen fixation, phosphate solubilisation and other beneficial roles.
- Cultivate cyanobacteria in laboratory by different methods
- Take decisions for carrier point of views in research, industries and academia entrepreneurships.

UNIT–I **(16 Lectures)**

Biofertilizers; General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic Nitrogen fixers: *Rhizobium* - Isolation, characteristics, types, Inoculum production and Mass cultivation; Field applications; Carrier materials.

UNIT-II **(10 Lectures)**

Non - symbiotic nitrogen fixers; Free living *Azospirillum*, *Azotobacter*- isolation, characteristics, mass inoculum, production and field application.

UNIT–III **(10 Lectures)**

Phosphate solubilizers; Phosphate solubilizing microbes - isolation, characterization, mass inoculum production, field applications.

UNIT–IV **(10 Lectures)**

Mycorrhizal biofertilizers: Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Inoculum production and mass production of VAM; field applications of Ectomycorrhizae and VAM.

UNIT –V **(14 Lectures)**

Cynobacteria: *Nostoc/ Anabaena*; cultivation methods (tray and pit methods); applications in field Azolla: isolation, characterization, mass multiplication, role in rice cultivation, crop response, field Application

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. N.S. SubbhaRao, Soil Microbiology, Science Publishers.
3. M.K.Rai, Handbook of Microbial Fertilizers, Internation Book Distributing Co.
4. Dubey, R.C. *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
5. Rangaswami,G. Agriculture Microbiolgy, Prentice Hall Indian Learning Ltd
6. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd Ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2 .
7. Fritsch, R. E. 1977. Structure and Reproduction of Algae, Cambridge University Press, London.
8. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.

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B.Sc. II Year **Semester – IV**

BBO –V401

VAC-4

Credits: 2

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B.Sc. III Year **Semester – V**

BBO -E501

DSE-5 Cytogenetics, Plant Breeding and Molecular Biology

MM : 100
Time : 3 hrs
L Credit
4 4
Total Hours: 60

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of cell and molecular biology.
- To acquire the basic information about the techniques of molecular biology.
- To acquire information on cell and cell cycle.
- To become familiar with 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:

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

Unit 1: Introduction to Genetics: (12 Lectures)

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance.

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: (18 Lectures)

Functions of membranes; models of membrane structure, Mitochondria: structure, and function; symbiont hypothesis; Chloroplast structure and function, Endoplasmic reticulum, Golgi body & Lysosome: structure and role. Peroxisomes and Glyoxisomes: structure, composition, functions. Nucleus: nuclear envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, and nucleolus.

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

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 and semi-conservative replication,. Types and structure of RNA (mRNA, tRNA, rRNA), RNA polymerases; translation (prokaryotes and eukaryotes), genetic code.

Unit 5: Pant Breeding: (10 Lectures)

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in crop plants- Centers of origin-biodiversity and its significance. Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection. Special breeding techniques.

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

1. To study the 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. To study mitosis and meiosis (temporary mounts and permanent slides).
5. To study the effect of temperature, organic solvent on semi permeable membrane.
6. Demonstration of dialysis of starch and simple sugar.
7. To study plasmolysis and deplasmolysis.
8. To measure the cell size (either length or breadth/diameter) by micrometry.
9. To study the structure of nuclear pore complex with the help of photograph.
10. To study special chromosomes (polytene & lampbrush) either by slides or photographs.
11. To study DNA packaging by micrographs.
12. Preparation of the karyotype and idiogram 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.
5. 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.
6. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
7. Chopra VL. 2001. Breeding Field Crops. Oxford & IBH.
8. Chopra VL. 2004. Plant Breeding. Oxford & IBH.
9. Gupta SK. 2005. Practical Plant Breeding. Agribios.
10. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
11. P.K. Gupta. BIOTECHNOLOGY AND GENOMICS. Rastogi Publications, 7th Reprint (1st Edition): 2016-2017.
12. P.K. Gupta. Genetics. Published by Rastogi Publications, Meerut.
13. P.K. Gupta Cytogenetics. Published by Rastogi Publications, Meerut.
14. A Textbook Of Basic And Molecular Genetics by Dr. Parihar P (pb) ISBN : 9788188826193.

