

# Department of Botany

Govt. Post. Graduate College Berinag, Pithoragarh  
Teaching Plan  
DR. J. N. Pant

Paper 1: Microbes, Algae, Fungi and Bryophytes (Course code: BOT101T) Credit: 4

Class: BSc 1<sup>st</sup> Semester

Subject: Botany

Unit 4 – 15 Hours (Credit-1)

Lecture No.	Topic	Subtopics
1	Introduction to Bryophytes	General characteristics, adaptations to land habit, diversity and distribution, evolutionary significance
2	Classification of Bryophytes	Major groups and their characteristics, comparison with Algae and Pteridophytes
3	Riccia	Morphology and anatomy
4		Reproduction and complete life cycle
5	Marchantia	Morphology and anatomy
6		Reproduction and complete life cycle
7	Funaria	Morphology and anatomy
8		Reproduction and complete life cycle
9	Ecology of Bryophytes	Role in water cycle, soil formation, nutrient cycling, succession, habitat diversity and conservation
10	Economic importance of Bryophytes	Sources of food, medicine, peat, biofertilizers, bioindicators and bioremediation
11	Review of the previous lectures	Summary of the main concepts and key points, quiz and discussion
12	Assignment presentation	Students present their assignments on selected topics related to Bryophytes, feedback and evaluation
13	Class seminar	An expert on Bryophytes delivers a lecture on the latest research and developments in the field, Q&A session
14	Final Assignment Work	Multiple choice questions, short answer questions and long answer questions, covering all the topics of the course
15		Assignment evaluation and feed back

**Paper 2: Practical/ Lab course (Course code: BOT102P) Credit: 2****Practical Work Plan**

<b>Practical No.</b>	<b>Topic</b>	<b>Subtopics</b>
<b>1</b>	<b>Introduction to Bryophytes</b>	General characteristics, adaptations to land habit, diversity and distribution, evolutionary significance
<b>2</b>	<b>Classification of Bryophytes</b>	Major groups and their characteristics, comparison with Algae and Pteridophytes
<b>3</b>	<b>Riccia</b>	Morphology of thallus, rhizoids and scales, observation and drawing of specimens
<b>4</b>	<b>Riccia</b>	Temporary slides of thallus through gemma cup and gemmae, observation and drawing of slides
<b>5</b>	<b>Riccia</b>	V.S. antheridiophore, archegoniophore and L.S. sporophyte, observation and drawing of permanent slides, identification of reproductive structures and spores
<b>6</b>	<b>Marchantia</b>	Morphology of thallus, rhizoids and scales, observation and drawing of specimens
<b>7</b>	<b>Marchantia</b>	Temporary slides of thallus through gemma cup and gemmae, observation and drawing of slides
<b>8</b>	<b>Marchantia</b>	V.S. antheridiophore, archegoniophore and L.S. sporophyte, observation identification of reproductive structures and spores
<b>9</b>	<b>Funaria</b>	Morphology, whole mount leaf, rhizoids, operculum, peristome, annulus and spores, observation and drawing of temporary slides, identification of vegetative and sporophytic structures
<b>10</b>	<b>Funaria</b>	Permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema, observation and drawing of slides, identification of reproductive structures and stages
<b>11</b>	<b>Review of the previous practical's</b>	Summary of the main concepts and key points, quiz and discussion
<b>12</b>	<b>Practical session</b>	Observation and identification of Bryophytes specimens, demonstration of life cycle and alternation of generations
<b>13</b>	<b>Practical session</b>	Observation and identification of Bryophytes specimens, demonstration of life cycle and alternation of generations
<b>14</b>	<b>Practical session</b>	Observation and identification of Bryophytes specimens, demonstration of life cycle and alternation of generations
<b>15</b>	<b>Final Acessionment</b>	Multiple choice questions, short answer questions and long answer questions, covering all the topics of the practical course

# Department of Botany

Govt. Post. Graduate College Berinag, Pithoragarh

Teaching Plan

DR. J. N. Pant

Class: BSc 2<sup>nd</sup> Semester

Paper 1: Pteridophytes, Gymnosperms and Angiosperms (BOT201T) Credit: 4

Unit –1 (Pteridophyta)

Time allotted – 15 Hours (1 Credit)

Lecture No.	Topic	Subtopics
1	Introduction to Pteridophytes	General characteristics, diversity and distribution, evolutionary significance
2	Classification of Pteridophytes	Major groups and their characteristics, comparison with Bryophytes and Gymnosperms
3	Early land plants	Origin and evolution of vascular tissue, Rhynia and its morphology, anatomy and reproduction
4	Selaginella	Morphology, anatomy and reproduction, comparison with Lycopodium and Isoetes
5	Heterospory and seed habit	Origin and evolution of heterospory, advantages and disadvantages of heterospory, pre-adaptations for seed habit
6	Equisetum	Morphology, anatomy and reproduction, comparison with Sphenophyllum and Calamites
7	Pteris	Morphology, anatomy and reproduction, comparison with Adiantum and Dryopteris
8	Stelar evolution	Types of steles, protostele, siphonostele and eustele, evolution of leaf gaps and leaf traces
9	Ecological importance of Pteridophytes	Role in soil formation, water conservation, erosion control, habitat diversity and carbon sequestration
10	Economic importance of Pteridophytes	Sources of food, medicine, ornamental plants, biofertilizers, bioindicators and fossil fuels
11	Review of the previous lectures	Summary of the main concepts and key points, quiz and discussion
12	Practical session	Observation and identification of Pteridophytes specimens, demonstration of heterospory and stelar types
13	Assignment presentation	Students present their assignments on selected topics related to Pteridophytes, feedback and evaluation
14	Guest lecture	An expert on Pteridophytes delivers a lecture on the latest research and developments in the field, Q&A session
15	Final exam	Multiple choice questions, short answer questions and long answer questions, covering all the topics of the course

