

National Curriculum and Credit Framework (NCCF)
Syllabus
for
<<BOTANY>>
w.e.f. Academic Session 2023-24



Kazi Nazrul University
Asansol, Paschim Bardhaman
West Bengal 713340

SEMESTER- I

MAJOR COURSE - 1

Course Name : Plant Groups and Microbial World

Course Code : BSCBOTMJ101

Course Type: Major (Theoretical & Practical)	Course Details: MJC-1		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

1. Combination of theoretical and practical components of this paper will provide comprehensive information and insight into the fascinating world of microbes and plants.
2. Hands on training will help students to learn use of microscope, various instruments handling, mounting, section-cutting and staining techniques for the study of bacteria and plant materials.
3. Making drawings in practical records will enhance understanding morphological and structural details and related functional aspects in diverse plant and microbial groups.
4. After the completion of the course the students will be able to develop understanding about the classification and diversity of different plants, microbes and their economic importance.
5. The students will develop conceptual skill about identifying plants and microbes.
6. The students will gain knowledge about developing commercial enterprise of the microbial products.

Detailed Syllabus -

Unit I: Plant Groups (Basic Concepts):

- Kingdom systems (*Two* kingdom, *Three* kingdom and *five* kingdom system), Classification of Plant Kingdom (By Eichler, 1883); Historical development of the discipline Botany (Contributions of Aristotle, Theophrastus, Dioscorides, Parasara, Sushruta, Charak, Carrolus Linnaeus, Engler and Prantl and Sir J.C Bose); General and Comparative account of plant group; Scope and prospects in Botany (include Archaeobotany, Astrobotany and Dendrology also); Alternation of Generations and concept of gametophyte and sporophyte; Origin and evolution of life on planet Earth, Geological Time Scale and Major events of plant lives.
- General Features and Classification: Engler and Prantl's Classification (upto Classes); General characteristics and classification of groups upto classes (Aglae By Fritsch (1935), Fungi By Gwenny-Vaughani and Barnes (1937), Bryophytes by Proskauer (1957), Pteridophytes by Sporne (1965), Gymnosperm by Bierhorst (1971).

- General features, systematic position and life cycle of the genera – *Spirogyra*, *Mucor*, *Riccia*, *Pogonatum*, *Pteris* and *Pinus*. Methods of collection, preservation, storage and recording of each of these plant groups.
- Lichens: Classification, thallus organization, internal anatomy, reproduction; ecological and economic significance.
- Phytochemistry – Structures, classifications and physiological roles of Carbohydrates (excluding derivatives), proteins, amino acids, lipids, terpenes, phenolics and alkaloids; Concepts of optical isomerism (L and D form), mutarotation, Different types of bonds (Glycosydic bond, ester bond and peptide bond), Zwitterion and pI.

Unit II: Introduction to microbial world

- Historical development in the field of microbiology - (contributions of Antoni van Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch and A. Fleming); Microbes and their types.
- Polyphasic approaches in bacterial taxonomy, General idea about Bergey's Manual, Three domain system by C. Woese (1991).
- Microbial nutrition: nutritional types, growth and Reproduction of bacteria.
- Economic importance of bacteria with reference to their role in agriculture, fermentation industry and medicine (This will include only a general list of microbial products and the microorganisms involved).
- Medical Microbiology – Epidemiology, pathogenesis, causal organism and control of air borne disease (influenza), water borne disease (Cholera) and food borne disease (Staphylococcal food poisoning).

Unit III: Bacteria and Viruses

- General Bacteriology: Size, shape and arrangement of bacteria; Structures and functions of – Bacterial Capsule, flagella, pili, cell wall (chemical composition and characteristics), plasma membrane, ribosomes, cytoplasmic inclusions, Plasmids and bacterial chromosome; endospore (structure, formation and germination).
- General characteristics of the domain Archaea and wall-less forms (Mycoplasmas, L-forms, Protoplasts and Spaheroplasts).
- Mechanism of gene transfer in bacteria: Transformation, Conjugation and Transduction.
- Viruses: General characteristics of viruses (size, symmetry, culture characteristics, general structure including concept of capsomere and peplomere, chemical composition).
- Structure of TMV, T₂ phage, HIV and SarsCov2.
- Viral multiplication – Lytic cycle and Lysogeny cycle (excluding regulation),
- Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics and as causal organisms of plant diseases.
- General characteristics and diseases due to Prions and Viroids.

Unit IV: Basic immunology (only outline) – Innate and acquired immunity, active and passive immunity, humoral (antibody mediated) and cellular (cell mediated) immunity, primary and secondary response, general structure of antibody and its types, Vaccines and their types.

Practical

- Microscopic examination of genera – *Spirogyra* (whole mount), *Mucor* (whole mount), *Riccia* (t.s of mature thallus), *Pogonatum* (l.s of Capsule), *Pteris* (t.s of mature leaf) and *Pinus* (t.s of needle and stem).
- Qualitative tests of carbohydrates (reducing, non-reducing sugar, starch (Molisch test, Fehling’s test and Iodine test), protein (biuret test), lipid (Sudan III test) from natural sources.
- Demonstration of the functioning of Autoclave, Hot-air oven, Laminar air-flow, Filtration, Incubator and tools like inoculating loops/needles, petriplates, spreader, culture tubes etc.
- Preparation of standard bacteriological media (Nutrient agar and Nutrient broth).
- Demonstration of Sub-culturing technique.
- Enumeration of soil/food microorganisms by serial dilution technique.
- Microscopic examination of bacteria from natural habitats: curd and root nodules of leguminous plants (simple staining only)

Bibliography –

1. College Botany Vol. –II.- Gangulee and Kar, New Central Book Agency, Kolkata.
2. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
3. Text Book of Botany, Voli-1, Hait, Ghosh and Bhattacharya, New Central Book Agency
4. Advanced Botany Vol-1 and Vol-2, By Sanjeev Pandey, Books and Allied (P) Ltd.
5. Morphology of Vascular Plants, By George H. M. Lawrence, 1951, Oxford & IBH Publishing Co.

MINOR COURSE - 1

Course Name : Plant Groups and Microbial World

Course Code : BSCBOTMN101

Course Type: Minor (Theoretical & Practical)	Course Details: MNC-1		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

- ✓ Combination of theoretical and practical components of this paper will provide comprehensive information and insight into the fascinating world of microbes and plants.
- ✓ Hands on training will help students to learn use of microscope, various instruments handling, mounting, section-cutting and staining techniques for the study of bacteria and plant materials.
- ✓ Making drawings in practical records will enhance understanding morphological and structural details and related functional aspects in diverse plant and microbial groups.
- ✓ After the completion of the course the students will be able to develop understanding

about the classification and diversity of different plants, microbes and their economic importance.

- ✓ The students will develop conceptual skill about identifying plants and microbes.
- ✓ The students will gain knowledge about developing commercial enterprise of the microbial products.

Detailed Syllabus -

Unit I: Plant Groups (Basic Concepts):

- Kingdom systems (*Two* kingdom, *Three* kingdom and *five* kingdom system), Classification of Plant Kingdom (By Eichler, 1883); Historical development of the discipline Botany (Contributions of Aristotle, Theophrastus, Dioscorides, Parasara, Sushruta, Charak, Carrolus Linnaeus, Engler and Prantl and Sir J.C Bose); General and Comparative account of plant group; Scope and prospects in Botany (include Archaeobotany, Astrobotany and Dendrology also); Alternation of Generations and concept of gametophyte and sporophyte; Origin and evolution of life on planet Earth, Geological Time Scale and Major events of plant lives.
- General Features and Classification: Engler and Prantl's Classification (upto Classes); General characteristics and classification of groups upto classes (Aglae By Fritsch (1935), Fungi By Gwenny-Vaughani and Barnes (1937), Bryophytes by Proskauer (1957), Pteridophytes by Sporne (1965), Gymnosperm by Bierhorst (1971).

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- Lichens: Classification, thallus organization, internal anatomy, reproduction; ecological and economic significance.
- Phytochemistry – Structures, classifications and physiological roles of Carbohydrates (excluding derivatives), proteins, amino acids, lipids, terpenes, phenolics and alkaloids; Concepts of optical isomerism (L and D form), mutarotation, Different types of bonds (Glycosydic bond, ester bond and peptide bond), Zwitterion and pI.

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- Microbial nutrition: nutritional types, growth and Reproduction of bacteria.
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- Medical Microbiology – Epidemiology, pathogenesis, causal organism and control of air borne disease (influenza), water borne disease (Cholera) and food borne disease (Staphylococcal food poisoning).

Unit III: Bacteria and Viruses

- General Bacteriology: Size, shape and arrangement of bacteria; Structures and functions of – Bacterial Capsule, flagella, pili, cell wall (chemical composition and characteristics), plasma membrane, ribosomes, cytoplasmic inclusions, Plasmids and bacterial chromosome; endospore (structure, formation and germination).
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- Mechanism of gene transfer in bacteria: Transformation, Conjugation and Transduction.
- Viruses: General characteristics of viruses (size, symmetry, culture characteristics, general structure including concept of capsomere and peplomere, chemical composition).
- Structure of TMV, T₂ phage, HIV and SarsCov2.
- Viral multiplication – Lytic cycle and Lysogeny cycle (excluding regulation),
- Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics and as causal organisms of plant diseases.
- General characteristics and diseases due to Prions and Viroids.

Unit IV: Basic immunology (only outline) – Innate and acquired immunity, active and passive immunity, humoral (antibody mediated) and cellular (cell mediated) immunity, primary and secondary response, general structure of antibody and its types, Vaccines and their types.