B.Sc. III Year **Semester – V**

BBO -S501
SEC-3 Indian Traditional Knowledge and Ethnobotany

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 30
ESE : 70
Pass Marks : 40

Total Hours: 60

Learning objective:

- To understand the basic knowledge of ethnobotany.
- To acquire the basics concept, scope and objectives of ethnobotany.
- To acquire information on methodology and role of ethanobotanical studies on modern medicine.
- To acquire an overall knowledge of IPR and traditional knowledge.
- To become familiar with general techniques used in ethanobotanical studies and IPR, Biopiracy 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 the course student shall be able to

- Familiar with relevance of ethnobotany in the present and future context.
- Understand about field work, herbarium, ancient literature, archaeological findings, temples and sacred places.
- Understand the medico-ethanobotanical sources in India.
- Understand the role of ethnic groups in the conservation of plant genetic resources.
- Learn and understand the ethnobotany as a tool to protect interests of ethnic groups, IPR, Biopiracy and traditional knowledge.
- Take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Ethnobotany (12 Lectures)

Introduction, concept, scope and objectives; ethnobotany as 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 Ethanobotanical 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 terrestrisf*) *Pongamia pinnatag*) *Cassia auriculatah*) *Indigofera tinctoria*; role of ethnobotany in modern medicine with special reference to *Rauvolfia sepentina, Artemisia, Withania*.

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

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

B.Sc. III Year **Semester – V**

BBO –V501

VAC-5

Credits: 2

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B.Sc. III Year **Semester – VI**

BBO -E601
DSE-6 Plant Physiology and Metabolism

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 30
ESE : 70
Pass Marks : 40

Total Hours: 60

Learning objective:

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

Learning outcomes:

- The student shall be able to understand basic knowledge of plant physiology and metabolism.
- The student shall be able to understand transpiration, guttation and essential elements required for growth and development.
- The student shall be able to understand the structure, function, composition of vascular tissues.
- The student shall be able to understand the physiology and biochemistry and mechanism of action of phyto-hormones, photosynthesis and respiration.
- The student shall be able to 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.

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DSE 6 SEMESTER VI / BBO-E651 (LAB COURSE CC-06)

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. To demonstrate that light is necessary for photosynthesis.
5. To demonstrate that CO_2 is necessary for photosynthesis.
6. To demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
7. To demonstrate that O_2 is releasing during photosynthesis with the help of hydrophytic plant.
8. Comparison of the rate of respiration in any two parts of a plant.
9. Separation of chlorophyll pigments by paper chromatography.
10. To demonstrate the analysis of soil pH, N, P and K.

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 & Physiology ELBS/Longmans-London.
5. Mayer, Anderson & Bonning(1965: Introduction to Plant Physiology D.Van Nostrand . 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.
11. Day, P. M. & Harborne, J.B. (Eds.,) 2000: Plant Biochemistry. Harcourt Asia (P) Ltd., India & Academic Press, Singapore.
12. A Laboratory Manual Of Plant, Physiology, Biochemistry And Ecology Author: Akhtar Inam Publisher: Agrobios (India).
13. Advanced Methods In Physiology And Biochemistry (pb) Author : Padmanaban G , Chandrasekaran CN , Thangavelu AU , Dr. Sivakumar R , Kalimuthu N., Dr. Boominathan P , Dr. Anbarasan P,Agrobios.
14. Methods in Plant Biochemistry and Molecular Biology. 1997. Dashek, WV (ed.). CRC Press.
15. Wilson and Walker .Practical Biochemistry: Principles and Techniques. Cambridge University Press. U.K.
16. Thimmaiah, SR. 2004. Standard Methods of Biochemical Analysis. Kalyani Publishers.
17. Henry, RJ. 1997. Practical Application of Plant Molecular Biology. Chapman & Hall, London

