

VIDYASAGAR UNIVERSITY

Midnapore, West Bengal



PROPOSED CURRICULUM&SYLLABUS (DRAFT) OF

B. Sc. (HONOURS/ HONOURS WITH RESEARCH)
MAJOR IN BOTANY

4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes
(CCFUP), 2023& NEP, 2020

VIDYASAGAR UNIVERSITY
BACHELOR OF SCIENCE (HONOURS/ HONOURS WITH RESEARCH) MAJOR IN BOTANY
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks			
								CA	ESE	TOTAL	
B.Sc. (Hons./ Hons. with Research)	4 th	VII	SEMESTER-VII								
			Major-14	BOTHMJ14	T: Analytical Techniques in Plant Science; P: Practical		4	3-0-1	15	60	75
			Major-15	BOTHMJ15	T: Advanced Cryptogamic Botany; P: Practical		4	3-0-1	15	60	75
			CRM	BOTHCM	T: Research Methodology and Ethics; P: Practical		4	3-0-1	15	60	75
			Major Elective-03	BOTDSE 03	Seed Biology and Technology OR Herbal technology OR Virology and Plant Disease		4	3-0-1	15	60	75
			Minor-07 (Disc.-I)	BOTMIN07	T: Biofertilizer and Floriculture; P: Practical (To be taken by the other Discipline)		4	3-0-1	15	60	75
		Semester-VII Total					20				375
		VIII	SEMESTER-VIII								
			Major-16	BOTHMJ16	T: Restoration Biology, Ecosystem Services and GIS Technology; P: Practical		4	3-0-1	15	60	75
			Major Elective-04	BOTDSE04	Bioinformatics OR Pollen and Pollination Ecology		4	3-0-1	15	60	75
			Major Elective-05	BOTDSE05	Horticulture and Post-Harvest Technology OR Bee Keeping and Management	FOR HONOURS STUDENTS	4	3-0-1	15	60	75
			Major Elective-06	BOTDSE06	Ethnobotany OR Advances in Plant Science		4	3-0-1	15	60	75
			Research	BOTHRD	DISSERTATION:	FOR HONOURS WITH RESEARCH STUDENTS	8	0-0-8	-	150	150
			Minor-8 (Disc.-II)	BOTMIN08	T: Plant breeding and Reproductive Biology; P: Practical (To be taken by the other Discipline)		4	3-0-1	15	60	75
		Semester-VIII Total					20				375
		YEAR-4					40				750
		To be awarded Bachelor of Science (Honours / Honours with Research) Major in Botany on Completion					166	Marks (Year: I+II+III+IV)			3075

MJ = Major, MI = Minor Course, DSE = Discipline Specific Elective Course, CRM= Compulsory Research Methodology, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

VIDYASAGAR UNIVERSITY, PASCHIM MIDNAPORE, WEST BENGAL

SEMESTER-VII

MAJOR (MJ)

MJ-14: Analytical Techniques in Plant Science

Credits 04 (Full Marks:75)

MJ-14T: Analytical Techniques in Plant Science (Theory)

Credits 03 (45 hrs.)

Course Content:

Unit	Topic
Unit- 1	Imaging and related techniques Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.
Unit- 2	Cell fractionation Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl ₂ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.
Unit- 3	Radioisotopes Use in biological research, auto-radiography, pulse chase experiment.
Unit- 4	Spectrophotometry Principle and its application in biological research.
Unit- 5	Chromatography Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.
Unit- 6	Characterization of proteins and nucleic acids Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Course Outline:

1. Study of Blotting techniques: Southern, Northern and Western
2. DNA fingerprinting, DNA sequencing, PCR (through photographs)
3. Demonstration of ELISA.
4. Demonstration on Paper chromatography, thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. Separation of chloroplast pigments by column chromatography.
7. Estimation of protein concentration through Lowry's methods.
8. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
9. Study the process of preparation of permanent slides (double staining).
10. Visit to Research Laboratory to familiarize students with the various instruments.

Suggested Readings:

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.

MJ-15: Advanced Cryptogamic Botany**Credits 04 (Full Marks:75)***MJ-15T: Advanced Cryptogamic Botany (Theory)**Credits 03***Course Content:**