# Practical Work Plan

Paper 2: Practical/ Lab course (BOT202P) Credit: 2

Lecture No.	Topic	Activity
1	Selaginella: Morphology	Observe the external features of Selaginella, such as the stem, leaves, and strobili. Draw and label the diagrams of the plant.
2	Selaginella: Whole mount leaf with ligule	Prepare a temporary slide of a Selaginella leaf with ligule. Observe the shape, size, and arrangement of the leaf and the ligule under a microscope. Draw and label the diagrams of the slide.
3	Selaginella: Strobilus, microsporophyll and megasporophyll	Prepare a temporary slide of a Selaginella strobilus, showing the microsporophylls and megasporophylls. Observe the structure, number, and arrangement of the sporophylls under a microscope. Draw and label the diagrams of the slide.
4	Selaginella: T.S. stem	Observe a permanent slide of a transverse section of a Selaginella stem. Identify the different tissues and cells in the stem, such as the epidermis, cortex, stele, and xylem. Draw and label the diagrams of the slide.
5	Selaginella: L.S. strobilus	Observe a permanent slide of a longitudinal section of a Selaginella strobilus. Identify the different parts of the strobilus, such as the axis, sporangia, spores, and elaters. Draw and label the diagrams of the slide.
6	Equisetum: Morphology	Observe the external features of Equisetum, such as the stem, leaves, nodes, internodes, and strobili. Draw and label the diagrams of the plant.
7	Equisetum: T.S. internode	Prepare a temporary slide of a transverse section of an Equisetum internode. Observe the structure and arrangement of the tissues and cells in the internode, such as the epidermis, cortex, vascular bundles, and pith. Draw and label the diagrams of the slide.
8	Equisetum: L.S. strobilus	Prepare a temporary slide of a longitudinal section of an Equisetum strobilus. Observe the structure and arrangement of the parts of the strobilus, such as the axis, sporangiophores, sporangia, and spores. Draw and label the diagrams of the slide.
9	Equisetum: T.S. and L.S. strobilus	Compare and contrast the transverse and longitudinal sections of the Equisetum strobilus. Note the differences and similarities in the shape, size, and orientation of the structures. Draw and label the diagrams of the slides.
10	Equisetum: Whole mount sporangiophore, spores (wet and dry)	Prepare a temporary slide of a whole mount sporangiophore of Equisetum. Observe the shape, size, and number of the sporangia and the spores under a microscope.
11	Equisetum: T.S. rhizome	Observe a permanent slide of a transverse section of an Equisetum rhizome. Identify the different tissues and cells in the rhizome, such as the epidermis, cortex, vascular bundles, and pith. Draw and label the diagrams of the slide.
12	Pteris: Morphology	Observe the external features of Pteris, such as the rhizome, fronds, pinnae, and sori. Draw and label the diagrams of the plant.
13	Pteris: T.S. rachis	Prepare a temporary slide of a transverse section of a Pteris rachis. Observe the structure and arrangement of the tissues and cells in the rachis, such as the epidermis, cortex, vascular

		bundles, and sclerenchyma. Draw and label the diagrams of the slide.
<b>14</b>	Pteris: V.S. sporophyll, whole mount sporangium and spores	Prepare a temporary slide of a vertical section of a Pteris sporophyll, showing the sori and the sporangia. Observe the structure and arrangement of the sporangia and the spores under a microscope. Draw and label the diagrams of the slide. Prepare another slide of a whole mount sporangium and spores and observe the shape, size, and number of the spores. Draw and label the diagrams of the slide.
<b>15</b>	Pteris: T.S. rhizome, whole mount prothallus with sex organs and young sporophyte	Observe a permanent slide of a transverse section of a Pteris rhizome. Identify the different tissues and cells in the rhizome, such as the epidermis, cortex, vascular bundles, and meristems. Draw and label the diagrams of the slide. Observe another permanent slide of a whole mount prothallus with sex organs and young sporophyte. Identify the different parts of the prothallus, such as the thallus, rhizoids, antheridia, archegonia, and sporophyte. Draw and label the diagrams of the slide.

# Department of Botany

Govt. Post. Graduate College Berinag, Pithoragarh

Teaching Plan

DR. J. N. Pant

Class: BSc 3<sup>rd</sup> Semester

Subject: Botany

Paper: I

Paper 1: Morphology and Anatomy (Course code: BOT301T) Credit: 4

Lecture No.	Topic	Subtopics
1	Introduction to secondary growth	Definition, types, significance and differences from primary growth
2	Structure and function of vascular cambium	Origin, location, structure, activity and function of vascular cambium, types of cambial cells and derivatives
3	Secondary growth in stem	Formation of secondary xylem and phloem, annual rings, heartwood and sapwood, tyloses and gum ducts
4	Secondary growth in stem	Formation of secondary cortex, periderm, cork cambium, cork and lenticels, bark and rhytidome
5	Secondary growth in root	Formation of secondary xylem and phloem, radial and concentric arrangement, exarch and endarch condition
6	Secondary growth in root	Formation of secondary cortex, periderm, cork cambium, cork and lenticels, bark and rhytidome
7	Abnormal secondary growth	Definition, causes, examples and effects of abnormal secondary growth
8	Abnormal secondary growth in stem	Anomalous secondary thickening in Boerhaavia, Achyranthes, Mirabilis, Nyctanthes and Dracaena
9	Abnormal secondary growth in stem	Anomalous secondary thickening in Bignonia, Aristolochia, Cucurbita and Tecoma
10	Abnormal secondary growth in root	Anomalous secondary thickening in Ipomoea, Asparagus, Dioscorea and Smilax
11	Review of the previous lectures	Summary of the main concepts and key points, quiz and discussion
12	Practical session	Observation and identification of secondary growth in stem and root specimens, demonstration of annual rings, bark and lenticels
13	Practical session	Observation and identification of abnormal secondary growth in stem and root specimens, demonstration of anomalous secondary thickening
14	Assignment presentation	Students present their assignments on selected topics related to secondary growth, feedback and evaluation
15	Final exam	Multiple choice questions, short answer questions and long answer questions, covering all the topics of the course