B.Sc. III Year **Semester – VI**

BBO –S601
SEC-4 Mushroom Culture Technology

MM : 100
Time : 3 hrs
L Credit
4 4
Total Hours: 60

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the techniques used mushroom culture technology.
- To acquire the information about the mushroom cultivation and management technology.
- To acquire an overall knowledge on 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:

- The student will be able to familiar with history, nutritional and medicinal value of edible mushrooms, and poisonous mushrooms.
- The student will be able to understand about the infrastructure and necessary tools and items required for cultivation.
  - The student will be able to understand the various methods used for pure culture, sterilization, preparation of spawn, multiplication, and mushroom bed preparation.
  - 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 learned various techniques used for short-term storage and long term storage of mushrooms.
  - The students can understand about the cost benefit ratio, marketing and export value of mushrooms.
  - 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, Agaricus bisporus*.

Unit 2: Cultivation of Mushroom : **(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 and cultivation of *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

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.

Suggested readings:

1. A text book of Mushroom cultivation: Theory and practice by Aggarwal, A; Sharma Y.P. and Jangra, E. (2022) New Rays Publishing House, New Delhi.
2. Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home. by Tavis Lynch, Publisher Quarry Books.

B.Sc. III Year **Semester – VI**

BBO –V601

VAC-6

Credits: 2

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B.Sc. IV Year **Semester – VII**

BBO –E701
DSE-7 Plant Biotechnology

MM : 100
Time : 3 hrs
L Credit
44
Total Hours: 60

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objective:

- To understand the basic knowledge of Plant Biotechnology.
- To acquire the basic information about the global impact and current excitement of plant biotechnology.
- To acquire an overall knowledge on the 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:

- The student shall be able to familiar with the historical back ground and recent advance in plant biotechnology.
- The student shall be able to understand about the global scenario and recent trends in plant biotechnology.
- The student shall be able to understand the various methods used for Cryopreservation.
- The student shall learn and understand the various methods used in tissue culture and micro-propagation.
- The student shall learn 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 shall be able to take the decisions for carrier point of views in research, industries and academia entrepreneurships etc.

Unit 1: Scope and Importance **(14 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. 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 improvement, virus resistant transgenic plants, insect resistant transgenic plants, Herbicide resistant transgenic plants, Molecular farming from transgenic plants.

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

Introduction and difficulties in cryopreservation; methods for cryopreservation, selection of material, addition of cyoprotectors, storage in liquid nitrogen, thawing, washing and recuturing 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, Western and Northern Blotting, 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 7 SEMESTER VII / BBO-E751 (LAB COURSE CC-07)

The practicals based on BBO E701 will be performed.

Spotters/Photographs

1. Callus culture from explants.
2. Protoplast isolation.
3. Plasmids – Ti plasmids
4. Gene cloning in *E. Coli*.
5. *Agrobacterium* mediated gene transfer.
6. Blotting techniques.
7. Colony hybridization technique.
8. Transgenic plants prescribed in the syllabus.
9. Familiarization with basic equipment's in tissue culture.
10. Study through photographs: anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
11. Study of molecular techniques: PCR, ELISA, AGE and PAGE.

Suggested readings:

1. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
2. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice. Publisher: Elsevier, North Holland
3. Chrispeel, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones and Barlett Publishers.
4. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
5. Smith, R. 2000 Plant Tissue Culture: Techniques and Experiments, 2nd edition, Academic
6. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
7. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.
8. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
9. Brown, T. A. Gene cloning and DNA analysis 2016: An Introduction. Wiley-Blackwell Publication.
10. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition) 2001 J.F. Sambrook and D.W. Russell, ed., Cold Spring Harbor Laboratory Press,

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B.Sc. IV Year **Semester – VII**

BBO –E702
DSE- 8 Recombinant DNA Technology

MM : 100
Time : 3 hrs
L Credit
4 4
Total Hours: 60

Sessional : 30
ESE : 70
Pass Marks : 40

Learning objectives:

- To make students clear about the structure and function of biologically important molecules.
- To know the historical background of DNA structure and its role as genetic material.
- To become familiar with different tools and techniques used in genetic engineering and recombinant DNA technology.
- To understand the applications of DNA modifying enzymes, cloning strategies, vector types, and screening of recombinants
- Students will know how gene expresses and regulates in prokaryotic cells.