Unit	Topic
Unit- 1	Parameters used in classifying algae. Concept of Streptophyta. Significance of ultra-structural features of algae. Endosymbiotic theory of origin of chloroplasts;
Unit- 2	Salient features of Cyanoprokaryote, Glaucophyta, Rhodophyta, Chlorophyta, and Heterokontophyta with evolutionary tendencies and phylogeny.
Unit- 3	Reclamation of soil by algae. Algae in pisciculture. Hydrocarbons from algae. Pheromone in algae. Pathogenic algae. Algal toxins and their impact.
Unit- 4	Homothallism, heterothallism, parasexuality. Development and types of ascocarps and basidiocarps; Mechanism of ascospore and basidiospore discharge. Use of fungi in antibiotics, organic acids and food production, role of fungi in biotechnology, including vaccine production.
Unit- 5	Outline of the recent classification of bryophytes by Mishler et al. (1994): Marchantiophyta (liverworts), Anthocerophyta (hornworts), and Bryophyta (mosses) compare with Proskauer (1957) Traditional Classification Class I. Hepaticopsida Class II. Anthocerotopsida Class III. Bryopsida.
Unit- 6	Characteristics, affinities and systematic position and phylogeny of Calobryales, and Takakiales. Bryophyte as site indicators; Bryomonitoring
Unit- 7	Early land plants and their adaptation for successful colonization on land habitats. Similarities and dissimilarities with bryophytes and gymnosperms. Distribution of pteridophytes with special reference to India. Classification of pteridophytes based on molecular data by Smith et al. 2006. Endangered pteridophytes and their conservatio
Unit- 8	Apospory and apogamy: Definition, factors for induction and significance. Progymnosperms: Concept, characteristics, classification, origin and evolution. Importance: Ecological and economic importance of Pteridophytes with special reference to food, medicine, bio-fertilizer, metal indicator plants and beautification.

Course Outline:

1. Study of vegetative structures of gametophytic and sporophytic plant bodies of the members from different algal taxa.
2. Study of reproductive and other perennating structures of different members of algae.
3. Study of live algal species from nature and their habitat.
4. Collection of algal species from natural sources. Submission of the list of collected species with photographs taken under microscope.
5. Study of peristome structures of Nematodontae and Arthrodontae of the Bryopsida .
6. Field work [Spot dominated with lower Cryptogams inside State or Outside state)].
7. Students are required to submit field survey report and laboratory records, preserved and dried specimens and permanent slides.
8. A comparative study of the vegetative and reproductive parts of some extant Pteridophytes occurring in West Bengal.
9. Study of some fossils (slide and megafossils).

Suggested Readings:

1. "Algae" by Linda E. Graham, James M. Graham, and Lee W. Wilcox.
2. "The Fungi" by Michael J. Carlile, Sarah C. Watkinson, and G.W. Gooday.
3. "Biology of Bryophytes" by R.N. Chopra and P.K. Kumra.
4. "The Biology and Evolution of Ferns and Lycophytes" by Tom A. Ranker and Christopher H. Haufler.

COMPULSORY RESEARCH METHODOLOGY (CRM)

[for both Hons. and Hons. with Research students]

CRM: Research Methodology and Ethics

CRM (T): Research Methodology and Ethics (Theory)

Credits 03

Course Content:

Unit- 1	Definition of research. Types of research – Descriptive vs. Analytical, Conceptual vs. Empirical, Applied vs. Fundamental, Quantitative vs. Qualitative. Need of conducting research and setting of objectives of research. Benefits of conducting research.
Unit- 2	Definition of research methodology and methods. Difference between research methodology and methods and their interdependence. Research process (Research methodology) – (a) Formulating research problem, (b) Literature review, (c) Setting of working hypothesis, (d) Preparing the research design, (e) Determination of sample design, (f) Collection of data, (g) Execution of research work, (h) Analysis of data, (i) Hypothesis testing, (j) Interpretation of the finding, (k) Drafting the research report. Research methods – (a) Survey and (b) Experimental uses of primary data and secondary data, (c) Uses of instruments and other appliances.
Unit- 3	Criteria of good research. Motivations to conducting research. Ethics followed to conducting research. Plagiarism – different kinds of it and check.
Unit- 4	Measuring the standard of conducted research – impact factor of publication, H- index to determining the standard of the journal or any other literacy supplement. Need of the use of statistics. Elements of research paper and Ph.D. thesis; ethics followed during preparation of research papers and PhD thesis. Reference citing in text and at the end of publication - different types.

CRM (P): Research Methodology and Ethics (Practical)

Credits 01

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

Suggested Readings:

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

MAJOR ELECTIVE (DSE)

Major Elective – 03:

(Seed Biology and Technology / Herbal technology /Virology and Plant Disease)

MJDSE-03: Seed Biology and Technology

Credits 04 (Full Marks:75)

MJDSE-03T: Seed Biology and Technology (Theory)

Credits 03 (45 hrs)

Course Content:

Unit	Topic
Unit- 1	Seed structure and related functions, Physiology of Seed, seed health and productivity
Unit- 2	Seed Germination: Phases of germination (imbibition, activation, and protrusion); biochemical and physiological changes during germination. Seed Dormancy: Types of dormancy (physical, physiological, morphological); mechanisms and methods to break dormancy (scarification, stratification).
Unit- 3	Seed Production: Principles and Practices, Principles and Techniques in Vegetable Seed production, Principles and Techniques in crop Seed production, Seed Production in Field Crops, Seed Production and Cultivation of Medicinal and Aromatic Plants (MAPs), Weed Management in Crop Seed Production, Hybrid Seed Production
Unit- 4	Seed Quality Testing, Seed Processing, Storage: Harrington's "Rule of Thumb", and Deterioration; The Seed Act (1966); Seed Control Order; Intellectual Property Rights (IPR) and Plant Breeders' Rights (PBR). Sampling procedures; International Seed Testing Association (ISTA) rules
Unit- 5	Seed pathology and Entomology, purity, storage and preservation , Seed Health Technology and quarantine, Seed Biotechnology

1. Study of seed structure in major cereal, pulse, and oilseed crops.
2. Separation of pure seed, inert matter, and weed seeds.
3. Moisture Testing Using the Hot Air Oven and Digital Moisture Meter methods.
4. Germination Test between Paper (BP) and Top of Paper (TP) methods; calculating germination percentage.
5. Viability Testing Conducting the Tetrazolium (TZ) test to assess living tissue.
6. Field Visit to a Seed Processing Plant or a Seed Certification Agency.

Suggested Readings:

1. Principles of Seed Technology by G.N. Kulkarni
2. Seed Physiology, Biology, and Technology of Seed Production and Storage by Copeland and McDonald
3. Seed Technology by R.L. Agrawal

OR

MJDSE-03: Herbal technology**Credits 04 (Full Marks: 75)***MJDSE-03T: Herbal technology (Theory)**Credits 03 (45 hrs)***Course Content:**

Unit	Topic
Unit- 1	Herbs as raw materials: Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation Source of Herbs Selection, identification and authentication of herbal materials Processing of herbal raw material. Biodynamic Agriculture: Good agricultural practices in cultivation of medicinal plants including Organic farming. Indian Systems of Medicine. Preparation and standardization of Ayurvedic formulations like- Aristas and Asawas, Ghutika, Churna, Lehya, and Bhasma.
Unit- 2	Nutraceuticals: General aspects, Market, growth, scope and types of products available in the market. Health benefits and role of Nutraceuticals in ailments like Diabetes, CVS diseases, Cancer, Irritable bowel syndrome and various Gastro intestinal diseases.
Unit- 3	Herbal-Drug and Herb-Food Interactions: General introduction to interaction and classification. Study of following drugs and their possible side effects and interactions: Hypercium, kava-kava, Ginkgo biloba, Ginseng, Garlic, Pepper & Ephedra.
Unit- 4	Evaluation of Drugs WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs. Patenting and Regulatory requirements of natural products: Definition of the terms: Patent, IPR, Bioprospecting and Biopiracy Regulatory Issues - Regulations in India (ASU DTAB, ASU DCC), Regulation of manufacture of ASU drugs - Schedule Z of Drugs and Cosmetics Act for ASU drugs.
Unit- 5	General Introduction to Herbal Industry Herbal drugs industry: Present scope and future prospects. A brief account of plant based industries and institutions involved in work on medicinal and aromatic plants in India. Good Manufacturing Practice of Indian systems of medicine. Components of GMP (Schedule – T) and its objectives.

Course Outline:

1. Morphological and taxonomical study of *Catharanthus roseus*, *Withania somnifera*, *Clerodendron phlomoides* and *Centella asiatica*.
2. Herbal formulations: Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosomes.
3. Preparation and standardization of Ayurvedic formulations like- Aristas and Asawas, Ghutika, Churna, Lehya and Bhasma.
4. Perform preliminary phytochemistry of crude drugs.
5. Determination of aldehyde, phenol and alkaloid content.

Suggested Readings:

1. Herbal Drug Technology by S.S. Agrawal and M. Paridhavi
2. Textbook of Pharmacognosy and Phytochemistry by Biren Shah and A.K. Seth
3. Trease and Evans' Pharmacognosy by William Charles Evans
4. An Approach to Evaluation of Botanicals by Pulok K. Mukherjee
5. A Guide to Modern Techniques of Plant Analysis by J.B. Harborne
6. Cultivation of Medicinal and Aromatic Crops by A.A. Farooqi and B.S. Sreeramu
7. Herbal Cosmetics Handbook by H. Panda
8. WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants"

OR

MJDSE-03: Virology and Plant Disease**Credits 04 (Full Marks: 75)***MJDSE-03T: Virology and Plant Disease (Theory)**Credits 03 (45 hrs)***Course Content:**

