

B.Sc. Botany V and VI Semester Syllabus as per NEP 2020.

SEMESTER V

Discipline Specific Elective (DSE) and Vocational Courses (VC)

DSE 1- Biotechnology and Genetic Engineering (Theory and Practical)

DSE 2- Resource utilization & Ethnobotany

VC1-Algal Biotechnology

VC 2-Applied Palynology

SEMESTER VI

Discipline Specific Elective (DSE) and Vocational Courses (VC)

DSE 3- Biodiversity and Environmental Management (Theory and Practical)

DSE 4- Genetics and Cell Biology

VC 3-Biofertilizers

VC 4-Medicinal and Aromatic Plants

SEMESTER V

Semester V: DSE 1-Biotechnology and Genetic Engineering
Course Code: SOLS/BOT/DSE-1 (T) (MM: 30+70)

Total No. of Lectures: 60

Credits: 04

Unit1:

Concept: Definition of Biotechnology, history and multidisciplinary nature of Biotechnology, applications of Biotechnology, Biotechnology and developing countries, commercialization of Biotechnology in a developing country.

Unit 2:

Biotechnology in Food: Introduction, dairy products, fish and meat products, food enzymes, sweeteners, bakery products, food wastes, microbial products, oriental fermented foods, drinks, alcoholic and non-alcoholic beverages

Unit 3:

Enzymology and Enzyme Technology: Definition of enzyme, enzymology and enzyme technology, nature of the enzymes, applications of enzymes, the technology of enzyme production, immobilization of enzyme.

Unit 4:

Recombinant DNA Technology: Concepts of Recombinant DNA, biological tools of Recombinant DNA technology, modification of the gene, methods of gene transfer, transgenic organisms.

Unit 5:

DNA Structure and Manipulation - Techniques for DNA isolation and purification. Methods for quantification and characterization of DNA samples. RNA Analysis and Gene Expression- Methods for RNA isolation and purification. Analysis of gene expression.

Unit 6:

Gene Manipulation Techniques - Methods of gene delivery. Physical, chemical, and biological methods. Transformation, transfection, electroporation and micro-injection. Gene knockout techniques in bacterial and eukaryotic organisms.

Unit 7:

Genome Editing - Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9, site-directed mutagenesis, and other genome editing methods.

Books

1. Bilgrami and Pandey. 1990. Introduction to Biotechnology. CBS Publishers. India.
2. Bullock, J. and Uritiansen, B. 1995. Basic Biotechnology. Academic Press, UK.
3. Dubey, R. C. 2014. A Textbook of Biotechnology. S. Chand and Co. Pvt. Ltd. New Delhi, India, ISBN: 81-219-2608-4.
4. Jack, G. Chirikjian. 1995. Biotechnology: Theory and Techniques. Volume I. Jones and Bartlett publisher, Boston, London, Singapore.
5. Natesh, S. 1993. Biotechnology in Agriculture. Oxford and IBM Pvt. Ltd. India.
6. Smith, J. E. 1988. Biotechnology. Edward Arnold Pub. NY, UK

Course Code: SOLS/BOT/DSE-1(P)

(MM 30+70)

DSE 1-Biotechnology and Genetic Engineering (Practical) (Credits: 2)

1. Demonstration of Agarose Gel Electrophoresis.
2. Conformation of plasmid by restriction digestion and Agarose Gel Electrophoresis
3. Ligation of DNA insert and plasmid vector backbone using DNA ligase enzyme.
4. Transformation of plasmid DNA in *E.coli* cells by Calcium Chloride method.
5. Isolation of plasmid DNA from bacterial cells by alkaline lysis method.
6. Screening of plasmid DNA transformed colonies by Blue-white method.
7. Confirmation of gene integration by polymerase chain reaction (PCR).
8. Micropropagation of plant organs i.e Leaf, stem, Shoot tips and axillary buds.

Suggested Readings:

1. E. Pullaiah, T., Rao, M.V. Subba, Sreedevi 2017. Plant tissue culture: Theory and Practicals 2nd Edition.
2. P V G K Sarma, 2021. A Practical Textbook of Genetic Engineering in Bacteria.
3. B.D. Singh, 2015 Biotechnology.

DSE 2- Resource Utilization & Ethnobotany

Course Code: SOLS/BOT/DSE-2

(MM: 30+70)

Lectures: 60

(Credits – 4)

Unit 1: (8 Lectures)

Plant resources: Concept, status, utilization, and concerns. World Centers of Primary Diversity of Domesticated Plants. Role of ethnic groups in the conservation of plant genetic resources.