Practical –

- Microscopic examination of genera – *Spirogyra* (whole mount), *Mucor* (whole mount), *Riccia* (t.s of mature thallus), *Pogonatum* (l.s of Capsule), *Pteris* (t.s of mature leaf) and *Pinus* (t.s of needle and stem).
- Qualitative tests of carbohydrates (reducing, non-reducing sugar, starch (Molisch test, Fehling's test and Iodine test), protein (biuret test), lipid (Sudan III test) from natural sources.
- Demonstration of the functioning of Autoclave, Hot-air oven, Laminar air-flow, Filtration, Incubator and tools like inoculating loops/needles, petriplates, spreader, culture tubes etc.
- Preparation of standard bacteriological media (Nutrient agar and Nutrient broth).
- Demonstration of Sub-culturing technique.
- Enumeration of soil/food microorganisms by serial dilution technique.
- Microscopic examination of bacteria from natural habitats: curd and root nodules of leguminous plants (simple staining only)

Bibliography –

1. College Botany Vol. –II.- Gangulee and Kar, New Central Book Agency, Kolkata. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
2. Text Book of Botany, Vol-1, Hait, Ghosh and Bhattacharya, New Central BookAgency
3. Advanced Botany Vol-1 and Vol-2, By Sanjeev Pandey, Books and Allied (P) Ltd. Morphology of Vascular Plants, By George H. M. Lawrence, 1951, Oxford & IBH PublishingCo

SKILL ENHANCEMENT COURSE - 1

Course Name : Mushroom Technology

Course Code : BSCBOTSE101

Course Type: SE (Theory)	Course Details: SEC-1		L-T-P: 3-0-0		
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			15		35

Course Learning Outcomes:

On completion of this course, the students will be able to:

- Recall various types and categories of mushrooms.
- Demonstrate various types of mushroom cultivating technologies.
- Examine various types of food technologies associated with mushroom industry.
- Value the economic factors associated with mushroom cultivation
- Devise new methods and strategies to contribute to mushroom production.

Detailed Syllabus -

Unit 1:

Introduction and history. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*; Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.

Unit 2:

Methods of cultivation of edible mushrooms (Oyster, Button and Paddy straw mushrooms). Diseases of Mushroom fungi and methods of remedy. Methods of Mushroom spawn production. Equipments and Tools required for mushroom as well as spawn production.

Unit 3:

Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

Unit 4:

Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

MULTIDISCIPLINARY COURSE - 1

Course Name : Introduction to Local Flora

Course Code : MDC118

Course Type: MD (Theory)	Course Details: MDC-1		L-T-P: 2-1-0		
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			15		35

Detailed Syllabus -

- What is Life? Criteria and features of life; Five kingdom concept.
- Plants groups, basic classification and general features of individual plant groups.
- Different types of ecological interaction among different plant groups. (Root nodules of legumes, Mycorrhiza, Parasitic Angiosperms).
- Ecological roles of Algae, Fungi, Bryophyta and vascular plants to maintain ecological balance and sustainability of ecosystem.
- Economic importance and future prospects of all plant groups; Traditional Knowledge about economic and medicinal use of important plants.
- Survey based Field study of local flora (Documentation and Report submission in the form of texts, photographs, tables and graphs).

SEMESTER- II

MAJOR COURSE - 2

Course Name : Cryptogamic Botany & Palaeobotany

Course Code : BSCBOTMJ201

Course Type: Major (Theoretical & Practical)	Course Details: MJC-2		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

1. Combination of theoretical and practical components of this paper will provide comprehensive information and insight into the fascinating world of cryptogams and plant fossils.
2. After the completion of the course the students will be able to develop critical understanding on morphology, anatomy and reproduction of Algae, Bryophytes, Pteridophytes & Gymnosperms and also an understanding of the plant evolution and their transition to land habit.
3. The students will learn the major patterns of diversity among cryptogams along with their characters.
4. The students will develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense.
5. The students will understand morphology, reproduction and developmental changes therein through typological study and create a knowledge base in understanding the basis of lower group of extant plants and fossil members'. They will also get acquainted to the diversity and economic values of such plants.

Detailed Syllabus -

Unit I: Algae:

- Introduction; Habitat and distribution; thallus organization; origin and evolution of sex in algae.
- Criteria for algal classifications; Broad outline of classification of Lee (2008) up to family and its basis.
- Comparative account and evolutionary relationship of: Cyanophyceae, Chlorophyceae, Charophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae.
- Cell structure and reproduction of Cyanophyceae and Diatoms.
- Life histories of *Nostoc*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus* and *Polysiphonia*.
- Economic importance of algae; Algal cultivation methods, Commercial cultivation and production of algal food.

Unit II: Bryology:

- Origin and phylogeny of Bryophytes; Habit and distribution; Broad outline of Classification of Giffinet (2009), Crandall-Stotler (2009) and Renzaglia (2007), Comparative study of Hepaticopsida, Anthocerotpoida and Bryopsida.
- Morphology, anatomy, reproduction and evolutionary trends of *Riccia*, *Marchantia*, *Pellia*, *Porella*, *Anthoceros*, *Sphagnum* and *Funaria*.
- Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit III: Pteridophytes- Introduction and Classification

- Introduction to Pteridophyta – Concept of Vascular Cryptogams; Land habit; stellar organization and its evolution; General features of Pteridophytes; Apogamy and apospory; Telome theory, Enation Theory.
- PPG1 (2016) classification of pteridophytes up to Suborder.
- Geological history and morphoanatomical and reproductive features of *Rhynia*, *Psilophyton* and *Zosterophyllum*; *Lepidodendron* (*Lepidodendron*, *Lepidocarpon*), *Calamites* (stem and strobilus-*Calamostachys* and *Palaeostachya*).
- Distribution, morphoanatomical and reproductive features of *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Pteris* and *Marsilea*.

Unit IV – Palaeobotany

- Introduction to Palaeobotany – Important terminologies and definitions; Types of fossil on the basis of modes of preservation; Nomenclature, Conditions suitable for fossilization; Importance of fossils and their study; Stratigraphy – Law of superposition, Stratigraphic correlation and stratigraphic deduction based on megafossil and microfossil assemblages.

Practicals:

- Micrometry-Standardization of compound microscope and measurement of cell size.
- Study of the vegetative and reproductive structures of the following genera using camera lucida: *Gloeotrichia*, *Scytonema*, *Zygnema*, *Oedogonium* and *Chara*.
- Study of the gametophytic and sporophytic structures of the following genera: *Riccia*, *Marchantia*, *Anthoceros* and *Funaria*.
- Study of external morphology and anatomical features of the following: *Lycopodium* (stem and strobilus), *Equisetum* (stem and strobilus) and *Marsilea* (Sporocarp).
- Macroscopic and microscopic identification of specimens of all genera included in the theoretical syllabus of Algae, Bryophytes and Pteridophytes.
- Study of the diagnostic features, geological time and mode of preservation of the following fossil members: *Lepidodendron*, (stem in T. S.), *Calamites* (stem in T. S.), *Bucklandia* (stem, specimen), *Glossopteris* (leaf, specimen), *Vertebraria* (root, specimen).
- Field Study: Specimen collection, identification and submission of collected and preserved materials with proper documentation.

- Preparation and Submission of permanent slides (with DPX/Canada balsam mount) of workout specimens.

Suggested Readings

1. College Botany Vol. –II.- Gangulee and Kar, New Central Book Agency, Kolkata.
2. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
3. Text Book of Botany, Vol-1 and 2, Hait, Ghosh and Bhattacharya, New Central Book Agency.
4. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
5. Vashishta B.R., Sinha A.K. and Singh V. P. (2008). Botany for Degree Students. Algae. S Chand and Co, New Delhi.
6. Vashishta B.R., Sinha A.K. and Singh V. P. (2008). Botany for Degree Students. Fungi. S Chand and Co, New Delhi.
7. Cryptogamic Botany Vol-1 By G. M. Smith
8. Algae By O.P. Sharma.
9. A Text Book of Botany: Lower Plants (2nd edition) Part-I: Bryophyta. Singh, Pandey and Jain. 1999. Rastogi Publications. Merut.
10. A Text Book of Botany, Pandey, S. N., Trivedi, P. S. and Misra, S. P. 1989. VikasPublishing House Pvt. Ltd.
11. Bryophytes, a broad perspective. Puri, P. 1973. Atma Ram & Sons. New Delhi.
12. The structure and life of Bryophytes, Watson, E. V. Hutchinson University Library, London.
13. Cryptogamic Botany Vol. II. GM Smith, Bryophytes and Pteridophytes (2nd edition). Mc.Graw Hill Book Co. New York.
14. E. M. Gifford and A. S. Foster. 1988. Morphology and Evolution of Vascular Plants.
15. N. S. Parihar: An Introduction to Embryophyta Vol-I and II. Central Book. Allahabad.
16. K. R. Sporne : The Morphology of Pteridophytes. B. S. Publications. Calcutta
17. P. C. Vasistha. 1980 Botany for degree student Pteridophyta. S. Chand & Company Pvt. Ltd. Rashid. 1976. An Introduction to Pteridophyta. Vikas Publishing . New Delhi.
18. S. SundarRajan. 1994. An introduction to Pteridophyta. New Age International Publishing Limited and Willey Eastern Ltd.

MINOR COURSE - 2

Course Name : Cryptogamic Botany & Palaeobotany

Course Code : BSCBOTMN201

Course Type: Minor (Theoretical & Practical)	Course Details: MNC-2		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

- Combination of theoretical and practical components of this paper will provide comprehensive information and insight into the fascinating world of cryptogams and plant fossils.
- After the completion of the course the students will be able to develop critical understanding on morphology, anatomy and reproduction of Algae, Bryophytes, Pteridophytes & Gymnosperms and also an understanding of the plant evolution and their transition to land habit.
- The students will learn the major patterns of diversity among cryptogams along with their characters.
- The students will develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense.
- The students will understand morphology, reproduction and developmental changes therein through typological study and create a knowledge base in understanding the basis of lower group of extant plants and fossil members'. They will also get acquainted to the diversity and economic values of such plants.