Learning outcomes:

At the end of course students will be able to

- Explain why DNA is the genetic material.
- Explain the application of genetic engineering techniques in basic and applied experimental biology.
- Amplify the DNA using PCR for the diagnosis and DNA fingerprinting.
- Describe how protein synthesis occur in procaryotic cell and enzyme involved in it.

UNIT- I **(16 Lectures)**

Introduction to Genetic Engineering

Milestones in genetic engineering and biotechnology; Molecular Cloning- Tools and Strategies-Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties of Plasmid vectors: pBR, Cosmids, Expression vectors.

UNIT- II **(14 Lectures)**

Methods in Molecular Cloning

Transformation of DNA: chemical method, electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern – blotting techniques, DNA Western blotting.

UNIT- III **(09 Lectures)**

DNA Amplification and DNA Sequencing PCR

Basics of PCR, Real-Time PCR, Sanger's method of DNA Sequencing: traditional and automated sequencing.

UNIT- IV **(09 Lectures)**

Construction and Screening of Genomic and cDNA Libraries

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR.

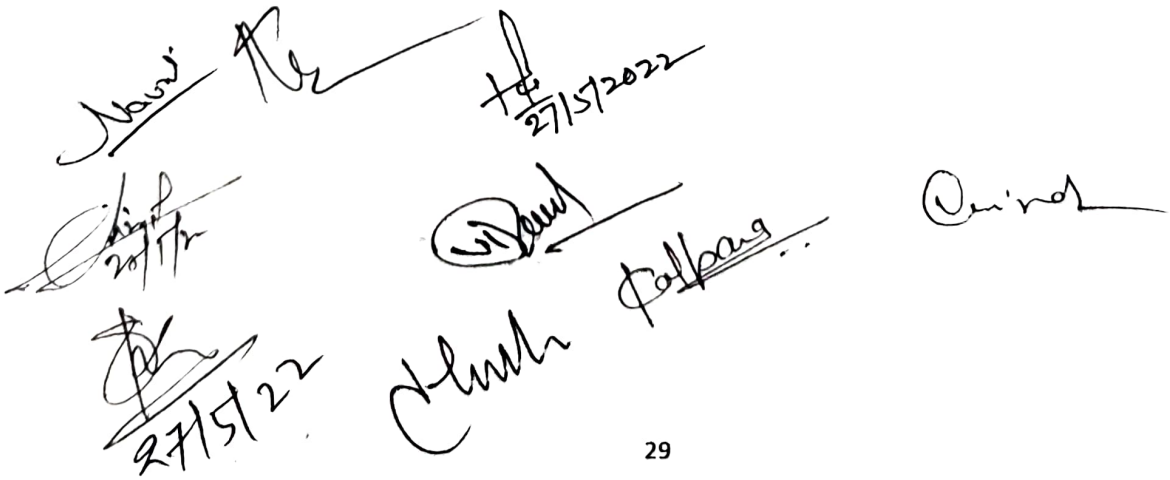
UNIT - V **(12 Lectures)**

Applications of Recombinant DNA Technology

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

Suggested Reading

1. Bruce Alberts. Molecular Biology of the Cells, W.W. Norton and Company, ISBN: 9780815344643
2. Harvey, Lodish. Molecular Cell Biology, W.H.Freeman.
3. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, II nd edition, Cold spring harbor laboratory press, New York.
4. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL Press, Oxford, 1995
5. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W. Wu , D. Kim and L.J. Cseke, CRC Press Florida 1995.
6. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
7. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990
8. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
9. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
10. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992
11. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
12. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998
13. An Introduction to Genetic Engineering, 3rd Edition. Desmond S. T. Nicholl, Cambridge University press, 2008.
14. Gene Cloning and Manipulation, 2nd Ed. Cristopher Howe, Cambridge University Press, 2007.



