



# NARAJOLE RAJ COLLEGE

(NAAC Accredited 'B' Grade Govt. Aided College)  
NARAJOLE: PASCHIM MEDINIPUR: WEST BENGAL: Pin-721211  
E-mail: [nrajolerajcollege@rediffmail.com](mailto:nrajolerajcollege@rediffmail.com)  
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## Course Outcome

## Botany (Hons.)

Semester	I
Title of Course	Plants and Microbial Diversity and its Evolution (MJ-1)
Paper Code	MJ-1T (Theory)
Credits	03
Hours	03 hours/week

### **The theory paper (MJ-1T) of this course (MJ-1) provides the student with-**

*The students of Botany (H) of Semester-I will acquire the knowledge about general characteristics of virus, bacteria, algae, fungi, bryophytes, pteridophytes, gymnosperms with their classification system and economic importance. Idea about morphology and life cycle pattern of some plant genus. Study about palaeobotany, geological time scale, fossils types, factors of fossilization.*

C01: Theory of introduction to microbial diversity; Whittaker's five-kingdom system and Carl Richard Woese's three-domain system.

C02: Ideas of general characteristics of virus; classification (Baltimore), idea about viroids and prions; detailed structure T4-phage and SARS-COV2, lytic and lysogenic cycle; Economic importance of viruses.

C03: Concept of general characteristics of bacteria; Types of bacteria, archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Bergey's classification, Cell structure; Nutritional types; vegetative and Reproductive structure - asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria.

C04: Theory of General characteristics of algae; Ecology and distribution; range of thallus organization; Classification (Van Den Hoek, 1995), reproduction and life cycles of *Nostoc*, *Oedogonium*, *Chara*, and *Polysiphonia*.

C05: Concept of general characteristics of fungi; Affinities with plants and animals; Thallus organization; Heterothallism and parasexuality. Classification Ainsworth (up to Order). Life cycles of *Synchytrium*, *Saccharomyces*, *Ascobolus*, *Agaricus*. Symbiotic associations: Lichen and Mycorrhiza. Economic importance.

C06: Idea of unifying features of archegoniates, general characteristics of bryophytes; Adaptations to land habit; Range of thallus organization. Idea about different orders. Outline classification (Mishler), Morphology, anatomy and reproduction of *Marchantia*, *Porella*, *Anthoceros*, *Notothylas* and *Funaria*; Economic importance with special reference to *Sphagnum*.

C07: Idea of general characteristics of pteridophytes; Idea about different orders. Classification (Sporne, 1975), Early land plants (*Rhynia* and *Asteroxylon*) Morphology, anatomy and reproduction of *Lycopodium*, *Selaginella*, *Equisetum* and *Pteris*. Economic importance.

C08: Idea of general characteristics of gymnosperms, idea about different orders, Classification (Sporne, 1965), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum*; Economic importance

C09: Understanding the palaeobotany, Geological time scale and important events, Types of plant fossils - impressions, compressions, petrification. Stromatolites, Factors for fossilization

Semester	I
Title of Course	Plants and Microbial Diversity and its Evolution (MJ-1)
Paper Code	MJ-1P (Lab)
Credits	01
Hours	02 hours/week

*The students Botany (H) of Semester-I will acquire the practical knowledge about the virus, bacteria, algae, fungi, lichen, bryophyte, pteridophyte gymnosperm and fossil genera.*

**The lab paper (MI-1P) of this course (MI-1) provides the student with-**

C01: Study of electron micrographs/Models of viruses – T-Phage and Sars-CoV2.

C02: Study of sketches of Lytic and Lysogenic Cycle.

C03: Study of curd organisms curd through Gram staining.

C04: Study of endospore staining.

C05: Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium* and *Polysiphonia*.

C06: Study of reproductive structures of *Ascobolus*, and *Agaricus*.

C07: Study of reproductive structure of *Saccharomyces* and *Penicillium*.