Unit 2: (16 Lectures)

Role of plants in relation to Human Welfare

- a) Cereals- Wheat and Rice.
- b) Pulses- A general account.
- c) Fruits- A general account.
- d) Alcoholic beverages.
- e) Important firewood and timber-yielding plants and non-wood forest products (NWFPs)
- f) Ornamental plants of India.
- g) Sugar cane and starches (sugarcane, beetroot, potato, sweet potato, cassava),
- h) Forage and fodder crops.
- i) Fiber crops.
- j) Medicinal and aromatic crops.

Unit 3: (12 Lectures)

Ethnobotany

Introduction, concept, scope, and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context: Major and minor ethnic groups or Tribals of India and their lifestyles. Plants used by the tribals: a) Food plants, b) intoxicants and beverages, c) Resins and oils and miscellaneous uses.

Unit 4: (12 Lectures)

Methodology for plant resource utilization and Ethnobotanical studies

a) Fieldwork b) Herbarium c) Ancient Literature d) Archaeological findings e) Temples and sacred places.

Unit 5: (12 Lectures)

Ethnobotany and legal aspects

Ethnobotany as a tool to protect the interests of ethnic groups. Sharing of wealth concept (Benefit Sharing) with a few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Lab Course: (Credits – 2)

1. Plant collection and Herbarium preparation techniques.
2. Ethnobotanical survey methodology.
3. Food crops: wheat, rice, maize, chickpea, potato, tapioca, sweet potato, sugarcane; morphology and anatomy.
4. Forage/fodder plants: Study of ten important fodder crops of the locality.
5. Plant fibers: Textiles fibers (cotton, jute, sun hemp, cannabis, Grewia, etc.), Cordage fibers (coir), and Stuffing fibers (silk cotton). Morphology, anatomy, and microscopic study of whole fibers using appropriate staining procedures.
6. Medicinal and aromatic plants, including narcotics and antibiotics.

Suggested Readings:

1. Bellamy, R. 1993. Ethnobotany in Tropical forests: expedition in field techniques, Royal Geographic Society of London.
2. Berlin, B. 1992. Ethnobiological Classification: Principles and categorization of plants and animals in traditional societies. Princeton Univ. Press. Princeton.
3. Chandel, K.P.S., Shukla, G. and Sharma, N.1996. Biodiversity in Medicinal and Aromatic Plants in India: Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
4. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
5. Council of Scientific & Industrial Research (1948-1976). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products. New Delhi. Raw Materials I-XII, Revised Volume I-III (1985-1992) Supplement (2000).
6. Council of Scientific & Industrial Research 1986. The Useful Plants of India. Publications and Information Directorate, CSIR, New Delhi.
7. Hill, A.F. 1952. Economic Botany. McGraw Hill., New York.
8. Kochar, S.L. 1998. Economic Botany in the Tropics. Mac Millan India Ltd. Delhi
9. Nair, M.N.B. et al. (Eds) 1998. Sustainable Management of Non-Wood forest Products. Faculty of Forestry, Universiti Putra Malaysia. 434004 PM Serdang, Selangor, Malaysia
10. Paroda, R.S. and Arora, R.K.1991. Plant Genetic resources conservation and Management. IPGRI (Publication) South Asia Office, C/o NBPGR, Pusa Campus, New Delhi.

Vocational Course 1: Algal Biotechnology

Course Code: SOLS/BOT/VC-1

(MM: 30+70)

Lectures: 30

(Credits – 2)

Unit 1 (6 Lectures)

Methods for mass cultivation of microalgae, Microalgal production in Photobioreactors. Microalgae-Based Biorefineries.

Unit 2 (4 Lectures)

Algal blooms: factors responsible for the formation of bloom in freshwater and marine systems, strategies for controlling nuisance blooms, consequences of blooms.

Unit 3 (10 Lectures)

High-rate algal ponds for the treatment of wastewaters and the production of useful biomass and energy; Carbon sequestration, hydrogen production by algae; immobilized, self-immobilized and inactivated algal biomass for metal and nutrient removal.

Unit 4 (4 Lectures)

Paddy field cyanobacteria: Use of algae as biofertilizers, reclamation of usar lands. Other roles of microalgae in agriculture.

Unit 5 (6 Lectures)

Algae as a source of nutraceuticals and pharmaceuticals; Commercial perspective of *Spirulina*, *Chlorella*, *Dunaliella*, *Porphyra* and other seaweeds; Importance of periphytic algal community to aquatic systems.