UNIT	TOPIC
1	Viruses : structural organization and chemistry of viruses; Cultivation of viruses; Virus purification and assays (hemagglutination and plaque assay); Principles of viral taxonomy; Replication of viral nucleic acids; One step growth curve; Lytic and Lysogenic cycle; early and late proteins;
2	Virus related agents–viroids and prions; virus-induced cancer. oncogenesis; antiviral drugs; Human Virus: HIV, SARS, HCV, Influenza genome organization, structure and replication. Plant viruses: Tobacco mosaic virus genome organization, structure and replication.
3	History of plant disease biology and its present status, plant disease, diagnosis, modern methods. Host pathogen interaction - mechanism of penetration, role of growth regulators. Control of plant diseases - exclusion, eradication. Epidemiology and disease forecasting.
4	Important pathogens causing selected plant diseases: brown spot, bacterial blight and blast of rice, wilt of pigeon pea, anthracnose of jute, crown gall diseases, scab of potato, downy mildew and powdery mildew of crop plants, black stem rust and loose smut of wheat.

*MJDSE-03P: Virology and Plant Disease (Practical)**Credits 01 (30 hrs)*

1. Study of Symptoms of virus diseases in plants.
2. Bioassay of virus cultures on indicator plants and host differentials
3. Demonstration of plaque assay.
4. Study of diseased specimens of plants.
5. Isolation and simple culture of pathogens.
6. Study of Black stem rust of wheat, Red rot of sugarcane, Downy mildew and Powdery mildew of crop plants.
7. Demonstration of different viral structures (model and photographs).

Suggested reading:

1. Plant Virology (5th Edition) by Roger Hull
2. Fundamentals of Plant Virology by R.C. Matthews
3. Applied Plant Virology by L.P. Awasthi
4. Plant Pathology (5th Edition) by George N. Agrios
5. Principles of Plant Pathology by R.S. Singh
6. Modern Plant Pathology by H.C. Dube

MINOR (MI)

Minor (MI)-07: Biofertilizer and Floriculture

Credits 04 (Full Marks:75)

MI-07T: Biofertilizer and Floriculture (Theory)

Credits 03 (45 hrs)

Course Contents-

Units	Topics
Unit 1	General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, symbiosis.
Unit 2	Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.
Unit 3	Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.
Unit 4	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.
Unit 5	Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.
Unit 6	Nursery Management and Routine Garden Operations: sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.
Unit 7	Commercial Floriculture: Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids).

MI-07P: Biofertilizer and Floriculture (Practical)

Credits 01 (30 hrs)

1. Submission a report on Preparation of Biocompost
2. Botanical Study: Identification of major commercial flowers (Rose, Marigold, Gladiolus, Tuberose, Chrysanthemum, and Anthurium).
3. Ornamental Foliage: Identification of indoor plants, cacti, succulents, and palms.
4. Cuttings: Softwood and hardwood cuttings in Hibiscus or Rose.
5. Layering: Air-layering in Guava or Jasmine.
6. Grafting & Budding: Practicing T-budding in Roses and Wedge grafting in Adenium.
7. Nursery Management: Preparation of nursery beds, sowing of flower seeds, and transplanting seedlings.

Suggested reading:

1. "Biofertilizers in Agriculture and Forestry" by N.S. Subba Rao
2. "Biotechnology of Biofertilizers" by Sadasivam Kannaiyan
3. "Biofertilizers Production and Application" by Ajeet Kumar
4. "Floriculture in India" by G.S. Randhawa and A. Mukhopadhyay
5. "Floriculture and Landscaping" by T.K. Bose, R.G. Maiti

SEMESTER-VIII

MAJOR (MJ)

MJ-16: Restoration Biology, Ecosystem Services and GIS Technology Credits 04 (FM:75)

MJ-16T: Restoration Biology, Ecosystem Services and GIS Technology (Theory) Credits 03 (45 hrs.)

Course Contents:

Unit	Topic
1	Ecological Concepts, Ecological Succession
2	Restoration Process: Steps in the Process, Understanding Limitations, Biological Limitations, Physical Limitations: Rock content ,Soil texture , Soil aggregation , Moisture, Bulk Density, Compaction and Available Rooting Depth, Slope, Topography and Stability, Soil Color , Top soil and sub soil depth; Chemical Limitations: Soil pH, Soil fertility , Overcoming Limitations (a few examples), Re-vegetation, Mulching, Equipment, Phytoremediation , Collaborative Restoration, Restoration in Various Settings (examples) , mining , metal and mineral, coal, Grasslands, Tropical Forests , Wetlands, Fire.
3	Management of the productive mine spoil, Increase soil fertility , Recharging Soil Microbes, Top Soil Management , Choice of seed or underground structure (Rhizome, bulb, corm) for plantation, Selection of C ₄ or C ₃ plants.
4	Re-vegetation at abandoned land, Agricultural approach , Ameliorative approach , Adaptive approach, Site specific ecotypes , Types of plant , Monoculture (herbs shrubs or trees), mixed culture , native plants , introduced plants
5	Four Types of Ecosystem Services, Ecosystem functions: The ‘supporting’ services, From biodiversity to bio-perversity: from good science to poor environmental policy, Provisioning and regulating services, Ecological production functions- Biodiversity and C- sequestration, Cultural and relational services, Coral reefs and ecotourism , Ecotourism in local places.
6	Definition of GIS; components (Hardware, Software, Data, People, Methods). Vector Data: Points (individual trees), Lines (rivers/roads), and Polygons (forest patches). Field Data Collection: Using handheld GPS units and mobile mapping apps. for botanical surveys. Land Use Land Cover (LULC): Tracking how forest or agricultural land changes over time.

Course Outline:

1. Measurement of Soil pH, Soil texture Measurement, Soil aggregation, Moisture, Bulk Density
2. Field Mapping, Collecting plant location data via smartphone GPS and importing it into a GIS.
3. Layout Design creating a "Print Map" with a scale bar, north arrow, and legend.

Suggested reading:

1. "Foundations of Restoration Ecology" by Margaret A. Palmer, Joy Bledsoe, and Donald A. Falk.
2. "Restoration Ecology" by Jelte van Andel and James Aronson
3. "Natural Capital: Theory and Practice of Mapping Ecosystem Services" by Reed et al.
4. "GIS for Environmental Management" by Robert Scally
5. "Remote Sensing and GIS for Ecologists: Using Open Source Software" by Maya Wegmann, Benjamin Leutner, and Stefan Dech

MAJOR ELECTIVE (DSE)

Major Elective – 04:
(Bioinformatics OR Pollen and Pollination Ecology)

MJDSE-04: Bioinformatics

Credits 04 (Full Marks:75)

MJDSE-04T: Bioinformatics (Theory)

Credits 03 (45 hrs)

Course Content:

Unit	Topic
Unit 1	Introduction, Branches of Bioinformatics, Aim, Scope and Research areas.
Unit 2	Databases in Bioinformatics: Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.
Unit 3	Biological Sequence Databases: National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ. Protein Information Resource (PIR): Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot.
Unit 4	Sequence Alignments: Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).
Unit 5	Molecular Phylogeny: Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.
Unit 6	Applications of Bioinformatics: Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

MJDSE-04P Bioinformatics (Practical)

Credits 01 (30 hrs)

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

Suggested Readings:

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

OR

MJDSE-04: Pollen and Pollination Ecology**Credits 04 (Full Marks: 75)****MJDSE-04T: Pollen and Pollination Ecology (Theory)****Credits 03 (45 hrs)****Course Content:**

Unit	Topic
Unit 1	Pollen Morphology: Shape, size, and aperture types (NPC system: Number, Position, and Character). Pollen Wall (Sporoderm): Ultra-structure of Exine and Intine; chemical composition of Sporopollenin. Pollen Kits and Viscin Threads: Their role in adherence and dispersal.
Unit 2	Pollen Viability and Longevity: Factors affecting viability; tests for viability (Tetrazolium and Fluorochromatic Reaction). Pollen Germination: In-vitro germination techniques (hanging drop, brew-baker medium); biochemical changes during pollen tube growth. Pollen Storage: Short-term vs. long-term storage; Cryopreservation (storage in liquid nitrogen at -196°C).
Unit 3	Stigma and Style: Types of stigmas (dry vs. wet); internal structure of the style. Recognition and Rejection: Self-incompatibility (Gametophytic and Sporophytic); molecular basis of S-alleles. Fertilization: Siphonogamy; entry of pollen tube into the ovule; double fertilization.
Unit 4	Abiotic Pollination: Anemophily (wind) and Hydrophily (water)—morphological adaptations. Biotic Pollination (Syndromes): Melittophily (Bees), Psychophily (Butterflies), Ornithophily (Birds), and Chiropterophily (Bats). Co-evolution: Floral rewards (nectar, pollen, oils) and floral "advertisements" (color, scent, UV-patterns). Pollination Strategies: Buzz pollination, trap blossoms, and deceptive pollination.
Unit 5	Melissopalynology: Analysis of pollen in honey to determine botanical and geographical origin. Aeropalynology: Study of airborne pollen; pollen calendars; impact on human health (Allergy/Hay fever). Forensic Palynology: Using pollen as evidence in criminal investigations. The Pollinator Crisis: Impact of pesticides, climate change, and habitat fragmentation on pollinator populations; strategies for conservation.