# Practical Work Plan

Class: BSc 3rd Semester

*Paper 2: Practical/Lab Course (Course code: BOT302P) Credits: 02*

Practical No.	Topic	Subtopics
1	Introduction to secondary growth	Definition, types, significance and differences from primary growth
2	Structure and function of vascular cambium	Origin, location, structure, activity and function of vascular cambium, types of cambial cells and derivatives
3	Normal secondary growth in stem	Observation and identification of secondary growth in stem specimens of dicot plants, such as sunflower, bean, hibiscus, etc.
4	Normal secondary growth in stem	Demonstration of annual rings, heartwood and sapwood, tyloses and gum ducts, bark and lenticels in stem specimens
5	Normal secondary growth in root	Observation and identification of secondary growth in root specimens of dicot plants, such as carrot, radish, turnip, etc.
6	Normal secondary growth in root	Demonstration of radial and concentric arrangement, exarch and endarch condition, bark and lenticels in root specimens
7	Abnormal secondary growth	Definition, causes, examples and effects of abnormal secondary growth
8	Abnormal secondary growth in stem	Observation and identification of abnormal secondary growth in stem specimens of plants, such as Boerhaavia, Achyranthes, Mirabilis, Nyctanthes and Dracaena
9	Abnormal secondary growth in stem	Demonstration of anomalous secondary thickening in stem specimens of plants, such as Bignonia, Aristolochia, Cucurbita.
10	Abnormal secondary growth in root	Observation and identification of abnormal secondary growth in root specimens of plants, such as Asparagus, Dioscorea etc.
11	Abnormal secondary growth in root	Demonstration of anomalous secondary thickening in root specimens of plants, such as Ipomoea, Asparagus, Dioscorea etc
12	Review of the previous practicals	Summary of the main concepts and key points, quiz and discussion
13	Practical session	Observation and identification of secondary growth in stem and root specimens, demonstration of annual rings, bark and lenticels
14	Practical session	Observation and identification of abnormal secondary growth in stem and root specimens, demonstration of anomalous secondary thickening
15	Final exam	Multiple choice questions, short answer questions and long answer questions, covering all the topics of the practical course

# Department of Botany

Govt. Post. Graduate College Berinag, Pithoragarh

Teaching Plan

DR. J. N. Pant

Class: BSc 4<sup>th</sup> Semester

Subject: Botany

Paper 1: Embryology and Cytogenetics (course code: BOT401) Credit: 4

Lecture No	Topic	Subtopics
1 & 2	Introduction to pollination and fertilization	Definition and types of pollination and fertilization - Structure and function of flower parts- Advantages and disadvantages of self-pollination and cross-pollination
3&4	Pollination mechanisms and adaptations	Types and examples of pollination agents: wind, water, animals - Plant adaptations to different pollination agents: morphology, color, scent, nectar, etc. Matching and mismatching of pollination syndromes
5&6	Structure of anther and pollen	Structure and function of an anther: microsporangia, tapetum, stomium, etc. Process of pollen formation and release: microsporogenesis and microgametogenesis Structure and function of a pollen grain: exine, intine, tube cell, generative cell, etc.
7&8	Development of male gametophyte	Definition and role of male gametophyte in plant reproduction. Stages of male gametophyte development from a pollen grain: germination, tube growth, mitosis, etc. Structure and function of the mature male gametophyte: pollen tube, vegetative nucleus, sperm cells, etc.
9&10	Development of female gametophyte	- Definition and role of female gametophyte in plant reproduction. Stages of female gametophyte development from an ovule: megasporogenesis and megagametogenesis - Structure and function of the mature female gametophyte: embryo sac, egg cell, synergids, antipodals, polar nuclei, etc.
11&12	Double fertilization	Definition and characteristics of double fertilization in angiosperms - Process and mechanism of double fertilization in a flower: pollen-pistil interaction, pollen tube guidance, gamete fusion, etc. - Outcomes and significance of double fertilization: zygote, endosperm, seed, fruit, etc.
13&14	Review and assessment	-Recap of the main concepts and terms of pollination and fertilization - Quiz and crossword puzzle on pollination and fertilization - Feedback and reinforcement of learning outcomes
15	Assignment and Evaluation	



# Practical Work Plan

Paper 2: Practical/Lab Course (Course code: BOT402) Credits: 4

Practical No.	Topic	Activities
1	Introduction to pollination types and seed dispersal mechanisms	- <a href="#">Watch a video of pollination types and seed dispersal mechanisms in plants<sup>1</sup></a> List some examples of plants that use different pollination types and seed dispersal mechanisms. Discuss the advantages and disadvantages of different pollination types and seed dispersal mechanisms for plants and the environment.
2	Pollination types: wind pollination	- <a href="#">Observe some photographs and specimens of wind-pollinated plants<sup>2</sup></a> Describe the features of wind-pollinated plants, such as small and inconspicuous flowers, large and feathery stigmas, abundant and light pollen grains, etc. Explain how these features help the plants to achieve wind pollination.
3	Pollination types: water pollination	<a href="#">Observe some photographs and specimens of water-pollinated plants<sup>3</sup></a> Describe the features of water-pollinated plants, such as submerged or floating flowers, long and flexible stems, filamentous or ribbon-like stigmas, buoyant and sticky pollen grains, etc. Explain how these features help the plants to achieve water pollination.
4	Pollination types: animal pollination	<a href="#">Observe some photographs and specimens of animal-pollinated plants<sup>4</sup></a> Describe the features of animal-pollinated plants, such as large and colorful flowers, fragrant and nectar-rich stamens, specialized and diverse shapes, etc. Explain how these features help the plants to attract and reward different animal pollinators, such as insects, birds, bats, etc.
5	Seed dispersal mechanisms: wind dispersal	Observe some photographs and specimens of wind-dispersed plants. Describe the features of wind-dispersed plants, such as light and small seeds, winged or hairy appendages, explosive or catapulting fruits, etc. Explain how these features help the plants to disperse their seeds by wind.
6	Seed dispersal mechanisms: water dispersal	Observe some photographs and specimens of water-dispersed plants. Describe the features of water-dispersed plants, such as buoyant and waterproof seeds, fibrous or spongy coverings, floating or drifting fruits, etc. Explain how these features help the plants to disperse their seeds by water.
7	Seed dispersal mechanisms: animal dispersal	Observe some photographs and specimens of animal-dispersed plants. Describe the features of animal-dispersed plants, such as fleshy and juicy fruits, edible and nutritious seeds, hooks or spines on fruits or seeds, etc. Explain how these features help the plants to disperse their seeds by animals, such as ingestion, adhesion, or caching.
8	Seed dispersal mechanisms: self-dispersal	- Observe some photographs and specimens of self-dispersed plants. Describe the features of self-dispersed plants, such as elastic or contractile tissues, dehiscent or indehiscent fruits, ballistic or shattering seeds, etc. Explain how these features help the plants to disperse their seeds by themselves.