DSE 8 SEMESTER VII / BBO-E752 (LAB COURSE CC-08)

The Practicals based on BBO E702 will be performed.

A. To perform Bacterial DNA isolation and Southern analysis.

1. Bacterial DNA isolation and restriction digestion.
2. Agarose gel electrophoresis, staining and southern transfer.
3. Probe preparation and southern hybridization.
4. Washing and Blot development.

B. To perform plasmid isolation and restriction mapping.

5. Plasmid isolation and restriction digestion.
6. Agarose gel electrophoresis.

C. To perform acquiring antibiotic resistance through bacterial transformation.

7. Preparation of competent cells.
8. Transformation of competent *E. coli* with pBR322.

B.Sc. IV Year **Semester – VII**

BBO –E703

DSE-9 Plant Diversity and Human Welfare

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4

Total Hours: 60

Learning objective:

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

Learning outcomes:

- The student shall be able to familiar with genetic, species, plant diversity at the ecosystem level, and cultivated plants.
- The student shall be able to understand basic information on loss of genetic, species, and ecosystem diversity.
- The student shall be able to understand the organizations associated with biodiversity management-methodology for execution like IUCN, UNEP, UNESCO, WWF, and NBPGR.
- The student shall be to understand the about the biodiversity management, and Conservation.
- The student shall be to learn and understand importance of forestry, utilization and important fruit crops for their commercial importance.
- The student shall 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.

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.

Unit 5: Management of Natural Resources:

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.

DSE 9 SEMESTER VII / BBO-E753 (LAB COURSE CC-09)

The Practicals based on BBO E703 will be performed.

Practicals

1. Prepare maps showing forest types in India and Uttarakhand.
2. Collect and study the remote sensing images showing forest vegetation in India and Uttarakhand.
3. Photographs/collection of three local endangered plants.
4. Collection and documentation of native medicinal plants.
5. Collection and documentation of cultivated plants.
6. Collection and documentation of invasive species.
7. Visit/excursion local conserves area (Biosphere reserve/National parks/Wild life sanctuaries/scared grooves.
8. Map of Vegetation types of India

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SEMESTER VII / BBO-T754, Value Addition Course

Credit: 6

Students shall have to undergo Industrial training/Survey and Field work/Research project/Dissertations

B.Sc. IV Year **Semester – VIII**

BBO –E801
DSE-10 Applied Microbiology and Plant Pathology

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 30
ESE : 70
Pass Marks : 40

Total Hours: 60

Learning objectives:

- To understand the Vedic culture in which there is description of different information related to microorganisms and also they will know how earth evolved and also know the landmarks discoveries of microbiology
- To acquire knowledge of different technique to stain microorganism and how they can visualize the microorganisms in different types of microscope.
- To acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes.
- To become familiar with general characteristic of prokaryotic and eukaryotic microbes and also acquire knowledge of cellular organization, life cycle and economic importance of prokaryotic

Learning outcomes:

At the end of course student will be able to

- Know the different milestones in the history of microbiology, importance of Vedic microbiology
- Understand and know the application of techniques used in the field of Microbiology.
- Identify key constituent prokaryotes cell and their function.
- Classify the prokaryotic cell by conventional as well as modern methods.
- Stain the bacteria with simple, differential and-special stain.

UNIT–I: General Microbiology **(8 Lectures)**

General features of various groups of microorganisms: bacteria, cyanobacteria, archaea, mycoplasma, viruses (Morphology and Multiplication of T4 Bacteriophage), protozoa and fungi, Bacterial cells (size and arrangement), ultra structure of bacterial cells.

UNIT-II: Golden age of Microbiology **(8 Lectures)**

Historical account of microbiology, spontaneous generation vs biogenesis, golden age of microbiology, contributions made by Anton von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner, Joseph Lister, Alexander Fleming; Germ theory of disease.