Detailed Syllabus -

Unit I: Algae:

- Introduction; Habitat and distribution; thallus organization; origin and evolution of sex in algae.
- Criteria for algal classifications; Broad outline of classification of Lee (2008) up to family and its basis.
- Comparative account and evolutionary relationship of: Cyanophyceae, Chlorophyceae, Charophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae.
- Cell structure and reproduction of Cyanophyceae and Diatoms.
- Life histories of *Nostoc*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus* and *Polysiphonia*.
- Economic importance of algae; Algal cultivation methods, Commercial cultivation and production of algal food.

Unit II: Bryology:

- Origin and phylogeny of Bryophytes; Habit and distribution; Broad outline of Classification of Giffinet (2009), Crandall-Stotler (2009) and Renzaglia (2007), Comparative study of Hepaticopsida, Anthocerotpoida and Bryopsida.
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Practicals:

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18. S. SundarRajan. 1994. An introduction to Pteridophyta. New Age International Publishing Limited and Willey Eastern Ltd.

SKILL ENHANCEMENT COURSE - 2

Course Name : Biofertilizer

Course Code : BSCBOTSE201

Course Type: SE (Theory)	Course Details: SEC-2		L-T-P: 3-0-0		
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			15		35

Course Learning Outcomes:

On the completion of this course, the students will be able to;

- Develop their understanding on the concept of bio-fertilizer
- Identify the different forms of biofertilizers and their uses
- Compose the Green manuring and organic fertilizers
- Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers and vesicular arbuscular mycorrhizal (VAM).
- Interpret and explain the components, patterns, and processes of bacteria for growth in crop production

Detailed Syllabus -

Unit-1:

- General account about the microbes used as biofertilizer; Isolation, mass production and application of Rhizobia, *Azospirillum* and *Azotobacter* as a biofertilizer; Actinorrhizal symbiosis (Organisms, hosts and general features).

Unit -2:

- General idea about Plant growth promoting rhizobacteria (PGPR) and Phosphate solubilizing bacteria (PSB); PGPR traits; Stress hormone Ethylene and PGPR.

Unit- 3:

- Cyanobacteria (blue green algae/ BGA) and *Azolla* as biofertilizer; Blue green algae and *Azolla* production; Application of BGA and *Azolla* in rice cultivation.

Unit -4:

- Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution; VAM fungi, and their influence on growth and yield of crop plants. (6 lectures)
- Organic farming – Green manuring and organic fertilizers; Organic Compost and Vermicompost - production and application.

Suggested Readings -

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.

3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

MULTIDISCIPLINARY COURSE - 2

Course Name : Herbal Home Remedies

Course Code : MDC217

Course Type: MD (Theory)	Course Details: MDC-2		L-T-P: 2-1-0		
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			15		35

Course outcome:

1. Develop conceptual skill about traditional Indian medicinal system, herbal medicines, their processing, storage and marketing.
2. Gain knowledge about developing commercial enterprise of herbal medicines.
3. Learn the basic tools and techniques for phytochemical analysis and propagation of the medicinal plants.

Unit	Topic	No. of lectures/ hrs (45)
1	Herbal medicines: History and scope - Definition of medical terms – History and Prospect of Ayurveda and Siddha systems of medicine.	5
2	Herbal remedies for common ailments – Blood sugar (Diabetes), Blood Pressure, Piles, Common cough and cold sore, Viral or other chronic fever, irritable bowel syndromes, skin diseases, psoriasis etc.; Memory boosters; Nerve Stimulants.	10
3	Herbal preparation Methods – Infusion (svarasa), decoction (kwatha), Arishta (fermented herbal decoction), tincture (Solvent based infusion or decoction), poultices (Upanaha), salves (Lepa) etc. Techniques of harvesting and drying herbs. Quality control and storage. Dose and ill effect of overdose.	10
4	Plants with healing properties – (parts, their uses in medicine and methods of uses) Trees – <i>Saraca asoka</i> (Ashoka), <i>Terminalia arjuna</i> (Arjuna), <i>Terminalia</i>	20

chebula (Hartaki), *Terminalia bellerica* (Bahera), *Emblica officinale* (Amla), *Alstonia scholaris* (Chhatim), *Moringa oleifera* (drumstick/sajina plant), *Azadirachta indica* (Neem), *Morinda citrifolia* (Noni), *Carica papaya* (Papaya)

Shrubs – *Holarhena antidysenterica* (Kurchi), *Costus speciosus*, *Justicia adhatoda* (Basak), *Calotropis procera* (Arka/Akanda), *Datura metel* (Dhutra)

Herbs – *Aloe vera*, *Aloe barbadense*, *Ocimum sanctum* (Tulsi), *Catharanthus roseus* (Nayantara), *Rauwolfia serpentina* (Sarpagandha), *Withania somnifera* (Aswagandha), *Clerodendron phlomoides* (Bamanhati), *Centella asiatica* (Thankoni), *Opium poppy* (Opium/Aphim), *Andrographis paniculata* (Kalmegh), *Senna alata*, *Achyranthes aspera* (Apang), *Eclipta alba* (Kesut), *Boerrhaavia repens* (Punarnava), *Baccopa monieri* (Brahmi), *Hygrophila spinosa* (Kulekhara).

Spices – *Zingiber officinale* (Ada), *Curcuma longa* (Turmeric/Halud/Haldi), *Cinamomum zeylanicum* (Darchini), *Foeniculum vulgare* (Fennel/sounf/Mouri), *Piper nigrum* (Pepper), *Ferula foetida* (Asafoetida/Hing), *Cuminum cyminum* (Cumin), *Coriandrum sativum* (Coriander).

Climber – *Hemidesmus indicus* (Indian Sarsaparilla/Anantamul), *Cissus quadrangularis* (Harjoda), *Tinospora cordifolia* (Giloy), *Coccinia grandis* (telakuchu).

[NB. Precautionary instructions must be associated with each drug]

SEMESTER- III

MAJOR COURSE - 3

Course Name : Gymnosperms, Mycology and Plant Pathology-I

Course Code : BSCBOTMJ301

Course Type: Major (Theoretical & Practical)	Course Details: MJC-3		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

1. The concept of progymnosperms and its significance in plant evolutionary history will be determined.
2. General characteristics of gymnospermous plant group with special reference to their classification, morphology, reproduction, distribution and ecology will be described.
3. True fungi will be identified and the principles and application of plant pathology in the control of plant disease will be demonstrated.
4. The common plant diseases according to geographical locations will be identified and devices to control measures will be known.

Unit I:

Gymnosperms (Theory):

- General features of Gymnosperms and comparisons with pteridophyte and angiosperms; Comparative account of Cycadophyta, Coniferophyta, Ginkgoales and Gnetophyta. Outline Classification of gymnosperm by Stewart and Rothwell (1993) up to order.
- Progymnosperms; concept of the group emphasizing on overall description of *Archaeopteris*.
- General account of fossil members: Pteridospermales: *Lyginopteris* (*Crossotheca* male organ and *Lagenostoma* female organ); Glossopteridales: (*Vertebraria* root, *Araucarioxylon* trunk, *Glossopteris* leaf, *Glossotheca* male organ, *Denkania* female organ); Bennettitales: *Williamsonia seawardiana* reconstruction (*Bucklandia* stem, *Ptilophyllum* leaf, *Weltrichia* male organ, *Williamsonia* female organ).

Unit II:

Mycology (Theory):

- **Historical development:** Contributions of Heinrich Anton de Bary, Prof. C. V. Subramanian, Dr. K. C. Mehta and Dr. N. K. Rao.
- **Introduction** (General characteristics) – Fungal body and tissue organization (range of somatic structures);, Hyphal Modifications; Fungal cell structure; Cell-wall composition; Septum and its types; Occurrence and Mode of nutrition ; Different classes of spore and mode of sexual reproduction; Sexual degeneration.
- Broad outline Classification of Ainsworth, (1973) up to Sub-division. Concept of *forma speciales* and physiological races in fungi.
- Detailed characteristics of individual classes* and life cycle of *Saprolegnia* (Mastigomycotina), *Rhizopus* (Zygomycotina), *Saccharomyces*, *Ascobolus* (Ascomycotina), *Agaricus* (Basidiomycotina); *Alternaria* (Deutromycotina).

*With special emphasis to the formation and development of ascus and ascospores (*Pyronema* type only), types of ascocarps; Mycelial types of Basidiomycotina, Cell division and Clamp-connection, Dikaryotization (Buller phenomenon), Basidial development, their types and types of fruitbodies in Basidiomycotina; Types of conidia and spores in Deuteromycotina, Conidial fruit body types in Asco- and Deuteromycotina.

Unit III:

Plant Pathology (Theory):

- Plant Diseases: Common Definitions; Koch's postulate; Disease cycle, Plant Disease Epidemiology.
- Classification of plant diseases based on symptoms and on spread and severity; Difference between Signs and Symptoms of plant diseases.
- Causal Organism, symptoms, disease cycles and control measures of **Bacterial diseases** – Bacterial blight of rice; **Viral diseases**- Tobacco Mosaic viruses **Fungal diseases**- Late blight of potato, Black stem rust of wheat, loose smut of wheat. **Nematode causing disease**- Root knot of rice; **Mycoplasmal disease** – little leaf disease of Brinjal.
- Disease Predisposing factors and disease forecasting; Use of modelling in disease forecast.