# Department of Botany

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Teaching Plan  
DR. J. N. Pant

Class: BSc 5<sup>th</sup> Semester

Subject: Botany

Paper: XIII

## SEMESTER -V Bot. 501: PAPER- XIII ECONOMIC BOTANY

Topic	Subtopic	Number of Lectures
<b>Introduction</b>	Questions, objectives, overview	2
<b>Cereals and millets</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of wheat, rice, maize, ragi, pearl millet	4
<b>Sugar yielding plants</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of sugarcane, sugar beet, date palm, maple, stevia	4
<b>Fruits</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of mango, apple, banana, citrus, litchi	6
<b>Fibers</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of cotton, jute, hemp, coir, agave, semal	6
<b>Vegetables</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of root, stem, and fruit vegetables	6
<b>Timbers</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of teak, shisham, sal, chir, deodar	6
<b>Medicinal plants</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of <i>aconitum</i> , <i>atropa</i> , <i>cinchona</i> , <i>rauwolfia</i> , <i>ephedra</i> , <i>withania</i>	8
<b>Oils</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of volatile and non-volatile oils	4
<b>Beverages</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of tea and coffee	4
<b>Fumitories and masticatories</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of tobacco, opium, cannabis, betel, areca	4
<b>Spices and condiments</b>	Definition, classification, morphology, cultivation, uses, value, benefits, drawbacks of pepper, ginger, turmeric, clove, cardamom, cinnamon, etc.	4
<b>Conclusion</b>	Summary, review, importance	2
<b>Evaluation</b>	Worksheets, quizzes, projects	4

# Practical Work Plan

Max. Marks: 60 Class: BSc 5<sup>th</sup> Semester

## Economic Botany

Plant category	Plant name	Plant part
<b>Cereals</b>	Wheat, Rice, Maize	To identify and collect the economically important part of the plant.
<b>Millets</b>	Finger millet, Foxtail, Ragi	To identify and collect the economically important part of the plant.
<b>Pulses</b>	Gram, Green gram, Pea, Pigeon pea, Soyabean, Chickpea	To identify and collect the economically important part of the plant.
<b>Timbers</b>	Shisham, Sal, Teak, Deodar, Pine	Usage and Economic importance
<b>Medicinal plants</b>	Dhatura, Berginia, Hedychium, Poppy, Basil, Barberry	Identification and collection of Herbarium of locally available medicinal plant
<b>Beverages</b>	Tea, Coffee	Visit to college tea garden
<b>Oils</b>	Mustard, Sesame, Coconut, Linseed, Groundnut, Castor, Laung, Sandal wood, Mentha	Collection of locally available oil producing seeds.
<b>Spices</b>	Coriander, Cardamom, Curcuma, Cinnamon, Laung, Cumin, Thyme, Nigella, Cinnamon leaf	Collection and identification of spices producing part of plants viz. Seeds, fruits, rhizomes, bark, buds, leaves
<b>Fibres</b>	Jute, Coconut, Hemp, Urtica, Cotton	Identification and collection of Fibers
<b>Sugars and starch yielding plants</b>	Sugarcane, potato, Beet root	Stems, tubers, roots
<b>Fruits and vegetables available in the area</b>	Mango, Banana, Papaya, Guava, Apple, Orange, Tomato, Cucumber, Carrot, Cabbage, Cauliflower, Spinach, etc.	Record the characteristics, uses, and value of the plants and their products.
<b>Gums and Resins</b>	Acacia, Eucalyptus, Pine, Boswellia, Commiphora, etc.	Record the characteristics, uses, and value of the plants and their products.

# Department of Botany

Govt. Post. Graduate College Berinag, Pithoragarh

Teaching Plan

Dr. J. N. Pant

SEMESTER-VI Bot. 601: PAPER –XVI

ECOLOGY

Max. Marks: 60

Lecture/ period	Topic	Subtopics
1	Plant and environment	Principles of environment, atmosphere, light, temperature, water, soil and biota.
2	Morphological, anatomical, and physiological responses of plants to water	Hydrophytes and Xerophytes
3	Morphological, anatomical, and physiological responses of plants to temperature	Thermoperiodism and vernalization
4	Morphological, anatomical, and physiological responses of plants to light	Heliophytes and sciophytes
5	Population	Growth curves, ecotype and ecads
6	Community	Definition, structure, and attributes: frequency, density, cover, life forms and biological spectrum
7	Ecological succession	Definition, types, and examples.
8	Ecosystem	Concept, energy flow, food chain, food web and ecological pyramids
9	Biogeochemical cycles	Carbon and nitrogen cycles
10	Biodiversity and its conservation	Basic concept and importance
11	Environmental pollution-air	Sources, effects, and control measures
12	Environmental pollution-water	Sources, effects, and control measures
13	Environmental pollution-soil	Sources, effects, and control measures
14	Environmental pollution-noise	Sources, effects, and control measures

# Practical Work Plan

Bot. 604: Lab course (Practical)

Max. Marks: 60

Experiment	Objective	Procedure	Materials
1	To calculate the frequency, abundance, density, and A/F ratio of the given data	<ol style="list-style-type: none"> <li>1. Select a suitable sampling unit (quadrat, transect, etc.) and size according to the vegetation type and heterogeneity.</li> <li>2. Randomly or systematically place the sampling unit in the study area and record the presence or absence of each species within the unit.</li> <li>3. Repeat the sampling until the desired number of units is covered.</li> <li>4. Calculate the frequency, abundance, density and A/F ratio for each species using the formulas: Frequency = (Number of units in which the species is present / Total number of units) x 100 Abundance = (Total number of individuals of the species / Total number of units in which the species is present) Density = (Total number of individuals of the species / Total area sampled) A/F ratio = (Abundance / Frequency)</li> </ol>	Quadrat or transect, measuring tape, data sheet, calculator
2	To calculate the relative frequency, relative density, relative abundance, and IVI of the given data by quadrat method and by developing artificial vegetation plots	<ol style="list-style-type: none"> <li>1. Follow the same procedure as above to calculate the frequency, abundance, and density of each species.</li> <li>2. Calculate the relative frequency, relative density and relative abundance for each species using the formulas: Relative frequency = (Frequency of the species / Sum of frequencies of all species) x 100. Relative density = (Density of the species / Sum of densities of all species) x 100 Relative abundance = (Abundance of the species / Sum of abundances of all species) x 100</li> <li>3. Calculate the importance value index (IVI) for each species using the formula: IVI = Relative frequency + Relative density + Relative abundance</li> </ol>	Quadrat or transect, measuring tape, data sheet, calculator
3	To determine the leaf area of the given leaves	<ol style="list-style-type: none"> <li>1. Collect fresh leaves of different shapes and sizes from the field or laboratory.</li> <li>2. Trace the outline of each leaf on a graph paper and cut out the leaf shape.</li> <li>3. Count the number of squares covered by the leaf shape and multiply by the area of one square to get the leaf area.</li> <li>4. Alternatively, use a leaf area meter or scanner to measure the leaf area directly.</li> </ol>	Leaves, graph paper, scissors, pencil, leaf area meter or scanner
4	To calculate net primary productivity of a grass land	<ol style="list-style-type: none"> <li>1. Select a representative area of the grassland and mark four plots of equal size (e.g. 1 m x 1 m) using stakes and strings.</li> <li>2. Harvest all the aboveground biomass from two plots and weigh them to get the dry weight. This is the standing crop biomass (SCB).</li> <li>3. Cover the remaining two plots with opaque cloth or plastic to prevent further photosynthesis and leave them for a certain time (e.g. one week).</li> <li>4. Harvest all the aboveground biomass from the covered plots and weigh them to get dry weight. This is the final crop biomass (FCB).</li> </ol>	Stakes, strings, scissors, weighing balance, cloth or plastic, data sheet, calculator