(6 Lectures)

Suggested readings:

1. R.E. Lee, Phycology, Cambridge University Press
2. Bux, Faizal, Chisti, Yusuf, Algae Biotechnology Products and Processes, Springer International Publishing
3. Posten, Clemens, Feng Chen, Steven, Microalgae Biotechnology, Springer International Publishing
4. Anderson, RA, Algal Culturing Techniques, Academic Press
5. Tripathi, BN, Kumar, D., Prospects and Challenges in Algal Biotechnology, Springer Singapore

Vocational Course 2: Applied Palynology

Course Code: SOLS/BOT/VC-2

(MM: 30+70)

Lectures: 30

(Credits – 2)

Unit I (6 Lectures)

Palynology- Introduction and history; basic vs applied palynology. Methods used in pollen grain analysis (Wodehouse and Erdtman), micrometry and terminology. Practical applications of palynology.

Unit II (8 lectures)

Melissopalynology: General introduction; types of honey bee in India. Bee biology; honey, nectar and how honey is formed? Types of honey. Bee pasturage, pollen pellets; pollen grains in honey. Chemical and physical characteristics of honey; assessment of honey-quality, floral source. Methods in Melissopalynology- qualitative and quantitative analysis; estimation of absolute number of plant elements in honey.

Unit III (6 Lectures)

Aeropalynology: Introduction to Aerobiology, aeropalynology- definition and scope; history . Airborne biological material: types and its transport; types of sampling devices. Pollen calendar and pollen forecasting. Methods for pollen allergy diagnosis.

Unit IV

(5 Lectures)

Forensic palynology: Introduction; techniques in Forensic palynology. Types of palynomorphs and their identification. Applications and importance of Forensic palynology.

Unit V (5 Lectures)

Quaternary Paleopalynology: Introduction, quaternary pollen records in India. Laboratory techniques used for pollen/spore extraction. Pollen diagram construction. Applications of Paleopalynology. Paleopalynology in hydrocarbon exploration- coal and petroleum.

Suggested readings:

1. Kashinath Bhattacharya, Manas Ranjan Majumdar, Swati Gupta Bhattacharya, **A Textbook of Palynology**, New Central Book Agency, Kolkata.
2. S. T. Tilak, **Aerobiology**, Satyajeeta Prakashan, Pune
3. Prabhawati Tiwari, J.K. Tiwari, Dinesh Singh Rawat, P. K Publishers and Distributers, New Delhi

4. Erdtman G. Handbook of Palynology, Hafner Publishing C Kolkata Kolkata o., New York.

SEMESTER VI

DSE-3: Biodiversity and Environmental Management (Theory)

Course Code: SOLS/BOT/DSE-3

(MM: 30+70)

Total No. of Lectures: 60

Credits: 04

Unit 1: (10)

Concept of Environmental Management, Major Environmental Problems, Environmental Laws: The Earth summit, Environmental Protection Act, Biological Diversity Act 2002, Environmental Protection and Fundamental rights, Man and Environment, Trade and Environment.

Unit 2 (10)

Natural Resources and Environmental Management, Pollution: Air pollution and management; Water Pollution Management; Waste disposal and management, Integrated solid waste management; Soil and its types: composition, formation and types of soils, Texture of the soil, soil horizon, profiles, Soil degradation and management, Soil Pollution: soil pollutants, types, sources, effects and management.

Unit 3 (10)

Environmental Impact Assessment: Planning and Significance, Legal frame work for EIA; Forest fires: Assessment, Impact and Risk Zonation; Urbanization and Industrialization, Mining activities, GHGs, CFCs, fossil fuels; Ozone Layer Depletion; Principles of Environmental Analysis.

Unit 4 (16)

Concept of ecosystem and community, populations and communities, Habitat and niche, species interaction, Hotspots, Key stone species, Species diversity and edge effects, Energy Flow, trophic levels and Food webs; *In-situ* and *ex-situ* conservation of Biodiversity, IUCN and Red data book, UNESCO, Biodiversity legislation, Indigenous knowledge and biodiversity conservation, Loss of biodiversity: causes and its impact; Invasive species: threats and management.