MJDSE-04P Pollen and Pollination Ecology (Practical)**Credits 01 (30 hrs)**

1. Preparation of pollen slides using the method.
2. Identification of pollen types from local flora (e.g., *Hibiscus*, *Tridax*, *Ocimum*).
3. Conducting a Germination test and Acetocarmine staining.
4. Qualitative testing for sugars and amino acids in floral nectar.
5. Recording "Pollinator Visitation Rates" in a local garden or park.

Suggested reading:

- "The Biology of Pollen" by G.P. Malakov.
- "Pollination Ecology" by K. Faegri and L. van der Pijl.
- "A Textbook of Palynology" by K. Bhattacharya, M.R. Majumdar, and S.G. Bhattacharya.
- "Plant Reproduction" by S.D. Russell.

MAJOR ELECTIVE- 05
[to be studied by Honours students only]

(Horticulture and Post-Harvest Technology / Bee Keeping and Management)

MJDSE-05: Horticulture and Post-Harvest Technology Credits 04 (Full Marks: 75)

MJDSE-05T: Horticulture and Post-Harvest Technology (Theory) Credits 03 (45 hrs)

Course Content:

Unit	Topic
1	Introduction: Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.
2	Ornamental plants : Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coraltree).
3	Horticultural techniques : Greenhouse Technology: Types of polyhouses, shade nets, and mist chambers; environmental control (temperature, humidity, and light). Precision Farming: Introduction to Hydroponics, Aeroponics, and Vertical Farming. Irrigation & Nutrition: Drip and sprinkler systems; fertigation schedules for major horticultural crops. Organic Horticulture: Principles of organic farming, bio-fertilizers, and botanical pesticides. Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation)
4	Floriculture: Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.
5	Post-harvest technology : Importance of post-harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.

6	Processing Principles: High temperature (Canning), Low temperature (Freezing), and Dehydration (Solar vs. Mechanical drying). Product Formulation: Preparation of Jams, Jellies, Pickles, Squashes, and RTS (Ready-to-Serve) beverages. Waste Management: Utilization of horticultural waste for compost and bio-fuel production. Food Safety: Introduction to FSSAI standards and HACCP (Hazard Analysis and Critical Control Points).
7	Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National,

MJDSE-05P: Horticulture and Post-Harvest Technology (Practical)

Credits 01 (30 hrs)

1. Hands-on practice of "T-budding" and "Veneer grafting" in mango/citrus.
2. Estimating of pH and EC (soil) for horticultural suitability.
3. Measuring Total Soluble Solids (TSS) using a Refractometer and Acidity by Titration.
4. Preparation of one fruit-based (Jam) and one vegetable-based (Pickle) product.
5. Field Visit to a commercial cold storage unit or a food processing industry.

Suggested reading:

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.

OR

MJDSE-05: Bee Keeping and Management**Credits 04 (Full Marks: 75)***MJDSE-05T: Bee Keeping and Management (Theory)**Credits 03 (45 hrs)***Course Content:**

Unit	Topic
1	Introduction to Apiculture: History and Scope: The transition from honey hunting to organized beekeeping; status of the beekeeping industry in India. Bee Diversity: Systematic position and identification of major honey bee species: <i>Apis dorsata</i> (Rock bee), <i>Apis florea</i> (Little bee), <i>Apis cerana indica</i> (Indian bee), <i>Apis mellifera</i> (European bee - commercial standard). Social Organization: The "Superorganism" concept; differentiation of castes (Queen, Drone, and Worker) and their specific duties.
2	Bee Biology and Communication: Basic external morphology (specialized structures like pollen baskets and wax glands). Life Cycle: Developmental stages and lifespan of different castes. Communication: The dance language of bees (Round dance and Waggle dance) for foraging efficiency. Flora and Forage: Identifying "Bee Pasturage" (nectar and pollen-yielding plants) and their flowering phenology.
3	Apiary Equipment and Management: The Modern Hive: Detailed study of the Lang troth Hive and Newton Hive; components (Bottom board, brood chamber, super, frames, and inner cover). Beekeeping Tools: Smokers, bee veils, gloves, hive tools, and honey extractors. Seasonal Management: Spring/Summer: Managing swarming and honey flow. Monsoon: Supplemental feeding and protection from moisture. Winter: Insulation and colony merging.
4	Bee Health and Protection: Infectious Diseases: Bacterial (American/European Foulbrood), Viral (Sacbrood), and Fungal (Chalkbrood) diseases. Pests and Predators: Management of Wax Moths, Varroa mites, wasps, and birds. Pesticide Safety: Understanding the impact of neonicotinoids and agrochemicals on bee health; "Bee-friendly" farming practices.
5	Economics and Value Addition: Bee Products: Composition and uses of Honey, Beeswax, Royal Jelly, Propolis, Bee Venom, and Pollen. Pollination Services: The economic value of bees in increasing crop yields (e.g., mustard, sunflower). Entrepreneurship: government schemes (National Beekeeping & Honey Mission - NBHM); FSSAI standards for honey quality.