Practical:

- Studies on the morphological and anatomical features of the following: *Cycas* (leaflet) and *Pinus* (needle).
- Studies on the vegetative and reproductive structures of *Cycas*, *Ginkgo* and *Gnetum* from permanent slides.
- *Morphological studies of the following fossil specimens and determination of their mode of preservation: *Glossopteris* (leaf), *Vertebraria* (root, specimen), *Bucklandia* (stem), *Lyginopteris* (stem in T.S.)

*[This part should be omitted from Sem-2 syllabus from Palaeobotany practical portion]

- Work out of the following with reproductive structure (Freehand drawing and drawing under drawing-prism with magnification): *Rhizopus* (asexual), *Ascobolus*, *Agaricus* (gill) and *Polyporus*.

MAJOR COURSE - 4

Course Name : Gymnosperms, Mycology and Plant Pathology-II

Course Code : BSCBOTMJ302

Course Type: Major (Theoretical & Practical)	Course Details: MJC-4		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

1. The role and economic importance of gymnosperms in human welfare will be known.
2. The evolutionary significance of gymnosperms will be understood along with their prehistoric life forms and evolution through geological ages.
3. The skills in laboratory, field and glasshouse work related to mycology and plant pathology will be gained.

4. An idea will be generated to develop an understanding of microbes and fungi and also to know their adaptive strategies.

Unit I:

Gymnosperms (Theory):

- Origin of gymnosperm (origin of secondary wood, heterospory and evolution of seed habit*, concepts of prepollen and preovule).
*Level of heterospory and seed habits in *Selaginella* and *Lepidocarpon* must be brought here in discussion.
- A comparative account of the life histories and their morpho-anatomical feature of the extant members - *Cycas*, *Pinus*, *Ginkgo* and *Gnetum*. Their distribution in India; Ecological and economic importance.

Unit II:

Mycology (Theory):

- Fungal cytogenetics: Sexual compatibility (homothallism and heterothallism); Parasexuality and haploidization, Nuclear behaviour in fungi (diplophase, haplophase and dikaryophase) and life cycle patterns; Karyochoresis; Phylogeny of fungi.
- A brief account on Myxomycota; Key to the classes of Myxomycota according to Ainsworth (1973); Outline life-cycle of Myxomycete and Plasmodiophoromycetes; Plasmodial development in *Stemonitis*.
- Fungal ecology: Mycorrhiza- Ectomycorrhiza, Endomycorrhiza and VAM fungi; Role of mycorrhizae and VAM in agriculture and forestry.
- Role of fungi in biotechnology; Application of fungi in food industry (Enlist application in Fermentation products, Baking and Brewing), Production of industrially important products from fungi viz. organic acids (citric acid), enzymes (protease) and applications of fungi in the production of pharmaceutical products. *Production of antibiotics (Penicillin) and vitamins (Vitamin B-complex and Vitamin B-12).
*This should include media required, microorganism involved, fermentation process and optimal conditions (pH, temp., substrate), scale up and down-stream processing.
- Fungal toxins (Mycotoxins) with special reference to Aflatoxin (General View).

Unit III:

Phytopathology (Theory):

- Parasitism and Disease Development: Parasitism and Pathogenicity; molecular and biochemical basis of Plant-Pathogen interactions (pre-penetration, penetration, Post-penetration; Brief idea about the roles of cell wall degrading enzymes and pathotoxins are to be included here).
- Structural (Cell wall modifications, histological changes and structural barriers) and biochemical (oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors) defense mechanism of plants; Basic concept of R genes (qualitative and quantitative resistance).
- Control of Plant diseases: Prophylactic measures; Plant quarantine; Physical, chemical and biological methods of disease control (should include chemical and biological fungicides); Concepts of LD_{50} , ID_{50} , EC_{50} and MIC; Genetic engineering for disease resistance.

Practical

- Isolation of pathogen from diseased leaf. Inoculation of fruit and sub-culturing.
- Study of the following diseases: White rust of Crucifer or Amaranth, Rust of wheat/Justicia (Puccinia: Herbarium specimens of Black Stem Rust of Wheat or infected Barberry leaves; section/tease mounts of spores of wheat or permanent slides of both the hosts), smut of wheat (or any member of Poaceae).
- Spot identification with reasoning from all specimens included in the theoretical syllabus.

- Collection, preservation and submission of Fungal specimen (both dried and wet specimens)[This should be supported by field note book and field record]
- Submission of herbarium sheet of disease affected plant parts of the surroundings.

Suggested Readings:

1. Botany for degree students. Fungi. B. R. Vashistha, A. K. Sinha. V. R. Singha (Latest edition). S. Chand.
2. College Botany Vol. –II. - Gangulee and Kar, New Central Book Agency, Kolkata.
3. Introduction to Fungi. Webster, J. Cambridge University Press.
4. Introduction to Fungi, Dubey, H. C. Vikas Publishing House.
5. Introduction to Mycology. Alexopoulos, C. J., Mims, C. W. and Blackwell Wiley. Bastern Limited, New Delhi.
6. Introductory Mycology. R. S. Mehrotra and Aneja, K. R. New Age International.
7. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
8. Plant Pathology. Agrios R. N. Academic Press.
9. Plant Pathology, Mehrotra, R. S. Tata Mc Graw Hill Publishing Company. New Delhi
10. Diseases of Crop Plants in India. Rangaswamy, G. Prentice Hall India Pvt. Ltd. New Delhi.
11. E. M. Gifford and A. S. Foster. 1988. Morphology and Evolution of Vascular Plants.
12. Stewart, W. N. & G. W. Rothwell. 1993. Palaeobotany and Evolution of Plants. Cambridge University Press.
13. Beck, C. B. 1988. Origin and evolution of gymnosperms. Columbia University Press.
14. Bhatnagar, S. P. & A. Moitra. 1996. Gymnosperms. New Age International Ltd., New-Delhi.

MINOR COURSE - 3

Course Name : Gymnosperms, Mycology and Plant Pathology

Course Code : BSCBOTMN301

Course Type: Minor (Theoretical & Practical)	Course Details: MNC-3		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

1. General characteristics of gymnospermous plant group with special reference to their classification, morphology, reproduction, distribution and ecology will be described.
2. True fungi will be identified and the principles and application of plant pathology in the control of plant disease will be demonstrated.
3. The common plant diseases according to geographical locations will be identified and devices to control measures will be known.

Unit I:

Gymnosperms (Theory):

General characteristics and Classification (Stewart and Rothwell's 1993 classification), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum*. (Developmental details not to be included). Economic importance of Gymnosperms.

Unit II:

Mycology (Theory):

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification (Ainsworth, 1973); True Fungi- General characteristics of all classes, life cycle of *Rhizopus* (Zygomycota) *Penicillium* (Ascomycota), *Puccinia* (Basidiomycota); Symbiotic Associations- Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance. Role of fungi in biotechnology; Application of fungi in food industry (Enlist application in Fermentation products viz, antibiotics, organic acids, enzymes, vitamins; Baking and Brewing).

Unit III:

Plant Pathology (Theory):

Common Definitions, Koch's Postulates, Classification of Plant disease based on symptoms, Plant defense mechanism against pathogens, role of environment in disease development. Control measures of plant diseases. Disease resistance in plants. General symptoms and control measures for the following plant diseases: bacterial blight of rice. Late blight of potato, rusts of wheat.

Practical

- Studies on the morphological and anatomical features of the following: *Cycas* (leaflet) and *Pinus* (needle).
- Studies on the vegetative and reproductive structures of *Cycas*, *Ginkgo* and *Gnetum* from permanent slides.
- Work out of the following with reproductive structure (Freehand drawing only): *Rhizopus* (asexual), *Ascobolus*, *Agaricus* (gill)
- Collection, preservation and Submission of Fungal specimen with proper documentation.
- Submission of herbarium sheet of disease affected plants of the surroundings.
- Study of plant diseases with help of infected plant specimen - loose smut of wheat, late blight of potato, rust of wheat.[All from herbarium sheets].
- Spot identification with reasoning from all specimens included in the theoretical syllabus.

Suggested Readings:

1. Botany for degree students. Fungi. B. R. Vashistha, A. K. Sinha. V. R. Singha (Latest edition). S. Chand.
2. Introduction to Fungi. Webster, J. Cambridge University Press.
3. College Botany Vol. –II. - Gangulee and Kar, New Central Book Agency, Kolkata.
4. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
5. Plant Pathology. Agrios R. N. Academic Press.

SEMESTER- IV

MAJOR COURSE - 5

Course Name : Structural Botany, Economic Botany and Pharmacognosy-I

Course Code : BSCBOTMJ401

Course Type: Major (Theoretical & Practical)	Course Details: MJC-5		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

On completion of this course, the students will be able to:

1. To know about different plants organ like root, stem and leaves and their importance.
2. Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems.
3. Increase the awareness and appreciation of plants & plant products encountered in everyday life.
4. Appreciate the diversity of plants and the plant products in human use.

Unit I:

Morphology (Theory):

- Roots, stems and leaves: Their structures with reference to modification with examples; Phyllotaxy and Fibonacci series; Stipules (types and modifications).
- Inflorescence: Types with examples, evolution (brief idea).
- Flowers: Types, calyx (modifications), corolla (forms, aestivation, modification), stamen (cohesion & adhesion, attachment of anther), carpel - apocarpous & syncarpous, evolution; Ovule – Organization of Orthotropous ovule and types of ovules.
- Placentation: types with examples, evolution (brief idea).
- Fruits and seeds: Types with examples, Dispersal mechanism.
- Defensive mechanism of plants (Homologous and analogous organs).