Unit 5 (14)

Sustainable development; Energy resources, renewable and non-renewable energy sources, Growing energy needs, Use of alternate energy sources, Urban problems related to energy; Water conservation, rain water harvesting; Watershed management: Definition and basic

concepts, Aims and Principles, Importance of integrated watershed management, Principal

watershed problems of India, Biofuel plants: *Jatropha*, sugarcane and oil crops, Biofuel plantation, achievement of sustainable Biofuel production.

Course Code: SOLS/BOT/DSE-3(P)

(MM 30+70)

Title of paper: Biodiversity and Environmental Management (Practical) (Credits: 2)

1. Study of Key stone species with the help of Photographs with Himalayan perspective.
2. Presentation of procedure of Environmental Impact Assessment (EIA) through flowchart.
3. Study of plants as pollution indicators with help of Photographic specimen.
4. Identification of soil texture: clay, silt, sand and loamy
5. Determination of soil moisture, bulk density and porosity.
6. To study the different economic values and valuation methods for ecosystem services.
7. Morphological study of a Biofuel plant.
8. Study the impact of forest fire on regional biodiversity and environment.

SUGGESTED READINGS

1. FAO Conservation Guide Nos. 12, 13/1, 13/3, 13/4, 13/6, 14. Rome.
2. Heywood, H.V. 1995. Global Biodiversity Assessment.
3. Lochwood, M., Worboys, G.L. and Ashish, K. 2006. Managing Protected Areas: A Global Guide.
4. Ramakrishnan, P.S., Saxena, K.G. and Chandrashekara, U.M. 1998. Conserving the sacred for Biodiversity Management. Oxford and IBH Publ. Co. New Delhi
5. Richard, P.P. 1998. Essentials of Conservation Biology. Boston University.
6. Agarwal, K.C., 2001, Environmental Biology, Nidi Publ. Ltd. Bikaner.
7. De, A.K., Environmental Chemistry, Wiley Eastern Ltd
8. Jadhav, H.& Bhosale, V.M., 1995, Environmental Protection and Laws, HimalayaPub. House, Delhi 284 p.

DSE 4- Genetics and Cell Biology

Course Code: SOLS/BOT/DSE-4

(MM: 30+70)

Lectures: 60

(Credits -4)

Unit 1: (8 Lectures)

CYTOLOGY AND CYTOSKELETON

Prokaryotic and eukaryotic cell, Cell Architecture, physio-chemical nature of plasma membrane and functions of cell organelle; nucleus, mitochondria, chloroplast, ribosomes, peroxisomes, Golgi bodies and endoplasmic reticulum. Cytoskeletal elements, Microtubules: structure & functions, shaping of the cells and mechanical support. Microfilaments: structure & functions. Structure of intermediate filaments. Cytoplasmic micro trabecular system (lattice). Covalent modifications of cytoskeletal proteins. Cytoskeletal architecture

Unit 2: (16 Lectures)

CELL CYCLE AND CELL SIGNALLING:

Cell cycle studies; mitosis and meiosis. Cell Birth, lineage and death, Cellular senescence and ageing, Hayflick phenomenon, Senescence in ageing and age-related disease, Apoptosis and Necrosis, Cancer Cell Biology, Asymmetrical cell division, patterns of stem cell division. Signalling molecules and cell surface, receptors; intracellular signal transduction; G protein coupled receptors; plant growth factors and hormones, Eukaryotic and Prokaryotic cell to cell signalling, endocrine signalling, quorum sensing and intercellular signalling, Signal peptides, biofilm formation.

Unit 3: (12 Lectures)

MEMBRANE TRANSPORT:

Membrane transport, passive and active transport; transport into prokaryotic cells; Endomembrane System: Golgi, Lysosomes Vesicular Traffic, Secretion, and Endocytosis, exocytosis; entry of viruses and toxins into cells Membrane trafficking: Translocation of secretory proteins across the ER membrane; protein modifications, folding and quality control in the ER; export and sorting of proteins to mitochondria, **chloroplast and peroxisomes.**

Unit 4: (12 Lectures)

GENETICS:

Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower color in sweet peas, Epistasis- Inhibitory and colored genes in fowls, simple problems. Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc.,

Unit 5: (12 Lectures)

Multiple alleles and groups antigens. Numericals based on concepts. Chromosome, Centriole, telomere, Chemical composition of chromatin, structural organization of nucleosomes, heterochromatin. Polytene and lamp-brush chromosomes, human chromosomes.

Unit 6: (12 Lectures)

CHROMOSOMAL DISORDERS

Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinopathies. Disorders of coagulation, Colour blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence.