		5. Calculate the net primary productivity (NPP) using the formula: $PP = (SCB - FCB) / \text{Time interval}$	
5	To Study the soil pH and soil moisture content	<ol style="list-style-type: none"> <li>1. Collect soil samples from different depths and locations using a soil auger or a spade.</li> <li>2. Label the samples and store them in plastic bags or containers.</li> <li>3. To measure the soil pH, use a pH meter or pH indicator paper. Follow the instructions of the device or the paper to prepare the soil solution and read the pH value.</li> <li>4. To measure the soil moisture content, weigh a known amount of soil sample and record the initial weight. Then, dry the sample in an oven at 105°C for 24 hours. Weigh the sample again and record the final weight. Calculate the soil moisture content using the formula:   - Soil moisture content (%) = <math>[(\text{Initial weight} - \text{Final weight}) / \text{Initial weight}] \times 100</math></li> </ol>	Soil auger or spade, plastic bags or containers, pH meter or pH indicator paper, weighing balance, oven, data sheet, calculator
6	To visualize the age distribution and sex ratio of a population	<ol style="list-style-type: none"> <li>1. Select a population of interest (e.g. humans, animals, plants, etc.) and obtain the data on the number of individuals in each age group and sex.</li> <li>2. Use software or a graph paper to draw a population structure diagram, also known as a population pyramid.</li> <li>3. The diagram consists of two horizontal bar graphs, one for each sex, placed back-to-back along a vertical axis.</li> <li>4. The vertical axis shows the age groups, usually in 5-year intervals. The horizontal axis shows the percentage or number of individuals in each age group.</li> <li>5. The shape and size of the bars indicate the age distribution and sex ratio of the population.</li> </ol>	Data on population, software or graph paper, pencil, ruler

Date 12/07/2023

**Jyoti Niwas Pant**

Assistant Professor Botany  
Govt. Post Graduate College Berinag

## Department of Botany

### Govt. Post. Graduate College Berinag, Pithoragarh

Session 2023- 2024

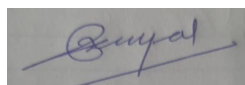
Teaching Plan  
DR. Beena Lohiya

Class: B.Sc V Semester

Subject: Botany

Paper: XIV

Sr. No.	No. of lectures	Unit	PLANT PHYSIOLOGY
1	03	1	1. Diffusion, osmosis, water potential and its components, Plasmolysis, Imbibition and Absorption of water, root pressure and guttation.
2	02	2	2. Transpiration and its significance, Factor affecting transpiration, mechanism of stomata opening and closing.
3	04	3	3. Mineral nutrition: Essential elements, macro and micro nutrients, criteria of essentiality of elements, role of essential elements, minerals deficiency symptoms, Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.
4	05	4	4. Translocation in phloem: composition of phloem sap, girdling experiment, pressure flow model, phloem loading and unloading. 5. Respiration: aerobic and anaerobic respiration. Glycolysis and Kerb's cycle. Oxidative phosphorylation, electron transport system, fermentation, R.Q.
5	06	5	6. Photosynthesis: photosynthetic pigments. Photosystem I and II, electron transport system and ATP synthesis. Path of carbon in C3 plants (C3 cycle), C4 plants (C4 cycle), CAM pathway.



Dr Beena Lohiya  
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Govt. P.G. College Berinag  
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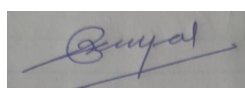
**Teaching Plan**  
**DR. Beena Lohiya**

**Class: B.Sc I Semester (NEP)**

**Subject: Botany**

**Paper: I**

Sr. No.	No. of lectures	Unit	Microbes, Algae, Fungi and Bryophytes
1	03	3	1. Fungi : Introduction-general characteristics, ecology and significance, range of somatic thallus organization, cell wall composition, nutrition.
2	03	3	reproduction and classification (G.C. Ainsworth); life cycle of Stemonitis (Myxomycota)
3	06	3	Rhizopus (Zygomycota) Penicillium (Ascomycota), Puccinia, Agaricus (Basidiomycota); Alternaria (Deutromycota).
4	02	3	Symbiotic associations: Lichens General account, reproduction and significance
5	01	3	Mycorrhiza: ectomycorrhiza, endomycorrhiza



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Session 2022- 2023

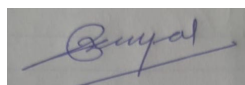
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**Class: B.Sc I Semester (NEP)**

**Subject: Botany**

**Paper: I**

Sr. No.	No. of lectures	Unit	Microbes, Algae, Fungi and Bryophytes
1	03	3	1. Fungi : Introduction-general characteristics, ecology and significance, range of somatic thallus organization, cell wall composition, nutrition.
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3	06	3	Rhizopus (Zygomycota) Penicillium (Ascomycota), Puccinia, Agaricus (Basidiomycota); Alternaria (Deutromycota).
4	02	3	Symbiotic associations: Lichens General account, reproduction and significance <sup>2</sup>
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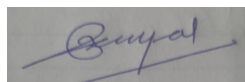
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**Teaching Plan**  
**DR. Beena Lohiya**

**Class: B.Sc II Semester**  
**Paper: I**

**Subject: Botany**

Sr. No.	No. of lectures	Unit	Pteridophytes, Gymnosperms and Angiosperms
1	03	2	Gymnosperms General characteristics, classification (up to family),
2	12	2	morphology, anatomy and reproduction of Cycas, Pinus and Ephedra; ecological and economic importance,



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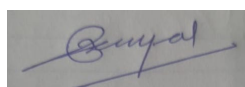
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Teaching Plan  
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Class: B.Sc III Semester  
Paper: I

Subject: Botany

Sr. No.	No. of lectures	Unit	
1	07	1	Meristematic and permanent tissues: Types of tissues, Root and shoot apical meristems.
2	08	1	Theories related to apical meristem, simple, complex and secretory tissues.