UNIT III Applied Microbiology **(14 lecture)**

Food fermentation and food produced by microbes, amino acids, Production of antibiotics, vitamins, alcoholic beverages, organic acid & genetic recombinant vaccines. Mass production of bacterial biofertilizers, blue green algae, *Azolla* and mycorrhiza. Plant growth promoting rhizobacteria & biopesticides—*Trichoderma* sp. and *Pseudomonas*, Single cell proteins, Organic farming inputs, Microbiology of air and water.

UNIT IV: Plant Pathology **(14 lecture)**

Disease concept, symptoms, etiology and causal complex, Primary and secondary inoculums, Infection, pathogenicity and pathogenesis, Koch's Postulates. mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration). Defence mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and induced systemic. Fungicides- Bordeaux mixture, Lime sulphur, Tobacco decoction, Neem cake and oil.

UNIT- V: Diseases and Control **(16 lecture)**

Symptoms , causal organism, disease cycle and control measures of – Early and late blight of Potato, Brown spot of rice, Black stem rust of wheat, White rust of crucifers, Red rot of sugarcane, Wilting of Arhar, Mosaic disease of papaya; citrus canker; damping off of seedlings, Disease management: - quarantine, chemical, biological, integrated pest disease management.

DSE 10 SEMESTER VIII / BBO-E851 (LAB COURSE CC-10)

PRACTICAL

The Practicals based on BBO E801 shall be performed.

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs.
3. Examination of bacteria from natural habitat (curd) by simple staining.
4. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule (live materials and photographs).
5. Gram staining

Plant Pathology

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides/ photographs.
3. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, and fairy rings are to be shown.
4. Phytopathology: Herbarium specimens/photographs of bacterial diseases; Citrus Canker; Viral diseases: Mosaic disease of papaya, Fungal diseases: Early and late blight of Potato, Brown spot of rice, Tikka disease of ground nut, Powdery mildew of locally available plants and White rust of crucifers, Black stem rust of wheat.

B.Sc. IV Year **Semester – VIII**

BBO –E802
DSE-11: AGRICULTURAL MICROBIOLOGY

MM : 100
Time : 3 hrs
L Credit
4 4

Sessional : 30
ESE : 70
Pass Marks : 40

Total Hours: 60

Learning objectives:

- Students will learn about positive or negative interaction of microorganisms with soil.
- To impart in-depth information on soil and agriculture.
- To know the importance of biofertilizers and Biopesticides.
- To make the students aware about various techniques involved in biofertilizers and Biopesticides production.

Learning outcomes:

At the end of course students will be able to

- Describe the positive and negative aspect of microbes in soil fertility.
- Explain or suggest different biocontrol method to control the pests.
- Develop biofertilizer or biopesticide in the lab conditions.
- Isolate *Rhizobium* from the root nodule of leguminous plants.

UNIT – I **(16 Lectures)**

Soil Microbiology

Soil as microbial habitat, soil profile and properties, soil formation, diversity and distribution of microorganisms in soil; mineralization of organic & inorganic matter in soil-mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus.

UNIT – II **(14 Lectures)**

Microbial Control of Soil Borne Plant Pathogens (Biopesticides)

Biological control; biocontrol mechanisms; microbial preparations used as biocontrol agents against plant pathogens, insects, weeds, commercial biofungicides.

UNIT - III **(16 Lectures)**

Biofertilizers & PGPRs

Plant growth promoting bacteria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs and its application.

UNIT - IV **(08 Lectures)**

Secondary Agriculture Biotechnology

Biomanure, biogas, biofuels– advantages and processing parameters.

UNIT - V **(06 Lectures)**

GM crops

Advantages, social and environmental aspects; methods of preparation; Bt crops, golden rice.