Unit II:

Economic Botany (Theory):

- Concept of Centres of Origin (Major Centres of origin according to Vavilov, 1951); Origin of Cultivated Plants of West Bengal; Crop domestication and loss of genetic diversity; Germplasm diversity.
- Cereals: Wheat and Rice (origin, morphology, processing & uses); cultivation of rice.
- Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes.
- Sources of sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation and uses.
- Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper.
- Beverages: Tea, Coffee (morphology, processing and uses); cultivation of tea.

Unit III:

Pharmacognosy (Theory):

- Introduction; definitions of drug, crude drug, folk medicine, active principle, Pharmacognosy; Pharmacology, Pharmacopoeia, etc.
- Classification of drugs on alphabetical, morphological, chemical and therapeutic basis; Drug Constituents (active and inert); drug adulteration (sophistication) and drug evaluation.
- A general account on cultivation, harvesting, processing and storage of herbal drugs.

Practical:

- Morphological Studies of different types of roots, stem, leaves, stipules, flowers, fruits and seeds; Modification of roots, stem, leaves and stipules; Types of – Stipules, inflorescence, fruits and seeds.
- T.S. of potato tuber to show localization of starch grains through iodine staining.
- Qualitative test of starch; Wheat or Rice
- Qualitative test for lipid in Soybean/ Groundnut/ Mustard. (test of oil droplets in crushed seeds)

MAJOR COURSE - 6

Course Name : Structural Botany, Economic Botany and Pharmacognosy-II

Course Code : BSCBOTMJ402

Course Type: Major (Theoretical & Practical)	Course Details: MJC-6		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

On completion of this course, the students will be able to:

1. Develop an understanding of concepts and fundamentals of plant anatomy.
2. Examine the internal anatomy of plant systems and organs.
3. Develop critical understanding on the evolution of concept of organization of shoot and root apex.
4. Analyze the composition of different parts of plants and their relationships.
5. Evaluate the adaptive and protective systems of plants.
6. To know about medicinal properties and uses of plants by folklore and ayurveda system.

Unit I:

Anatomy of Angiosperms (Theory):

- Introduction and scope of Plant Anatomy.
- Applications in systematics, forensics and pharmacognosy.
- Cell wall Structure, chemical composition, wall thickening with reference to pits.
- The tissue systems – dermal, ground tissue and vascular tissue (stems, roots and leaves). Types of vascular bundles, stomata and trichomes; Stellar organization and types; Root-stem transition.
- Classification of tissues: Definitions and types; Simple tissues - types, nature, distribution and functions; Complex tissues - Xylem and Phloem: Structure, ontogeny of tracheary elements and sieve elements; Sclereids; Transfer cells. Secretory structures and ergastic substances- brief idea.
- Apical meristems: Concept of organization of shoot and root apices (Different theories regarding the organizations of shoot and root apices) .
- Structure of primary bodies (dicot and monocot root, stem and leaf). General account on: Cuticle, Stomata, Hydathodes, Cavities, Laticifers, Kranz anatomy.
- Vascular Cambium and Cork Cambium: structure and function. Secondary growth in root and stem. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood; Dendrochronology. Tyloses and tyloids; Development of periderm, rhytidome and lenticels. Adaptive and Protective Systems Periderm- brief idea.
- Different principles regarding such distribution of mechanical tissues in flowering plants.
- Anomalous secondary growth in stem of *Boerhavia*, *Bignonia*, *Dracaena*, *Tinospora*.

Unit II:

Economic Botany (Theory):

- Sources of oils and fats: Fixed Oils: General description, classification, extraction, their uses and health implications; groundnut, linseed, soybean, mustard and coconut (Botanical name, family and uses).

- Essential Oils: General account (sources and chemical nature), extraction methods, comparison with fatty oils, sources and uses of some common essential oils (Eucalyptus, lemongrass, citronella, cinnamomum, chamomile, clove, and rose).
- Natural Rubber Para-rubber: tapping, processing and uses.
- Timber plants: General account with special reference to sal and teak
- Fibres: Classification based on the origin; Cotton and Jute (morphology, extraction and uses); cultivation of Jute.

Unit III:

Pharmacognosy (Theory):

- Diagnostic features, active principles and therapeutic uses of:
Rauwolfia serpentina (root), *Adhatoda vasica* (leaf), *Strychnos nux-vomica* (seed), *Cinchona succirubra* (bark), *Catharanthus roseus* (Whole plant), *Taxus* sp. (bark).
- Family, plant part used, therapeutic use and habit of following drugs: *Withania somnifera* (Ashwagandha), *Andrographis paniculata* (kalmegh), *Zingiber* (Ginger), *Curcuma* (Turmeric), *Bacopa monnieri* (Bramhi), , *Digitalis purpurea* (foxglove), *Papaver somniferum* (Afeem) and *Cannabis sativa* (Marijuana).

Practical

- Study of anatomical details through temporary slide preparation of the stem - monocot (maize), dicot (sunflower); root – monocot (Canna), dicot (Chick pea) and leaf – monocot (grass leaf any preferably rice/maize), dicot (mango).
- Microscopic study from permanent slides of: Bulliform cells, stomatal types, hairs (glandular), lenticels, raphides (acicular and sphaeraphides), cystolith, cavities and laticifers.
- Study of wall thickenings and pittings on xylem vessels, fibres and tracheids through maceration in *Pinus* and *Cucurbita* (Any other suitable dicot).
- Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres - Permanent slides.
- Secondary anomalous structure in stem with specimens included in theoretical syllabus.
- Quality control of fibres*: Cotton (whole mount of seed/ seed epidermis to show lint and fuzz;), Jute (whole mount of fibre).*[This study should include, measuring the diameter and length of the fibre, number of convolutions in cotton fibre, lumen size, presence of defect like cracks, fissure or deformities and fungal or bacterial infection if any. In case of jute, lignin content is determined by adding phloroglucinol-HCl to the fibre to see its amount and distribution under compound microscope].
- Study of wood anatomy – Density, Hardness and Grain pattern (with respect to Sal and Teak)
- Organoleptic and microscopic examination of following plant drugs to be supplied fresh and powdered form – *Adhatoda vasica* (leaf), *Strychnos* (seed), Zinger (rhizome).

Suggested Readings:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
4. 5. Pandey B.P.(2012) Plant Anatomy. S.Chand & Company Ltd., New Delhi
6. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
7. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
8. Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers.
9. Sanjeev Pandey, Advance Botany, Volume-1, 2nd Edn, Pub. Books and Allied (P) Ltd. Kolkata.

MINOR COURSE - 4

Course Name : Plant Morphology, Plant Anatomy & Plant Taxonomy

Course Code : BSCBOTMN401

Course Type: Minor (Theoretical & Practical)	Course Details: MNC-4		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

On completion of this course, the students will be able to:

1. To know about different plants organ like root, stem and leaves and their importance.
2. Develop an understanding of concepts and fundamentals of plant anatomy
3. Examine the internal anatomy of plant systems and organs
4. Interpret the rules of ICN in botanical nomenclature
5. Generalize the characters of the families according to Bentham & Hooker's system of classification
6. Evaluate the Important herbaria and botanical gardens

Unit I:

Plant Morphology (Theory):

- Roots, stems and leaves: Their structures with reference to modification with examples; stipules; phylotaxy
- Inflorescence: Types with examples (brief idea only).
- Flowers: Types, calyx (modifications), corolla (forms, aestivation, modification), stamen (cohesion & adhesion, attachment of anther), carpel - apocarpous & syncarpous.
- Placentation: types with examples.
- Ovules: types with examples.
- Fruits and seeds: Types with examples, Dispersal mechanism.

Unit II:

Plant Anatomy (Theory):

- Introduction of Plant Anatomy, Cell wall Structure.
- The tissue systems – dermal, ground tissue and vascular tissue. Types of vascular bundles.
- Classification of tissues: Simple tissues – types and functions; Complex tissues - Xylem and Phloem: Structure and functions.
- Apical meristems: Concept of organization of shoot and root apices (Tunica Corpus theory, Korper-Kappe theory). Structure of primary bodies (dicot and monocot root, stem and leaf).
- Secondary growth in root and stem. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood.
- Anomalous secondary growth in stem of *Bignonia*, *Strychnos*, *Dracaena*.

Unit III:

Plant Taxonomy (Theory):

- Introduction to systematics; Plant identification, Classification, Nomenclature.

- Field inventory; Importance of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: intended (yolked) and bracketed keys.
- Plant classification - artificial, natural and phylogenetic approach; Outline of the system of classification – Linnaeus (1753); Bentham and Hooker (1862-83) and Arthur Cronquist (1981).
- Botanical Nomenclature: Principles and rules (ICBN/ICN); Ranks and names; Typification, author citation.
- Diagnostic characters, floral formula, floral diagram and economic importance of the following plant families with examples from common Indian species.
Dicotyledons: Magnoliaceae, Brassicaceae, Solanaceae, Malvaceae, Fabaceae, Apocynaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Rubiaceae, Asteraceae.
Monocotyledons: Poaceae, Cyperaceae and Orchidaceae.

Practical

- Study of different types of stem, leaves, stipules, flowers and fruits.
- Study of primary structure: Stem: monocot (Maize), dicot (Sunflower); Root: monocot (*Canna*), dicot (Chick pea).
- Microscopic study from permanent slides of: Bulliform cells, stomatal types, lenticels, raphides (acicular and sphaeraphides), cystolith, cavities and laticifers.
- Study of the anomalous structures of stems of the following genera: *Bignonia*, *Dracaena* and *Boerhaavia*
- 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, Fabaceae, Apocynaceae, Solanaceae, Lamiaceae, Verbenaceae, Asteraceae (Take at least one genus from each family).
- Field visit (local or outside depending on situation).
- Mounting of a properly dried and pressed specimen of any 10 wild plants with Herbarium label (to be submitted during examination).