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Session 2023-2024

Teaching Plan

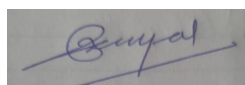
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Class: M.Sc I<sup>st</sup>Semester

Subject: Botany

Paper: III

Sr. No.	No. of lectures	Unit	Mycology
1	01	1	General Features of Fungi
2	01	1	Classification of Fungi
3	01	2	Reproduction: Vegetative, asexual and sexual)
4	01	2	Heterothallism, Heterokaryosis, Parasexuality
5	01	2	Recent trends in classification
6	01	3	Phylogeny of fungi
7	01	4	Importance of fungi
8	01	5	Class Myxomycotina: Stemonitis, Physarum
9	01	6	Class Mastigomycotina: Allomyces, Plasmodiophora, Monoblepharis
10	01	7	Class Oomycotina: Saprolegnia, Pythium,
11	01	7	Phytophthora, Peronospora, Sclerospora
12	01	8	Class Zygomycotina: Mucor, Pilobolus
13	01	8	Entomophthora, Syncephalastum
14	01	9	Class Ascomycotina: Saccharomyces, Aspergillus, Talaromyces, Taphrina
15	01	9	Uncinula, Phyllactinia, Peziza, Cordiceps
16	01	9	Mycophora, Chaetomium, Claviceps
17	01	10	Class Basidiomycotina: Puccinia, Ustilago, Amanita, Auricularia
18	01	10	Ganoderma, Fomes, Tilletia, Uromyces, Nidularia
19	01	11	Class Deuteromycotina: Fusarium, Cercospora, Pyricularia
20	01	12	Colletotrichum, Phoma, Trichoderma, Helminthosporium



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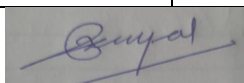
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**Class: M.Sc III<sup>rd</sup>Semester**

**Subject: Botany**

**Paper: IX**

Sr. No.	No. of lectures	Unit	Plant ecology
1	01	1	• Climate, soil and vegetation patterns of the world: Major biomes and vegetation types and environmental funct
2	01	1	Population dynamics: Characters, r and k strategies.
3	02	2	Vegetation organization: Concepts of community and continuum; community character, concept of ecological niche, ordination.
4	01	3	• Ecological succession: Causes, mechanism and types, concepts of climax.
5	02	3	Ecosystem: Structure and functions; primary production (methods of measurement, global pattern, controlling factors);
6	02	4	energy dynamics (Trophic organization, energy flow pathways, ecological efficiencies);
7	01	4	litter fall and decomposition (mechanism, substrate quality and climatic factors.
8	02	4	biogeochemical cycles of C, N, P and S; (pathways, processes, in terrestrial and aquatic ecosystems;
9	03	4	Biological diversity: Concept and levels; species richness, diversity indices, concept of $\alpha$ and $\beta$ diversity, role and application of biodiversity in ecosystem function; speciation and extinction;
10	02	4	IUCN categories of threat; distribution and global patterns of biodiversity, hot spots; inventory. •
11	01	4	Environmental pollution: Kinds; sources, quality parameters;
12	01	4	Climate change: Greenhouse gases sources, trends and role; ozone layer and ozone hole;
13	01	4	climate change (CO <sub>2</sub> ; sequestration, global warming, sea level rise, UV radiation.



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Govt. P.G. College Berinag  
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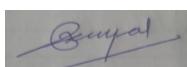
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**Class: M.Sc III<sup>rd</sup> Semester**

**Subject: Botany**

**Paper: XII**

Sr. No.	No. of lectures	Unit	Plant physiology and biochemistry
1	03	1	<ul style="list-style-type: none"> <li>Membrane transport and translocation of water and solutes: Plant-water relations, mechanism of water transport through xylem, phloem loading and unloading, passive and active solute transport, membrane transport.</li> </ul>
2	03	1	<ul style="list-style-type: none"> <li>Enzymology: General aspects, allosteric mechanism, regulatory and active sites, isozymes, kinetics of enzymatic analysis, Michaelis-Menten equation and its significance.</li> </ul>
3	03	2	Signal transduction and sensory photobiology: Receptors, phospholipids signalling, phytochromes and cryptochromes.
4	04	3	<ul style="list-style-type: none"> <li>Photosynthesis: General concepts and historical back ground, steps of photosynthesis, Emerson's effect, two pigment systems, Calvin cycle, photorespiration and its significance, C4 cycle, CAM pathway.</li> </ul>
5	04	3	<ul style="list-style-type: none"> <li>Respiration: Glycolysis. TCA cycle, electron transport chain and ATP synthesis, pentosephosphate pathway, glyoxylate cycle.</li> </ul>
6	03	4	<ul style="list-style-type: none"> <li>Nitrogen fixation and metabolism: Biological nitrogen fixation, mechanism of nitrate uptake and reduction, ammonium assimilation.</li> </ul>
7	04	4	<ul style="list-style-type: none"> <li>Plant growth regulators: Physiological effects and mechanism of auxins, gibberellins, cytokinins, ethylene, abscisic acid, polyamines,</li> </ul>
8	03	4	<ul style="list-style-type: none"> <li>Photoperiodism and vernalization: Photoperiodism and its significance, floral induction and development, significance of vernalization.</li> </ul>
9	03	4	<ul style="list-style-type: none"> <li>Stress physiology: Plant responses to biotic and abiotic stress, mechanism of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, freezing and</li> </ul>
10	05	4	<ul style="list-style-type: none"> <li>Carbohydrates: Monosaccharide's, oligosaccharides, polysaccharides. Lipid ;fat metabolism (Simple lipids, compound lipids, derived lipids). • Alkaloids: Structure and classification of alkaloids</li> </ul>



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 Govt. P.G. College Berinag Pithoragarh