Unit 7: (12 Lectures)

POPULATION GENETICS:

Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis

Books

1. The Cell – A Molecular Approach, Cooper & Hausman, ASM Press, 2004.
2. Cell and molecular biology, EDP De Robertis, EMF De Robertis, Lea & Febiger Intl. ed.1991.
3. Molecular Biology of the Cell, B. Alberts, et al., Garland Science, 4th ed. 2002.
4. Molecular Cell Biology Hardcover, James E. Darnell, Harvey Lodish, David Baltimore, 1999

Vocational Course 3: Biofertilizers

Course Code: SOLS/BOT/VC-3

(MM: 30+70)

Lectures: 30

(Credits – 2)

Unit 1: (4 Lectures)

General account about the microbes used as biofertilizer, merits and challenges of using biofertilizers.

Unit 2: (6 Lectures)

Symbiotic and non-symbiotic nitrogen fixing bacteria as biofertilizers, phosphate solubilizing bacteria, PGPRs,

Isolation, inoculum maintenance and mass multiplication of *Azospirillum*, *Azotobacter*, *Rhizobium* and Frankia.

Unit 3: (8 Lectures)

Symbiotic and non-symbiotic nitrogen fixing cyanobacteria as biofertilizers. Role microalgae in agriculture as phosphate solubilizer, degrader of agrochemicals, growth promoter, bio-controlling agent and soil stabilizer. Importance of *Nostoc*, *Anabaena*, *Aulosira* and other cyanobacteria in rice cultivation. Large-scale cultivation of *Azolla*, methods of application

Unit 4: (6 Lectures)

Mycorrhizal association- types of mycorrhizal association, 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: (6 Lectures)

Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

Suggested Readings

1. Dubey, R.C. & Maheshwari, D.K. 2022. A Textbook of Microbiology S. Chand & Co, New Delhi, ISBN: 978-93-550-1186-2.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. R.E. Lee, Phycology, Cambridge University Press
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi
6. Tripathi, BN, Kumar, D., Prospects and Challenges in Algal Biotechnology, Springer Singapore

Vocational Course 4: Medicinal and Aromatic Plants

Course Code: SOLS/BOT/VC-4

(MM: 30+70)

Lectures: 30

(Credits – 2)

Unit – I (04 Lectures)

Introduction to Medicinal and Aromatic Plants (MAPs): Definition, history, importance and future prospects in world and India.

Unit – II (06 Lectures)

Promotion of the medicinal plant sector at the national level: National Medicinal Plant Board and State Medicinal Plant Boards - objectives and functions. Other organizational initiatives for the promotion of MAPs at National and International levels. Demand and supply of medicinal plants. Herbal industries.

Unit – III (06 Lectures)

Important medicinal plants of India with their systematics, geographical distribution, and uses. *Acorus calamus*, *Adhatoda vasica*, *Withania somnifera*, *Taxus baccata*, *Abrus precatorius*, *Aloe vera* and *Ocimum sanctum*.

Unit – IV (07 Lectures)

Introduction and historical background of aromatic plants. Aromatic and cosmetic products. Raw material for perfumes, etc. Cosmetic Industries. Major, minor, and less-known aromatic plants of India.

Important aromatic plants of India with their systematics, geographical distribution, and uses. Java citronella, damask rose, geranium, large cardamom, lavender, lemon grass, mentha, holy basil, rosemary, vetiver, and eucalyptus.

Aromatic spices - clove, cinnamon, ajwain, curry leaf and saffron.

Unit – V (07 Lectures)

MAPs as industrial crops - constraints and remedial measures. Medicinal plant diversity & local healthcare in the Indian Himalayan region (IHR). AYUSH Systems of Medicine. Non-timber forest products (NTFP), Good Agriculture Practices (GAP). Medicinal plant conservation – issues and approaches. Conservation of endangered and endemic medicinal plants. In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens.

Suggested Readings:

1. Medicinal Plants of Uttarakhand by C.P. Kala (2010).
2. Indian Medicinal Plants by P.C. Trivedi (2009).

3. Hand Book of Aromatic Plants by S.K. Bhattacharjee (2004).
4. Handbook of MAPs by S.K. Bhattacharjee (2009).
5. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
6. S.K. Jain, 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
7. S.K. Jain, 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur.
8. Swaminathan, M.S. and Kocchar, S.L. (Eds.) 1989. Plants and Society. Macmillan Publication Ltd., London.
9. Thakur, R.S., Puri, H.S. and Husain, A. 1989. Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.