Suggested Readings:

1. College Botany Vol. I. New Central Book Agency. Calcutta.
2. College Botany Vol. III. New Central Book Agency. Calcutta.
3. Datta, S. C. 1991. Systematic Botany. Wiley Eastern Ltd. New Delhi, Calcutta.
4. Lawrence, G. H. M. 1981. Taxonomy of Vascular Plants. Mc Milian New York.
5. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi.
6. Plant Groups. (Recent Edition). H. Mukherjee. New Central Book Agency.
7. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
8. Fahn, 1982. Plant Anatomy. John Willey.
9. P. Roy. Plant Anatomy, New Central Book Agency, Kolkata

SKILL ENHANCEMENT COURSE - 3

Course Name : Horticulture, Nursery and Gardening

Course Code : BSCBOTSE401

Course Type: SE (Theory)	Course Details: SEC-3		L-T-P: 3-0-0		
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			15		35

Course Learning Outcomes:

On completion of this course the students will be able to:

1. Understand the concept of different types of horticultural practices for value addition
2. Understand the process of sowing seeds in nursery
3. List the various resources required for the development of nursery
4. Distinguish among the different forms of sowing and growing plants
5. Analyse the process of Vegetative propagation
6. Appreciate the diversity of plants and selection of gardening
7. Examine the cultivation of different vegetables in nursery and gardening

Unit I: Horticulture:

- Types, classification (annuals, perennials, climbers and trees);
- Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Bonsai Production;
- Production of ornamental, fruits and vegetables, medicinal and aromatic plants.
- Identification and salient features of some ornamental plants [rose, marigold, tuberose].
- Ornamental flowering trees (Gulmohar, Lagerstroemia and areca palms);
- Description of plants and their economic products;
- Management and marketing of vegetable (Potato and Brinjal) and fruit crops (Mango and Banana);
- Cultivation, processing and marketing of products of major medicinal plants (*Senna*, *Ashwagandha*, *Amla*, *Vetiver*, *Aloe vera*).

Unit II: Nursery and Gardening:

- Definition, objectives and scope and building up of infrastructure for nursery,
- Planning and seasonal activities - Planting - direct seeding and transplants.
- Different types of gardening: ornamental, kitchen, vertical, and rooftop gardens
- Seed storage: Seed banks, factors affecting seed viability.
- Vegetative propagation: air-layering, cutting; treatment of cutting, rooting medium and planting of cuttings.
- Hardening of plants – Principles and methods.
- Protected cultivation methods - greenhouse, mist chamber, , shade house and glasshouse;
- Landscape and home gardening – Principles and landscape designing, planning and designing of home gardens; Xeriscaping, Growing plants of aesthetic value.
- Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes and carrot;
- Post harvest management and marketing - Storage and marketing procedures, Factors affecting storage; Marketing strategies for nursery plants and other plant produce, Problems related to nursery maintenance and marketing, possible solutions.

Suggested Readings:

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

SEMESTER- V

MAJOR COURSE - 7

Course Name : Genetics, Plant Breeding, Biostatistics and Cell Biology - I
Course Code : BSCBOTMJ501

Course Type: Major (Theoretical & Practical)	Course Details: MJC-7		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

On completion of this course, the students will be able to:

- ❖ Understand Mendelian genetics, gene interactions, and sex-related traits
- ❖ Develop knowledge of genetic barriers to gene flow and mutations causing genetic disorders
- ❖ Learn about regulation of gene expression in prokaryotes and eukaryotes
- ❖ Understand extranuclear genetic material and non-Mendelian inheritance patterns
- ❖ Describe sources and types of genetic variation and their importance for plant improvement
- ❖ Learn plant breeding strategies, including conventional breeding, marker-assisted selection, and genomic selection
- ❖ Understand breeding methods for self-pollinated and cross-pollinated crops
- ❖ Apply knowledge to improve crop quality and nutritional value
- ❖ Understanding statistical principles and methods
- ❖ Applying statistical techniques to analyze biological data
- ❖ Interpreting results and drawing conclusions
- ❖ Understand cell ultrastructure and function
- ❖ Learn techniques in cell biology, including microscopy and cell culture
- ❖ Apply knowledge of cell biology to understand biological processes and phenomena

GENETICS (20 MARKS)

- **Principles of genetics and Biology of Inheritance** - Mendelism: History; Mendel's Laws of inheritance; Chromosome theory of inheritance; Incomplete dominance and codominance; Gene Interactions - Multiple alleles, Lethal genes, Epistasis, Complementary and inhibitory gene action; Pleiotropy, Penetrance and Expressivity.
- **Linkage and crossing over** – Linkage, Linkage groups, Complete and incomplete linkage, Coupling and Repulsion theory; Linkage and Crossing over, three-point test cross and linkage mapping (with sums), Recombination frequency, Coincidence and interference; Cytological basis of crossing over; Mechanism of Crossing Over (Copy-choice theory, Breakage and Reunion theories and Holliday Model).

PLANT BREEDING (10 Marks)

- **General Introduction and Methods of crop improvement** - Introduction, aims and objectives of plant breeding; Plant introduction, acclimatization and domestication. Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.
- **Quantitative inheritance, Inbreeding depression and heterosis** - Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance. History, genetic basis of inbreeding depression and heterosis; Applications. Single seed descent, Ideotype breeding (brief overview).

BIostatISTICS (10 MARKS)

- **Introduction to Biostatistics** - Definition and Scope; Importance in Biological Sciences; Types of Data – Qualitative and Quantitative; Variables and their Types (Independent, Dependent, Discrete, Continuous).
- **Descriptive Statistics** - Measures of Central Tendency (Mean, Median, Mode); Measures of Dispersion (Range, Variance, Standard Deviation, Standard Error); Data Visualization – Bar Graphs, Histograms, Pie Charts, Box Plots, Scatter Plots.

CELL BIOLOGY (10 MARKS)

- **Membrane biology** – Overview of membrane structure and function; fluid mosaic model and membrane dynamics; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.
- **Nucleus** - Structure and function - nuclear envelope, nuclear pore complex, nuclear lamina, nuclear transport; nucleolus.
- **Structural organization and Functions of cell organelles:** Chloroplast, mitochondria, peroxisomes, lysosomes and vacuoles; endomembrane system: endoplasmic reticulum – types and structure. golgi apparatus – organization, protein glycosylation.

PRACTICAL

- Study of plant cell structure with the help of epidermal peel mount of Onion/ *Rhoeo*.
- Demonstration of plasmolyses and deplasmolyses in *Rhoeo* leaf epidermal cells.
- Study of the movement of chloroplast (Cytoplasmic streaming/ Cyclosis) in the leaves of *Hydrilla*.
- Cell separation through centrifugation and microscopic visualization (May use pond water to separate protists from filamentous algae and other rotifers; observe *Amoeba*, *Paramecium*, *Euglena*, *Scenedesmus*, *Chlorella*, *Chlamydomonas* and Diatoms).
- Calculation of mean, standard deviation and standard error mean of a given data (from some field study)

[NB. Each Practical bears 4 marks for attendance; 5 marks for Laboratory Note Book; 5 marks for Viva-voce for CA/Internal Assessment of Practical]

MAJOR COURSE - 8

Course Name : Genetics, Plant Breeding, Biostatistics and Cell Biology-II

Course Code : BSCBOTMJ502

Course Type: Major (Theoretical & Practical)	Course Details: MJC-8		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

On completion of this course, the students will be able to:

- ❖ Develop knowledge of genetic barriers to gene flow and mutations causing genetic disorders
- ❖ Learn about regulation of gene expression in prokaryotes and eukaryotes
- ❖ Apply genetic principles to solve problems in biotechnology and research
- ❖ Learn plant breeding strategies, including conventional breeding, marker-assisted selection, and genomic selection
- ❖ Understand breeding methods for self-pollinated and cross-pollinated crops

- ❖ Develop skills in plant breeding techniques and methodologies
- ❖ Apply statistical techniques to interpret results and draw conclusions
- ❖ Develop skills in using statistical software and tools
- ❖ Develop knowledge of cell signaling pathways and receptors
- ❖ Apply cell biology principles to understand biological processes and phenomena

GENETICS (15 MARKS)

- **Mutation and Chromosomal aberration** – Definition of mutation, Different types of point mutations; Transition and Transversion; Frame-shift mutation; Molecular basis of Spontaneous and Induced Mutations; Induction of mutations and Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents and UV radiation); Structural aberrations - Deletion, Duplication, Inversion, Translocation, Position effect; Numerical Aberrations - Euploidy, Aneuploidy and Amphidiploidy and Consequences and implications of structural and numerical aberrations.
- **Fine Structure of Gene, Population and Evolutionary Genetic** - Evolution of Gene Concept – One gene-one character; One gene-one enzyme, one gene-one polypeptide hypotheses; Cis-trans complementation test for functional allelism; Gene as unit of function, mutation and recombination.
 Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants and animals (Plants – *Silene latifolia* and *Rumex acetosa*; Human, *Drosophila* and other animals); Sex-linked, sex-limited and sex-influenced characters.
 Dosage compensation, Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, its assumptions; Genetic variation and Speciation.

PLANT BREEDING (15 MARKS)

- **Molecular Markers and Genomics in plant breeding** - Marker assisted selection (MAS) and its advantages. DNA molecular markers: Principles, types and applications; Restriction Fragment Length Polymorphism (RFLP), Amplified Fragment Length Polymorphism (AFLP), Randomly Amplified Polymorphic DNA (RAPD), Simple Sequence Repeat (SSR), Single Nucleotide Polymorphism (SNP), Restriction Site Associated DNA (RAD) markers. Molecular markers in genetic diversity analysis and breeding for complex characters. QTL mapping, Association mapping (outline only)
- **Mutations in plant breeding and plant variety release** - Mutation breeding overview, Random mutagenesis techniques: Gamma rays and X-rays and their limitations. Targeting Induced Local Lesions in Genomes (TILLING) (overview).