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**B.Sc II Sem (NEP)**

**Paper I**

Sr. No	No. of Lectures	Unit	Pteridophytes, Gymnosperms and Angiosperms (BOT201T)
1	01	3	Introduction to plant taxonomy: Identification, classification, nomenclature
2	01	3	Functions of herbarium, important herbaria and botanical gardens of the world and India.
3	01	3	Important flora, botanical nomenclature (principles and rules (ICN); ranks and names
4	02	3	Binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations)
5	02	3	Classification: Types of classification-artificial, natural and phylogenetic
6	03	3	Bentham and Hooker (up to series), Hutchinson classification and Angiosperm Phylogeny Group (APG IV) classification
7	04	4	Taxonomy of plant families: Ranunculaceae, Malvaceae
8	04	4	Family Rutaceae, Fabaceae
9	04	4	Family Apiaceae, Asteraceae
10	04	4	Family Solanaceae, Lamiaceae
11	04	4	Family Euphorbiaceae, Orchidaceae and Poaceae



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Asst. Prof Botany  
Govt. Post Graduate College Berinag  
Pithoragarh, Uttarakhand

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**B.Sc IV Sem**

**Paper VIII**

Sr. No	No. of Lectures	Unit	Genetics and Plant Breeding
1	01	1	Structure of DNA
2	01	1	Structure of RNA
3	01	1	Different forms of DNA (A, B, Z)
4	01	2	Properties of genetic code,
5	01	2	Classical and modern concept of gene
6	01	3	Law of inheritance: Mendel's experiments
7	01	3	Principle of segregation and independent assortment,
8	01	3	Incomplete dominance
9	01	4	Chromosomal aberration: structural; deficiency, duplication
10	01	4	Chromosomal aberration: structural; inversion & translocation
11	01	4	Chromosomal aberration: (euploidy & aneuploidy), alteration in chromosomes.
12	01	5	Sex chromosomes, sex determination in <i>Drosophila</i>
13	01	5	Sex determination in Man and plants specially <i>Melandrium</i>
14	01	6	Sex linked inheritance
15	01	7	Complementary gene interaction
16	01	7	Epistasis (Dominant & Recessive)
17	01	7	Supplementary gene interaction



Dr. Ashwani Kumar  
Asst. Prof Botany  
Govt. Post Graduate College Berinag  
Pithoragarh, Uttarakhand



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**M.Sc II Sem**

**Paper VIII**

Sr. No	No. of Lectures	Unit	Cell and Molecular Biology
1	01	1	Cell wall: Structure and functions, biogenesis
2	01	2	Plasma Membrane: Structure, models and functions,
3	01	2	Plasmodesmata and their role in movement of molecules and macromolecules
4	02	3	Chloroplast: Structure and genome organization and transcription
5	02	4	Mitochondria: Structure, genome organization, biogenesis, RNA editing
6	02	5	Plant vacuoles: Tonoplast membrane, ATPase, storage organelles
7	03	6	Nucleus: Structure, DNA structure, A, B and Z forms, nuclear pores, nucleosome organization
8	04	7	Ribosomes: Structure, protein synthesis, mechanism of translocation, Initiation and termination.
9	03	8	Cell shape and motility: The cytoskeleton, organization and role of microtubules and microfilaments.
10	03	9	Cell cycle and Apoptosis: Role of cyclins and cyclin-dependent kinases, cytokinesis and cell plate formation
11	03	10	Other cellular organelles: Structure and functions of microbodies, Golgi apparatus, lysosomes, endoplasmic reticulum
12	03	11	Techniques in cell biology: Immunotechniques, FISH, GISH, confocal microscopy



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Pithoragarh, Uttarakhand

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**M.Sc IV Sem**

**Special Paper XIV**

Sr. No	No. of Lectures	Unit	Forest Ecology
1	02	1	General aspects of forests: Forest ecology and forest ecosystem
2	02	1	Importance of forests in environmental conservation, wildlife, and biodiversity.
3	02	2	Methods of estimating biomass and productivity across the forests of world
4	01	2	allocation of biomass and productivity to different tree components
5	02	2	production efficiency of leaves particularly in relation to leaf-span and other related leaf characters
6	02	3	Types of litter and coarse woody debris, litter fall, forest floor litter mass
7	02	3	litter decomposition and factors affecting such as microbes, fauna, abiotic factors and litter characters
8	02	4	Impact of forest on precipitation apportionment, water discharge from watersheds, water's role in nutrient cycling
9	02	5	Concept of inter and intra system cycling and tree-internal cycling; distribution of nutrients in different forest components
10	02	5	nutrient immobilization, role of microbes, especially of nitrogen-fixers and mycorrhiza in forest nutrient cycling.
11	02	6	An idea of forest succession with particular reference to Himalaya, attributes of species of different successional stages
12	02	7	Tropical rain forests, monsoon forest, temperate coniferous, temperate deciduous forest
13	02	8	Forest classification of India, forest of Himalaya with particular reference to Oak, Pine and Sal forest
14	02	9	Relationship between man and forest in the Himalaya
15	02	10	Linkages between subsistence hill and agriculture and living and forests and other non-cultivated land
16	02	11	Global climate changes and forests



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**B.Sc I Sem (NEP)**

**Paper I**

Sr. No	No. of Lectures	Unit	Microbes, Algae, Fungi and Bryophytes (Course code: BOT101T)
1	03	1	Microbes : Viruses-discovery, general structure, replication (general account)
2	03	1	DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV)
3	03	1	Economic importance; bacteria–discovery, general characteristics and cell structure
4	03	1	Reproduction–vegetative, asexual and recombination (conjugation)
5	03	1	Reproduction (transformation and transduction); economic importance
6	02	2	Algae: General characteristics; Range of thallus organization
7	03	2	Reproduction; classification of algae;
8	03	2	Morphology and life cycle of Nostoc, Chlamydomonas
9	03	2	Morphology and life cycle of Oedogonium, Vaucheria
10	03	2	Sargassum, Polysiphonia
11	01	2	Economic importance of algae



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**B.Sc III Sem (NEP)**

**Paper I**

Sr. No	No. of Lectures	Unit	Morphology, Anatomy and Embryology (BOT301T)
1	01	3	Pollination mechanisms
2	01	3	Pollination adaptation
3	01	3	Structure of anther and pollen
4	01	3	Development of male gametophytes
5	01	3	Development of female gametophytes
6	01	3	Double fertilization
7	01	4	Types of ovules
8	01	4	Types of embryo sac
9	01	4	Structure of embryo and endosperm
10	01	4	Types of endosperm
11	01	4	Structure of dicot embryo
12	01	4	Structure of monocot embryo
13	01	4	Apomixis and polyembryony.