List of Practical:

Suggested reading:

1. "The ABC and XYZ of Bee Culture" by A.I. Root.
2. "Beekeeping in India" by S. Singh (ICAR Publication).
3. "Textbook of Applied Entomology" (Vol. II) by K.P. Srivastava.
4. "Prosperous Beekeeping" by R.C. Misra.

MAJOR ELECTIVE- 06
[to be studied by Honours students only]

(Ethnobotany / Advances in Plant Science)

MJDSE-06: Ethnobotany

Credits 04 (Full Marks: 75)

MJDSE-06T: **Ethnobotany** (Theory)

Credits 03 (45 hrs)

Course Content:

Unit	Topic
Unit-1	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 life styles using a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.
Unit-2	Methodology of Ethnobotanical studies: a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.
Unit-3	Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) <i>Azadirachta indica</i> b) <i>Ocimum sanctum</i> c) <i>Vitex negundo</i> . d) <i>Gloriosa superba</i> e) <i>Tribulus terrestris</i> f) <i>Pongamia pinnata</i> g) <i>Cassia auriculata</i> h) <i>Indigofera tinctoria</i> . Role of ethnobotany in modern medicine with special example <i>Rauvolfia serpentina</i> , <i>Trichopus zeylanicus</i> , <i>Artemisia sp.</i> , <i>Withania sp.</i>
Unit 4	Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). Ethnobotany and legal aspects Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy.

MJDSE-06P: **Ethnobotany** (Practical)

Credits 01 (30 hrs)

Practical Outline:

1. Collection, processing and preservation of ethnobotanical specimens in the institutional repository.
2. Conduct an interview with a local herbalist (Vaidiya), elder, or forest dweller using a structured questionnaire.
3. Calculate the following indices using collected data: Use Value and Informant Consensus Factor (ICF).
4. Prepare a value-added product based on ethnobotanical knowledge.

Suggested Readings:

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons- Chichester
3. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
4. Rajiv K. Sinha (1996). Ethnobotany the Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur.

OR

MJDSE-06: Advances in Plant Science**Credits 04 (Full Marks: 75)***MJDSE-06T: Advances in Plant Science (Theory)**Credits 03 (45 hrs)***Course Content:**

Unit	Topic
Unit-1	Types of Nano-materials: Quantum dots, carbon nanotubes (CNTs), graphene, metal nanoparticles (gold, silver), metal oxide nanoparticles, and liposomes. Synthesis Techniques: Self-assembly, nano-precipitation, sol-gel method, micro-emulsion techniques. Lithography, laser ablation, mechanical milling. Functionalization of nanoparticles with ligands for biocompatibility and targeting. Imaging of nanostructures with: Electron Microscopy (SEM/TEM), Atomic Force Microscopy (AFM).
Unit-2	Nano Biology Applications: in Drug Delivery, Biosensors, Cancer, Agricultural Nanotechnology, Nano-fertilizers, nano-pesticides, and food preservation.
Unit-3	Fundamentals of Genome Structure and Organization: Genome Mapping and Sequencing Technologies. Sequencing Strategies: Sanger sequencing, Next-Generation Sequencing (NGS) (Illumina), and 3rd generation technologies. Genome Mapping: Physical and genetic mapping techniques.
Unit-4	Transcriptomics: RNA-Sequencing techniques for global gene expression analysis and differential expression. Functional Assays: Microarrays and reverse genetics. Applications: Genomics in medicine (disease studies), agriculture (crop improvement), and forensics.
Unit-5	Introduction to forensic science: Definition, History, Development and Scope of Forensic Science in India. Basic Principles of Forensic Science and its Significance, Organization and Functioning of State and Central Forensic Science Laboratories, Ethics in Forensic Science.
Unit-6	Forensic Botany: Introduction, types, significance, location, collection and Forensic evaluation of botanical evidences such as pollen grains, leaves, seeds Wood- types of wood, soft and hard wood. Identification and comparison. Diatoms: types, life cycle, morphology, methods of extraction from tissue and bones, their identification and significance.

*MJDSE-06P: Advances in Plant Science (Practical)**Credits 01 (30 hrs)*

1. Demonstration of Synthesis of iron oxide or gold nanoparticles.
2. Characterization using zeta potential and UV-Vis spectroscopy.
3. Antibacterial assay of nanoparticles.
4. Demonstration of different nano particles.
5. Preparation of Phylogenetic tree using sequences.
6. Demonstration of different types of sequencers.