BIOSTATISTICS (10 MARKS)

- **Population and Sampling** - Definition of Population and Sample; Sampling Methods – Random, Stratified, Systematic, Cluster Sampling; Determining Sample Size and its Importance.
- **Probability and Distributions** - Basic Probability Concepts; Normal, Binomial, and Poisson Distributions; Applications in Biological Data.
- **Statistical Inference** - Hypothesis Testing; Confidence Intervals; Parametric and Non-Parametric Tests; Chi-square test and goodness-of-fit.

CELL BIOLOGY (10 MARKS)

- **Cytoskeleton** – Role and structure of microtubules, microfilaments and intermediary filament; associated proteins, motor proteins and function.
- **Cell Division, Cell cycle and cell death** - Mitosis and Meiosis (Different stages and Significance); Cell cycle- different phases, regulation (cyclin and cdk) and checkpoints to control cell division and exit, cytokinesis and cell plate formation; Programmed Cell death (PCD) and its regulation.
- **Signal transduction** – Receptor concept (GPCRs and RLKs), concept of secondary messenger (cAMP and Ca-calmodulin); Typical signal transduction pathway (PKA-pathway and PIP pathway).

PRACTICAL

- Study of Mitotic cell division and chromosome complements in *Allium cepa* root tips by aceto-orcein squash technique.
- Study of Meiotic divisions in *Allium cepa* or *Rhoeo spathacea/R. discolor* by aceto-carmin staining technique. Determination of chiasma frequency in these plants.
- Pedigree analysis for dominant and recessive autosomal and sex linked traits.
- Study of mitochondrial activity in onion epidermal cells through vital staining by Janus Green B.
- Chi-square test in assessing observed genetic ratios from expected Mendelian inheritance patterns and deviations from it.

[NB. Each Practical bears 4 marks for attendance; 5 marks for Laboratory Note Book; 5 marks for Viva-voce for CA/Internal Assessment of Practical]

SUGGESTED READINGS

1. The Cell: A Molecular Approach, Geoffrey M. Cooper, Kenneth Adams, Sinauer Associates / Oxford University Press, 9th edition, 2022
2. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, Garland Science, 7th edition, 2019
3. Essential Cell Biology, Bruce Alberts, Karen Hopkin, Dennis Bray, Alexander Johnson, W. W. Norton & Company, 6th edition, 2022
4. Molecular Cell Biology, Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Macmillan Higher Education, 8th edition, 2021
5. Karp's Cell and Molecular Biology, Gerald Karp, Janet Iwasa, Wallace Marshall, Wiley, 8th edition, 2022
6. Becker's World of the Cell, Jeff Hardin, Gregory Paul Bertoni, Lewis J. Kleinsmith, Pearson Education, 9th edition, 2018
7. Genes XVIII, Benjamin Lewin, Jones & Bartlett Learning, 18th edition, 2024
8. Introduction to Genetic Analysis, Anthony J. F. Griffiths, Susan R. Wessler, Sean B. Carroll, John Doebley, W. H. Freeman and Company, 11th edition, 2023
9. Principles of Genetics, D. P. Snustad, M. J. Simmons, Wiley, 14th edition, 2024
10. Concepts of Genetics, William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Pearson Education, 12th edition, 2023
11. I-Genetics: A Molecular Approach, Peter J. Russell, Pearson Education, 4th edition, 2021
12. Molecular Biology of the Gene, James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Pearson Education, 7th edition, 2017
13. Advanced Botany Volume 2, Sanjeev Pandey, Books & Allied (P) Ltd., 1st Edition, 2022
14. A Textbook of Botany Vol III, Gopinath Hait & Kashinath Bhattacharya (with A. K. Ghosh), New Central Book Agency, 3rd Edition, 2023
15. Cell Biology, Genetics and Plant Breeding with Practical, Arun Chandra Sahu, Kalyani Publications, 1st Edition, 2018
16. Plant Cell Biology and Biotechnology, A. Verma & S. Rao, New Age International, 1st Edition, 2023
17. Molecular Microbiology and Cell Biology, R. Gupta et al., Books & Allied (P) Ltd., 1st Edition, 2025
18. Quantitative Cell Biology, M. Huang et al., Academic Press, 1st Edition, 2024
19. Epigenetics & Cell Fate Decisions, N. Srinivasan, Springer India, 1st Edition, 2024
20. Current Protocols in Cell Biology (Annual update), F. M. Ausubel et al., Wiley, 2025 edition
21. Elementary Principles of Plant Breeding, H.K. Chaudhari, Oxford & IBH Publishing Company, 5th Edition, 1984
22. Plant Breeding, L.D. Vijendra Das, New Age International Publishers, 2nd Revised Edition, 2019
23. Principles and Practices of Plant Breeding, J.R. Sharma, Tata McGraw-Hill Publishing Company Ltd., 1st Edition, 1994
24. Plant Breeding: Principles and Methods, B.D. Singh, MedTech Science Press (India), 12th Edition, 2022

25. Essentials of Plant Breeding, Phundan Singh, Kalyani Publishers, 7th Revised Edition, 2018
26. Biostatistics: A Foundation for Analysis in the Health Sciences, Wayne W. Daniel, Chad L. Cross, John Wiley & Sons, 11th Edition, 2019
27. Introduction to Biostatistics and Research Methods, P.S.S. Sundar Rao, J. Richard, PHI Learning Pvt. Ltd., 5th Edition, 2012
28. Statistical Analysis of Epidemiologic Data, Steve Selvin, Oxford University Press, 3rd Edition, 2004
29. Statistics for Biologists, R.C. Campbell, Cambridge University Press, Reprint Edition, 2002

MAJOR COURSE - 9

Course Name : Molecular Biology and Plant Biotechnology
Course Code : BSCBOTMJ503

Course Type: Major (Theoretical & Practical)	Course Details: MJC-9		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

- ❖ Understand the structure and function of biomolecules: DNA, RNA, and proteins
- ❖ Apply knowledge of gene expression and regulation: Understand how genes are turned on or off, and how this affects cellular processes
- ❖ Analyze molecular data: Interpret data from molecular biology experiments, such as DNA sequencing and gene expression analysis
- ❖ Develop skills in molecular biology techniques: Proficiency in techniques like PCR, DNA sequencing, and gene cloning
- ❖ Understand plant genetic engineering: Learn how to introduce desirable traits into plants using genetic engineering
- ❖ Apply plant tissue culture techniques: Develop skills in micropropagation, somatic embryogenesis, and protoplast culture
- ❖ Analyze plant responses to environmental stress: Understand how plants respond to stress and develop strategies for improving plant stress tolerance
- ❖ Develop skills in plant breeding: Understand methods of crop improvement, including selection, hybridization, and genetic modification

MOLECULAR BIOLOGY (30 MARKS)

- **Nucleic Acids: Carriers of Genetic Information and Structure** - Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiments). DNA Structure according to Watson and Crick (Salient features of double helix), Types of DNA (A-DNA, B-DNA and Z-DNA); Types of genetic material (in viruses). RNA - Structure, types and functions; Organelle DNA -- mitochondria and chloroplast DNA.
- **Central dogma of molecular biology** - Central dogma of molecular biology after Temin and Baltimore; DNA Replication – Different models of DNA replication (conservative, discontinuous and semiconservative models), Messelson and Stahl's experiment to prove DNA replication is semiconservative, DNA replication is bidirectional, Process of DNA replication (as in E. coli and in comparison to eukaryotes) – initiation, elongation and termination giving emphasis on enzymes and proteins involved; Including proofreading.

- **Transcription** – Definition, Properties of DNA dependent RNA polymerase, Characteristics and significance of prokaryotic and eukaryotic promoters, Transcription process in bacterial system – initiation, elongation and termination (rho-dependent and rho-independent termination (attenuation)); Post transcriptional modifications (splicing, 5'-capping and 3'-polyadenylation); Split gene concept (exons and introns, their boundaries, exon shuffling and alternate splicing).
- **Genetic code** - Evidences that Genetic code is triplet in nature, Salient features of Genetic Code, Deciphering or Cracking the genetic code, Give emphasis to Wobble hypothesis and Codon degeneracy, Codon dictionary, Universality and variations in Genetic code, codon biasness.
- **Translation** - Prokaryotic protein synthesis (Charging of tRNA, Steps involved initiation, elongation and termination of polypeptides), Comparison with Eukaryotic translation. Post translational modifications.
- **Gene Regulation** – Concept of Operons, Types of operon (inducible and repressible); Control of Lac operon, mutants of lac operons; Glucose effect (diauxic growth); trp operon with emphasis on trp operon attenuation control.
- **Transposons** – Definition and discovery (Ac-Ds element); IS elements and Tn Transposons – characteristic features; Retrotransposons (examples); Mechanism of transposition; Significance and application.

PLANT BIOTECHNOLOGY (20 MARKS)

- Recombinant DNA definition; Basic steps involved in gene cloning; Restriction-Modification System, Types; Vectors – plasmids, Phage, Cosmid, phagemid vectors; High capacity cloning vectors – YAC and BAC; Ti plasmid vectors and method of transgenesis in plants (*Agrobacterium*-mediated Transformation protocols, molecular mechanism of T-DNA transfer); Linkers and adaptors;
- Techniques of gene isolation; Construction of DNA Libraries; Molecular probes (random priming and Nick translation); General concept of blotting techniques (Southern Blot); Northern and Western blots (definition only); Methods of gene transfer; PCR and its applications; DNA seq. by Sanger's method and gross idea of NGS. Genome editing techniques – outlines with emphasis on CRISPR-Cas9; Applications of genetic engineering (in medical, agricultural and industrial fields); Bioethics in relation to GMOs.