C08: Study of lichens: Photomicrographs of different types of Lichens.

C09: Study of *Marchantia*- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of antheridiophore, archegoniophore, longitudinal section of sporophyte (all permanent slides).

C010: Study of *Anthoceros*- Morphology of thallus, dissection of sporophyte (to show spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).

C011: Study of *Pogonatum*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); Permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.

C012: Study of *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).

C013: Study of *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores, transverse section of rhizome (all permanent slide).

C014: Study of *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).

C015: Study of *Cycas*- Morphology (leaf), vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).

C016: Study of *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle (temporary slide), transverse section of stem, longitudinal section of / transverse section of male cone,

whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).

CO17: Study of *Gnetum*- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (all permanent slide).

CO18: Study of fossil genera - *Rhynia*, *Cooksonia*, *Lepidodendron* and *Lepidocarpon* through photographs.





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## Course Outcome

## Botany (Hons.)

Semester	I
Title of Course	Biofertilizers (SEC-1)
Paper Code	SEC-1P (Lab)
Credits	03
Hours	03 hours/week

*The students of Botany (H) of Semester-I will acquire the practical knowledge about the microbes used as biofertilizers, mycorrhizal association, types of mycorrhiza and organic farming.*

### **The lab paper (MI-1P) of this course (MI-1) provides the student with-**

C01: Study of general account about the microbes used as biofertilizer - Rhizobium - isolation, identification, mass multiplication, carrier-based inoculants, Actinorrhizal symbiosis.

C02: Study of *Azospirillum*: isolation and mass multiplication - carrier-based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics - crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

C03: Study of Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

C04: Study of 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.

C05: Study of 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.





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## Course Outcome

### BOTANY

#### Multidisciplinary Studies

Semester	I
Title of Course	Plant Groups and Taxa(MJ-1)
Paper Code	MJ-1T (Theory)
Credits	03
Hours	03 hours/week

*The students with Botany Multidisciplinary studies of Semester-I will acquire the knowledge about general characteristics of virus, bacteria, algae, fungi, bryophytes, pteridophytes, gymnosperms with their classification system and economic importance. Idea about morphology and life cycle pattern of some plant genus.*

#### **The theory paper (MI-1T) of this course (MI-1) provides the student with-**

CO1: Theory of introduction to microbial world and Whittaker's five-kingdom system.

CO2: Ideas of general characteristics of virus, Baltimore classification, economic importance.

CO3: Idea of general characteristics of bacteria, Bergey's classification, economic importance.

CO4: Theory of algae general characteristics, habitat, Van Den Hoek's (1995) classification, life cycle pattern of *Volvox* and *Batrachospermum*, concept of economic importance.

CO5: Concept of general characteristics of fungi, idea of Ainsworth's classification upto order, life cycle pattern of *Rhizopus* and *Agaricus*, economic importance, concept of lichen and mycorrhiza.

C06: Idea of bryophytes general characteristics, Proskauer's (1957) classification, morphology with anatomy and reproduction of *Riccia*, *Anthoceros* and *Funaria*, economic importance.

C07: Idea of pteridophytes general characteristics, Sporne's (1975) classification, morphology with anatomy and reproduction of *Lycopodium*, *Adiantum* and *Marsilea*, economic importance.

C08: Idea of general characteristics of Gymnosperms, Sporne's (1965) classification, morphology with anatomy and reproduction of *Cycas* and *Pinus*, economic importance

C09: Understanding the palaeobotany, concept of geological time scale and important events, types of plant fossils.

Semester	I
Title of Course	Plant Science-I (MI-1)
Paper Code	MI-1P (Lab)
Credits	01
Hours	02 hours/week

*The students with Botany Multidisciplinary studies of Semester-I will acquire the practical knowledge about the virus, gram staining of bacteria, algae, fungi, bryophytes, pteridophytes, gymnosperms and fossil types.*

**The lab paper (MI-1P) of this course (MI-1) provides the student with-**

C01: Study of electron micrographs/Models of viruses – T-Phage and Sars-CoV2.