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**B.Sc V Sem**

**Paper X**

Sr. No	No. of Lectures	Unit	BIOCHEMISTRY
1	01	1	Foundation of Biochemistry: Forces and interaction of biomolecules
2	01	1	chemical bonds covalent and ionic bond; stabilizing interaction
3	02	1	(Vander wall, electrostatic, hydrogen bonding, hydrophobic interaction, concept of pH, pKa, titration curve, acid, bases and buffers, Henderson Hasselbalch equation)
4	02	2	Carbohydrate: Classification into mono-, di- and poly- saccharides
5	02	2	Glyoxylate cycle, Pentose- phosphate pathway
6	02	3	Protein: Basic aspects of protein conformation
7	03	3	protein synthesis (activation of amino acid, initiation, elongation, termination)
8	02	4	Fats and Lipids: Structure and function of lipids
9	02	4	Saturated and unsaturated fatty acids; $\beta$ -oxidation
10	02	5	Enzymes: Classification; mechanism of action;
11	03	4	factors affecting enzymes activities; concept of holoenzymes, apoenzyme and co-factors



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**M.Sc I Sem**

**Paper I**

Sr. No	No. of Lectures	Unit	Microbiology: Vedic and Modern Microbiology
1	03	1	Vedic Microbiology: Introduction to Vedas-Types and great saying of Vedas, Aryans-definition, indigenous or invaders
2	02	1	Rishi Kandva as the father of microbiology, Charak; shape and colours of germs (Krimis);
3	02	1	Occurance of germs in the environment-on animal, body surface of human, water whey, milk, food grains
4	01	1	Knowledge of invisible germs through logic and Divine eyes
5	02	1	Classification of germs- major groups of Krimis- Drishta, Adrishta; various names of Krimis in Vedas
6	02	1	Different terms used for microbes- Amiva, Durnama, Sunama, Yatudhan, Pisaca
7	03	2	Emergence of modern microbiology: Spontaneous Vs Biogenesis, Golden era of microbiology, Golden age of microbiology
8	03	2	Five kingdom system of classification, Eight kingdom of classification, different types of microscopy
9	02	2	Different types of staining of microbes
10	04	3	Methods of isolation and culture of microorganisms; measurement of microbial growth; microbial genetics
11	03	3	Gram-negative and Gram-positive Bacteria, Virus, virioids, virions
12	03	3	Economic importance of virus and bacteria
13	03	4	Role of microorganism: Root nodules, nif gene organization, role of microorganisms in soil (decomposition and nutrient cycling)
14	02	4	Role in industry- production of antibiotics, bio-fertilizers and bio-pesticides



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**M.Sc I Sem**

**Paper II**

Sr. No	No. of Lectures	Unit	Phycology
1	03	1	History and Classification of Algae: Criteria of classification, important systems of classification
2	02	2	Ecology of Algae: Diversified habitats of algae, eutrophication, water blooms and phytoplanktons
3	01	3	Basic concept of Cyanophages
4	02	4	Importance of Algae: Useful and harmful aspects of algae
5	03	5	Cyanophyta: Chroococcales (Chroococcus, Gleocapsa, Microcystis)
6	05	5	Oscillatoriales (Oscillatoria, Lyngbya); Nostocales (Nostoc, Anabaena, Spirullina)
7	03	5	Scytonematales (Scytonema; Tolypothrix; Rivulariales (Rivularia, Gloeotrichia)
8	03	5	Chlorophyta: Chlamydomonadales (Haematococcus); Volvocales (Gonium, Pandorina, Eudorina);
9	05	5	Chlorococcales (Chlorella, Hydrodictyon, Pediastrum); Oedogoniales (Oedogonium, Bulbochaete, Scenedesmus)
10	04	5	Ulvales (Ulva, Enteromorpha); Cladophorales (Cladophora, Pithophora)
11	03	5	Chaetophorales (Chaetophora), Fritschiales (Fritschella), Zygnematales (Zygnema)
12	02	5	Charophyta: Charales (Nitella, Chara)
13	02	5	Xanthophyta: Heterosiphonales (Botrydium, Vaucheria)
14	03	5	Bacillariophyta: Pennales and Centrales (Pinnate diatoms and Centric diatoms)
15	04	5	Phaeophyta: Ectocarpales (Ectocarpus); Dictyotales (Dictyota), Laminariales (Laminaria); Fucales (Fucus, Sargassum)
16	04	5	Rhodophyta: Nemalionales (Nemalion); Gigartinales (Gracillaria); Gelidiales (Gelidium); Ceramiales (Ceramium)



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**M.Sc III Sem**

**Paper XI**

Sr. No	No. of Lectures	Unit	Biotechnology
1	02	1	Biotechnology: Principle and scope, bio-safety guidelines
2	02	2	Plant cell and tissue culture: Concept of cellular differentiation and totipotency
3	02	2	principle of root and shoot generation in vitro, applications of cell and tissue culture
4	02	3	Callus culture, cell suspension culture, cryopreservation, clonal propagation, organ culture
5	03	3	protoplast culture, organogenesis, somatic embryogenesis, somatic hybridization, artificial seed, hybrids and cybrids, and somaclonal variation
6	03	4	Recombinant DNA technology: Tools of genetic engineering; enzyme, vectors; plasmids, cosmids, lamda phage vectors,
7	03	4	Shuttle vectors. BACs and YACs. Cloning strategies, genomic libraries, CDNA libraries, single gene cloning
8	02	5	Detection and characterization of transformants: Screening and selection for transformants
9	02	5	Hybridizations - colony, Southern, Northern, Western. DNA sequencing techniques
10	03	5	expression vectors in bacteria and eukaryotes; expression of industrially important products
11	02	6	Genetic engineering of plants: Aims, tools, strategies
12	03	6	Development of transgenic plant with suitable example, alien gene transfer and applications.
13	03	7	Elementary Knowledge of next generation sequencing
14	02	7	Intellectual property rights, genomics and proteomics.
15	02	8	Biological databases (gene and protein). DNA restriction map analysis)
16	02	8	DNA and protein sequence alignment. BLAST, and FASTA



Dr. Ashwani Kumar  
Asst. Prof Botany  
Govt. Post Graduate College Berinag  
Pithoragarh, Uttarakhand