Suggested Reading

1. Singh and Purohot, Microbial Ecology, AGROBIOS
2. Atlas. Microbial Ecology, Pearson Education ISBN13: 9788129707710.
3. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, Singapore: John Wiley & Sons.
4. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
5. Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi

DSE 11 SEMESTER VIII / BBO-E852 (LAB COURSE CC-11)

The Practicals based on BBO E802 shall be performed.

1. To perform isolation of fungal pathogens (*Fusarium* sp., *Macrophomina phaseolina*, *Phytophthora* sp. from soil.
2. Demonstration of production of amino acid by soil fungi.
3. Demonstration of phosphate solubilisation by given organism.
4. Production of ammonia from organic compounds i.e., ammonification.
5. Isolation of *Azotobacter* from garden soil.
6. Isolation of *Rhizobium* from soil/root nodules.
7. Demonstration of bacterial commensalism.
8. Demonstration of bacterial synergism.
9. Demonstration of bacterial/fungal antagonism.

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B.Sc. IV Year **Semester – VIII**

BBO –E803

DSE-12 Ecology, Environment and Elementary Paleobotany

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4

Total Hours: 60

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.

Learning outcomes:

At the end of course student will be able to:

- Understand the importance of the natural resource and functioning for sustainable development.
- The student will be able to structural and functional ecological web.
- Identify key points for biogeochemical cycling, complex interrelationship between organisms and environment.
- Understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
- Understand the strategies for sustainable natural resource management and biodiversity conservation.
- Take the decisions for carrier point of views in research, industries and academia.

UNIT – I **(16 Lectures)**

Natural Resources and Sustainable Utilization: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water , Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy, Contemporary practices in resource management : EIA, GIS, Participatory Resource Appraisal, Ecological Footprint and carbon footprint.

UNIT – II **(14 Lectures)**

Ecology & Ecosystem: Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic factors- Energy flow in an ecosystem. Ecological Succession-definition & types. hydrosere and xerosere. Food chains and food webs, Ecological pyramids, production and productivity; And components. Types of ecosystems: Forest Ecosystem, Grass land, Crop land, aquatic Ecosystems Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.

UNIT – III **(14 Lectures)**

Biodiversity and its Conservation: Definition -genetic, species, and ecosystem diversity. Value of biodiversity: hot spots of Biodiversity & threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators. *Conservation of Biodiversity:* Ex-situ and in-situ conservation, Red data book, botanical gardens, National park, Sanctuaries, hot spots and Bioreserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI.

UNIT – IV **(08 Lectures)**

Soil Formation, Properties & Conservation: Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Crop rotation.

UNIT – V **(08 Lectures)**

Elementary Palaeobotany: An elementary knowledge of Palaeobotany, Fossils: Types of fossils and process of fossilization. A general idea about Geological era. Living fossils.

Suggested Reading

1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press
2. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.
3. Begon, M., Herper, J.L. and Townsend, C.R. Ecology- Individuals, Populations and Communities (3rd ed.), Oxford Blackwell Science
4. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company
5. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders

DSE 12 SEMESTER VIII / BBO-E853 (LAB COURSE CC-12)

The Practicals based on BBO E803 will be performed.

1. Analysis of herbaceous vegetation - by using quadrate / line transects method to find out frequency, density, abundance.
2. Estimation of dissolved oxygen content in the given water sample.
3. Estimation microbial load in water samples.
4. Morphological adaptations of hydrophytes and xerophytes.
5. Study of anatomical adaptations of hydrophytes and xerophytes and correlate to their particular habitat. Hydrophytes: *Nymphaea, Hydrilla Xerophytes: Nerium, Casuarina.*
6. Morphological adaptations of Halophytes-Vivipary and Pneumatophore.
7. Study of native and invasive species and their impacts on environments.
8. A study of plant distribution maps - endemic distribution and continental drift.
9. Vegetation map and types of India.
10. Study of some fossil slides / photographs as per theory.

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SEMESTER VIII / BBO-T854, Value Addition Course

Credit: 6

Students shall have to undergo Industrial training/Survey and Field work/Research project/Dissertations