C02: Study of curd organisms through Gram staining.

C03: Study of vegetative and reproductive structure of *Volvox*, and *Batrachospermum*.

C04: Study of morphology and reproductive structure of *Rhizopus* and *Agaricus*.

C05: Study of morphology of thallus and reproductive structure of *Riccia*, *Anthoceros* and *Funaria*.

C06: Study of morphology vegetative and reproductive structure of *Lycopodium*, *Adiantum* and *Marsilea*.

C07: Study of morphology and vegetative structure of *Cycas* and *Pinus*.

C08: Study of fossil types (impressions, compressions, petrification).





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## Course Outcome

### Botany (Hons.)

Semester	I
Title of Course	Plant Science-I(MI-1)
Paper Code	MI-1T (Theory)
Credits	03
Hours	03 hours/week

*The students of Botany (H) of Semester-I will acquire the knowledge about general characteristics of virus, bacteria, algae, fungi, bryophytes, pteridophytes, gymnosperms with their classification system and economic importance. Idea about morphology and life cycle pattern of some plant genus.*

#### **The theory paper (MI-1T) of this course (MI-1) provides the student with-**

C01: Theory of introduction to microbial world and Whittaker's five-kingdom system.

C02: Ideas of general characteristics of virus, Baltimore classification, economic importance.

C03: Idea of general characteristics of bacteria, Bergey's classification, economic importance.

C04: Theory of algae general characteristics, habitat, Van Den Hoek's (1995) classification, life cycle pattern of *Volvox* and *Batrachospermum*, concept of economic importance.

C05: Concept of general characteristics of fungi, idea of Ainsworth's classification upto order, life cycle pattern of *Rhizopus* and *Agaricus*, economic importance, concept of lichen and mycorrhiza.

C06: Idea of bryophytes general characteristics, Proskauer's (1957) classification, morphology with anatomy and reproduction of *Riccia*, *Anthoceros* and *Funaria*, economic importance.

C07: Idea of pteridophytes general characteristics, Sporne's (1975) classification, morphology with anatomy and reproduction of *Lycopodium*, *Adiantum* and *Marsilea*, economic importance.

C08: Idea of general characteristics of Gymnosperms, Sporne's (1965) classification, morphology with anatomy and reproduction of *Cycas* and *Pinus*, economic importance

C09: Understanding the palaeobotany, concept of geological time scale and important events, types of plant fossils.

Semester	I
Title of Course	Plant Science-I (MI-1)
Paper Code	MI-1P (Lab)
Credits	01
Hours	02 hours/week

*The students of Botany (H) of Semester-I will acquire the practical knowledge about the leaf types, inflorescence types, floral diversity, fruit types study of vegetative and floral characteristics of some families.*

**The lab paper (MI-1P) of this course (MI-1) provides the student with-**

C01: Study of leaf types (simple and compounds).

C02: Study of inflorescence types (racemose and cymose).

C03: Study of floral diversity with special reference to adhesion and cohesion.

C04: Study of fruit types: Berry (*Cucumis sativus*, *Capsicum annum*, *Solanum melongena*), Drupe (*Mangifera indica*, *Borassus flabellifer*), Hesperidium (*Citrus*), Nut (*Arachis hypogea*).

C05: Study of vegetative and floral characteristics of the following families: Malvaceae (*Sida sp./Abutilon sp.*), Acanthaceae (*Ruellia sp./Barleria sp.*), Papilionaceae (*Tephrosia sp./Crotalaria sp.*), Verbenaceae (*Lantana sp./Duranta sp.*).