Suggested Reading:

1. Plant Biotechnology and Genetics: Principles, Techniques, and Applications" (3rd Edition, 2025) by C. Neal Stewart.
2. Innovative Genomic Strategies for Modern Plant Breeding" (2025) by Anuradha et al.

PROJECT / DISSERTATION (RD)

[to be undertaken by students opting for and eligible for Hons. with Research]

DISSERTATION: Credit: 8; Full Marks: 150

Guidelines:

- Students will prepare a **dissertation of 10,000 words (approx.)** with a suitable title
- **Writing the Dissertation:**
Introducing the area of research, Literature Review, Locating research gaps, Spelling out the central argument/hypothesis, Preparing the theoretical framework, Making the core chapters, Conclusion and Scope for further research, Endnotes to individual chapters, List of Works Cited/Bibliography, Appendix, if any.

Structure of the dissertation

Preliminary Pages

- Title Page: Includes name of the student, university, degree, and submission date.
- Certificate/Declaration: Signed statement of originality and supervisor's approval
- Abstract: A 250-350 word summary covering research problem, methodology, and core findings.
- Acknowledgements: To supervisors and others, if any.
- Table of Contents: Clear hierarchical mapping of chapters with page number
- List of Abbreviations: Specialized terms, if any

Introduction

- Background & Context: Situates the topic in historical or theoretical context.
- Research Problem & Objectives: The specific question or gap the research is addressing.
- Thesis Statement/Hypothesis: The core argument the dissertation intends to prove.
- Scope and Significance: Why the study matters.
- Literature Review & Theoretical Framework

Literature Review: Analyzes existing scholarly works to show the gap the study fills.

- Theoretical Framework: Identifies the philosophers, critics, or schools of thought shaping the analysis in the dissertation.

Methodology

- Describes *how* the research was conducted - Anyone or a combination of textual analysis/ archival research/ conducting interviews/ ethnographic/semi-ethno-graphic research involving both textual analysis and field visit etc.
- Thematic or Analytical Chapters

The Core Body: Usually 3 to 4 chapters focusing on the core concerns of the study.

- Structure: Each chapter introduces its specific theme, analyzes primary and secondary sources, and contributes to the overarching thesis.

Conclusion

- Summary & Synthesis: Recaps your main points without simply repeating them.

Final Verdict: Answers the research questions posed in the introduction.

Future Scope: Suggests how future scholars can build upon your work.

- Works Cited/ Reference, and/or Bibliography: A comprehensive list of all primary and secondary sources cited as per the latest MLA style.

Appendices: Transcripts, interview logs, or raw archival data, if any.

Marks distribution-

Sl. No	Particulars	Marks
1	Research Project / Dissertation Report	70
	▪ Proposal and Abstract (along with some keywords)	10
	▪ Literature Review & Theoretical Framework	10
	▪ Methodology and Research design	10
	▪ Thematic Analysis (Chapter-wise)	20
	▪ Report Quality	20
2	Seminar Presentation	30
3	Viva-Voce	50
Total		150

MINOR (MI)

Minor (MI)-07: Plant breeding and Reproductive Biology Credits 04 (Full Marks: 75)

MI-08T: Plant breeding and Reproductive Biology (Theory)

Credits 03 (45 hrs)

Course Contents-

UNIT	Details
Unit 1	Plant Breeding: Introduction and objectives. Selection methods: For self-pollinated, cross pollinated and vegetative propagated plants; Hybridization: For self, cross and vegetative propagated plants – Procedure, advantages and limitations. Distant hybridization and role of biotechnology in crop improvement. Heterosis and Inbreeding Depression.
Unit 2	Composition of media; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).
Unit 3	Reproductive development Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.
Unit 4	Anther and pollen biology Anther wall: Structure and functions, Microgametogenesis; Pollen wall structure, NPC system; Palynology and scope (a brief account); Pollen viability, storage and germination.
Unit 4	Pollination and fertilization Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.
Unit 5	Embryo, Endosperm and Seed Structure and types; embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Embryo development in <i>Paeonia</i> . Seed structure, importance and dispersal mechanisms. Polyembryony and apomixis

Practical:

1. Demonstration of hybridization technique in a papilionaceous flower (*Cajanas cajan*) and in a graminaceous flower (*Oryza sativa*).
2. Demonstration of T-budding, I-budding in rose. Demonstration of grafting and air layering (gootie) of plant specimens
3. Pollen grains: pollinia (slides/photographs), Pollen viability: Tetrazolium test.
4. Female gametophyte through permanent slides/ photographs. Intra-ovarian pollination; Test tube pollination through photographs.
5. Endosperm: photographs of developing seeds for endosperm with free-nuclear haustoria.

Suggested Reading:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. 1 (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