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## Course Outcome

### Botany (Hons.)

Semester	II
Title of Course	Morphology, Anatomy and Plant Taxonomy (MJ-2)
Paper Code	MJ-2T (Theory)
Credits	03
Hours	03 hours/week

*The students of Botany (H) of Semester-II will acquire the knowledge about general characteristics of plant morphology, flower, fruit and seeds types, structure and development of plant body, significance plant systematics, taxonomic hierarchy, systems of classification, general descriptions of the given families.*

#### **The theory paper (MJ-2T) of this course (MJ-2) provides the student with-**

CO1: Theory of vegetative morphology of root, stem & leaves with different types of modifications; Different types of stipules and modifications along with phyllotaxy and diversity of leaves.

CO2: Ideas of different types of inflorescences; Floral morphology, aestivation with special reference to adhesion and cohesion of the floral parts, Placentation - types; Floral formula, Floral diagram.

CO3: Concept of fruits, seed types and dispersal mechanism.

CO4: Concept of structure and Development of Plant Body. internal organization of plant body: The three tissue systems, types of cells and tissues. Root stem transition. Apical meristems, types of stomata, Types of vascular bundles; Stele and its evolution

C05: Concept of vascular Cambium and Wood Structure, function and seasonal activity of cambium; Secondary growth in root and stem, Types of Anomalous secondary growth with special emphasis on *Boerhavia and Dracaena*. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Annual ring; composition of periderm, rhytidome and lenticels.

C06: Concept of significance of Plant systematics; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.

C07: Idea of taxonomic hierarchy, Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature, Principles and rules (ICN); Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

C08: Idea of systems of classification, Overview of artificial, natural and phylogenetic classification; Classification system of Bentham and Hooker (up to series). Brief reference of Angiosperm Phylogeny Group (APG IV) classification.

C09: Idea of Taximetrics: numerical taxonomy and cladistics Characters; OTUs, Cluster analysis; Phenograms, cladograms (definitions and differences).

C010: Concept of phylogeny of Angiosperms: Terms and concepts (homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms. Concept of Basal Angiosperms and Eudicots.

C011: Concept of General descriptions of the given families: Magnoliaceae, Malvaceae, Acanthaceae, Verbenaceae, Scrophulariaceae, Fabaceae, Caesalpinioideae, Asteraceae, Euphorbiaceae, Lamiaceae, Poaceae, Orchidaceae.

Semester	II
Title of Course	Morphology, Anatomy and Plant Taxonomy (MJ-2)
Paper Code	MI-2P (Lab)
Credits	01
Hours	02 hours/week

*The students of Botany (H) of Semester-II will acquire the practical knowledge about the phyllotaxy, stipules, inflorescence types, floral morphology, fruit types, study of vegetative and floral characteristics of some families, making of herbarium, anatomical study of root, stem, leaf, study of secondary growth, stomatal types and the study of local flora.*

**The lab paper (MI-2P) of this course (MI-2) provides the student with-**

C01: Study of phyllotaxy and stipules.

C02: Study of Inflorescence types- Racemose, Cymose, Special types (Capitulum, Verticillaster, and Hypanthodium)

C03: Study of floral morphology with special reference to adhesion and cohesion of the floral parts, placentation types.

C04: Study of different fruit types.

C05: Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Malvaceae – *Sida* sp. / *Abutilon* sp., Acanthaceae – *Ruellia* sp./*Barleria* sp., Fabaceae – *Tephrosia* sp./*Crotalaria* sp., Verbenaceae – *Lantana* sp./*Duranta* sp., Asteraceae – *Vernonia* sp./*Ageratum* sp., *Eclipta* sp./*Tridax* sp., Lamiaceae – *Leucas* sp./*Ocimum* sp., Euphorbiaceae – *Euphorbia* sp. / *Jatropha* sp., Poaceae – *Triticum* sp./*Chrysopogon* sp. or any local common grass, Orchidaceae- *Vanda* sp.

C06: Study of mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book – At least 25 nos.).

C07: Study of root: monocot, dicot, secondary growth.

C08: Study of stem: monocot, dicot - primary and secondary growth.

C09: Study of anatomy of Leaf: isobilateral, dorsiventral.

C010: Study of anomalous secondary growth (Through permanent slides).

C011: Study of Stomata and its types.

C012: Study of Field visit (two) at least one to study the local flora.





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## Course Outcome

## Botany (Hons.)

Semester	II
Title of Course	Floriculture (SEC-2)
Paper Code	SEC-2P (Lab)
Credits	03
Hours	03 hours/week

*The students of Botany (H) of Semester-II will acquire the practical knowledge about the history of gardening, nursery management, ornamental plants, garden design, landscaping and commercial floriculture.*

### **The lab paper (MI-1P) of this course (MI-1) provides the student with-**

C01: Study of introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

C02: Study of 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.

C03: Study of ornamental plants: 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.

C04: Study of principles of garden designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water Garden. Some Famous gardens of India.

C05: Study of landscaping places of public importance:Landscaping highways and educational institutions.

C06: Study of commercial floriculture: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, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Liliium, Orchids).







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## Course Outcome

## Botany (Hons.)

Semester	II
Title of Course	Plant Science-II(MI-2)
Paper Code	MI-2T (Theory)
Credits	03
Hours	03 hours/week

*The students Botany (H) of Semester-II will acquire the knowledge about general characteristics of plant morphology, flower, fruit and seeds types, structure and development of plant body, significance plant systematics, taxonomic hierarchy, systems of classification, general descriptions of the given families.*

### **The theory paper (MI-2T) of this course (MI-2) provides the student with-**

C01: Theory of general morphology of root, stem and leaves of monocot and dicot, concept of phyllotaxy.

C02: Ideas of different types of inflorescences of flower, aestivation, placentation types, floral formula and floral diagram.

C03: Concept of fruits and seed types.

C04: Concept of Structure and Development of Plant Body. The three tissue systems, primary structure of root, stem, and leaf; types of stomata, Types of vascular bundles; Secondary growth in root and stem, Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood; Annual ring; peridermand lenticels.

C05: Concept of significance of plant systematics, functions of herbarium, idea of important herbaria and botanical gardens of the world and India, brief concept about flora, monographs, keys: single access and multi access.

C06: Concept of taxonomic hierarchy, concept of taxa (family, genus, species), species concept (taxonomic, biological, evolutionary), botanical nomenclature, principles and rules of ICN, author citation and valid publication.

C07: Idea of Systems of classification, Overview of artificial, natural and phylogenetic classification; Classification system of Bentham and Hooker (up to series). Brief account of Angiosperm Phylogeny Group classification. Concept of primitive and Advance angiosperms (basal angiosperm and eudicots).

C08: Idea of General descriptions of the given families: Malvaceae, Papilionaceae, Acanthaceae, Verbenaceae, Asteraceae, Poaceae.

Semester	II
Title of Course	Plant Science-II(MI-2)
Paper Code	MI-2P (Lab)
Credits	01
Hours	02 hours/week

*The students of Botany (H) of Semester-II will acquire the practical knowledge about the leaf types, inflorescence types, floral diversity, fruit types study of vegetative and floral characteristics of some families.*

**The lab paper (MI-2P) of this course (MI-2) provides the student with-**

C01: Study of leaf types (simple and compounds).

C02: Study of inflorescence types (racemose and cymose).

C03: Study of floral diversity with special reference to adhesion and cohesion.

C04: Study of fruit types: Berry (*Cucumis sativus*, *Capsicum annum*, *Solanum melongena*), Drupe (*Mangifera indica*, *Borassus flaballifer*), Hesperidium (*Citrus*), Nut (*Arachis hypogea*).

C05: Study of vegetative and floral characteristics of the following families: Malvaceae (*Sida* sp./*Abutilon* sp.), Acanthaceae (*Ruellia* sp./*Barleria* sp.), Papilionaceae (*Tephrosia* sp./*Crotalaria* sp.), Verbenaceae (*Lantana* sp./*Duranta* sp.).