PRACTICAL

- Isolation and purification of plasmid DNA.
- Agarose gel electrophoresis.
- Restriction digestion of plasmid DNA.
- Preparation and analysis of restriction maps using online servers.
- Strategizing sub-cloning of a gene from restriction map data using online servers.

[NB. Each Practical bears 4 marks for attendance; 5 marks for Laboratory Note Book; 5 marks for Viva-voce for CA/Internal Assessment of Practical]

SUGGESTED READINGS

1. Molecular Biology of the Cell, Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts, Peter Walter, W. W. Norton & Company, 7th Edition, 2022
2. Molecular Cell Biology, Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Macmillan Higher Education, 8th edition, 2021.
3. Molecular Biology, Robert F. Weaver, McGraw-Hill Education, 6th Edition, 2021
The Cell: A Molecular Approach, Geoffrey M. Cooper, Kenneth Adams, Oxford University Press/Sinauer Associates, 9th Edition, 2022
4. Becker's World of the Cell, Jeff Hardin, Gregory Paul Bertoni, Lewis J. Kleinsmith, Pearson (Benjamin Cummings), 9th Edition, 2025
5. Biochemistry: Concepts and Connections, Jeffrey D. Perry et al., Cengage Learning, latest around 2020s

6. Molecular Biotechnology: Principles and Applications, Bernard R. Glick, Cheryl L. Patten, ASM Press, 6th Edition, 2022
7. Quantitative Cell Biology, M. Huang et al., Academic Press, 1st Edition, 2024
8. Cell and Molecular Biology: Methods & Applications, edited by Simran Arora et al., Books & Allied, 1st Edition, 2024
9. Epigenetics and Genome Regulation in Biotechnology, N. Srinivasan, Springer India, 1st Edition, 2024
10. A Textbook of Botany: Vol III, Kashinath Bhattacharya & Gopinath Hait, New Central Book Agency, Latest Edition (eBook/Print), 2020
11. Advanced Botany Volume 2, Sanjeev Pandey, Books & Allied (P) Ltd., 1st Edition, 2022
12. Fundamentals of Molecular Biology and Plant Biotechnology, Phundan Singh, Sushma Tiwari, Mridula Billore, Daya Publishing House, 1st Edition, 2022
13. Objective Molecular Biology and Plant Biotechnology, Phundan Singh, Sushma Tiwari, Sharda Choudhary, Daya Publishing House, 1st Edition, 2021
14. Plant Biotechnology and Molecular Biology: A Laboratory Manual, M. S. Punia, Scientific Publishers (India), 1st Edition, 2019
15. Molecular Biology: Structure and Dynamics of Genomes and Proteomes, Jordanka Zlatanova, Garland Science, 2nd Edition, 2023
16. Recent Advances in Plant Molecular Biology, Nidhi Shrivastav & Sameer S. Bhagyawant, Himalaya Publishing House, 1st Edition, 2019
17. Plant Biotechnology, Volume 1: Principles, Techniques & Applications, Bishun Deo Prasad, Sangita Sahni, Prasant Kumar & M. W. Siddiqui (eds), Apple Academic Press, 1st Edition, 2018

MINOR COURSE - 5

Course Name : **Economic Botany and Pharmacognosy**
Course Code : **BSCBOTMN501**

Course Type: Minor (Theoretical & Practical)	Course Details: MNC-5		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

- ❖ Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems.
- ❖ Develop a basic knowledge of taxonomic diversity and important families of useful Plants
- ❖ Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership
- ❖ Increase the awareness and appreciation of plants & plant products encountered in everyday life.
- ❖ Appreciate the diversity of plants and the plant products in human use.
- ❖ To know about medicinal properties and uses of plants by folklore and ayurveda system.
- ❖ Ability of conserve rare and threatened plant species both in in-vivo and in-vitro conditions.

ECONOMIC BOTANY

1. Introduction to economic botany; definition and scope of economic botany.
2. Botanical name, family, morpho-anatomy of economically important part(s) used and economic importance of following crops:
 Cereals: (rice, wheat); pulse (chickpea, lentil); fruit crops (mango, banana); vegetable crops (potato, tomato); Spices (pepper, cardamom); Oil yielding crops (Mustard, Coconut); Condiments (onion, garlic);

Fiber crops (cotton, jute); timber yielding plants (teak, sal); Sugar yielding plants (Sugarcane, Beet) and Beverage (Tea, coffee).

PHARMACOGNOSY

1. Introduction to Pharmacognosy; definition of drugs, folk medicine, active principles; Pharmacology, Pharmacognosy, Pharmacopoeia, drug adulteration (sophistication) and drug evaluation.

2. Study of the following drug yielding plants:

Diagnostic features, active principles and uses of: *Rauwolfia serpentina* (root), *Adhatoda vasica* (leaf), *Strychnos nuxvomica* (seed), *Catharanthus roseus* (Whole plant), *Taxus* sp. (bark).

PRACTICAL

1. T.S. of potato tuber to show localization of starch grains
2. Qualitative test for starch using either rice/potato
3. Identification of jute fibre through maceration technique
4. Qualitative test for lipid in crushed seeds of mustard
5. Whole mount of cotton seed to show lint and fuzz fibres
6. Organoleptic and microscopic examination of following plant drugs to be supplied fresh and powdered form – *Adhatoda vasica* (leaf), *Strychnos* (seed), Zinger (rhizome).

[NB. Each Practical bears 3 marks (Sl. 1 to 5) & 5 marks (Sl 6) for attendance, i.e. attendance should bear 20 marks; 5 marks for Laboratory Note Book; 5 marks for Viva-voce for CA/Internal Assessment of Practical]

SUGGESTED READINGS

1. Agarwal, V. S. & Ghosh, B. 1985. Drug Plants of India: root drugs. Kalyani Publishers.
2. C. K. Kokate; A. P. Purohit; S. B. Pokhale. Pharmacognosy, NiraliPrakashani.
3. Eames, A. J. and Mc Daniels, L. H. An Introduction of Plant Anatomy. Tata Mc. Graw Hill Company Limited.
4. Kochhar S. L. Economic Botany in the Tropics, Sec edition, MacMillan India Ltd.
5. Prasad R. L. Essentials of Eco Botany. Medtec publication.
6. Sanjeev Pandey, Advance Botany, Volume-1, 2nd Edn, Pub. Books and Allied (P) Ltd. Kolkata.
7. Singh Pandey and Jain. Economic Botany. Rastogi Publication.
8. Tayler, V. E. 1988. Pharmacognosy.

SEMESTER- VI

MAJOR COURSE - 10

Course Name : Plant Physiology and Biochemistry, Plant Ecology and Phytogeography- I
Course Code : BSCBOTMJ601

Course Type: Major (Theoretical & Practical)	Course Details: MJC-10		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

- ❖ Students will develop analytical skills to assess plant–water relationships, transpiration dynamics, and nutrient uptake—critical for water-efficient agriculture and smart irrigation practices.
- ❖ Learners will acquire practical knowledge of hydroponic systems and nutrient management, enabling self-employment in urban farming and commercial soilless cultivation.

- ❖ Basic understanding of phytoremediation will empower learners to contribute to environmental cleanup and sustainable land-use planning using plant-based technologies.
- ❖ Students will gain competency in interpreting biochemical data such as pH, buffer systems, absorbance, and energy relationships, which are foundational for lab-based work in agriculture, biotech, and pharma industries.
- ❖ Learners will be equipped to evaluate photosynthetic efficiency in plants, contributing to research in crop productivity, climate adaptation, and carbon sequestration strategies.
- ❖ Training in population modelling, ecological interactions, and ecosystem functioning will enable students to participate in biodiversity monitoring, ecological restoration, and conservation projects.
- ❖ Exposure to species distribution and phytogeographic principles will help students engage in biodiversity mapping, ecotourism planning, and conservation biology initiatives.
- ❖ Students will develop foundational skills in data interpretation and scientific modelling (e.g., Pressure–Flow, growth curves), enhancing their ability to communicate scientific findings effectively in academic and applied settings.
- ❖ Theoretical knowledge of plant physiology, ecology, and biochemistry will enhance holistic understanding of plant behavior and adaptation, supporting further advancement in farming innovations, ecological conservation, and biotechnological applications.

PLANT PHYSIOLOGY (18 MARKS)

Water Relations

- Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–theories on Ascent of sap. Transpiration and factors affecting transpiration, antitranspirants; mechanism of stomatal movement – K^+ - H^+ antiport theory, role of CO_2 , sucrose and ABA and blue light on stomatal movement.
- Essential and beneficial elements; Macro and micronutrients; Hydroponics; Criteria for essentiality of elements; Mineral deficiency symptoms and roles of essential elements; Heavy metal toxicity on plants; Phytoremediation (basic concept).
- Soil as a nutrient reservoir, transport of ions across cell membrane, passive and active absorption of ions, carrier mediated transport, uniport, co-transport, symport, antiport; Nernst equation.
- Translocation of photosynthate; Source–sink relationship; Phloem loading and unloading, Munch’s Pressure–Flow Model.

Photosynthesis and Photorespiration

- Photosynthesis: Photosynthetic apparatus - organization and pigments, basic concept about mechanism of light dependent reactions, Photosynthetic electron transport, Calvin cycle; Carbon assimilation reactions in C_3 , C_4 and CAM plants
- Photorespiration - definition, sites, mechanism and significance.

BIOCHEMISTRY (12 MARKS)

- **General biochemistry:** Types and significance of chemical bonds (give emphasis to weak interactions); Structure and properties of water; significance of pH and buffers, ionic product of water, Handerson-Hasselbalch equation, biological role of water.
- **Bioenergetics** - Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule.
- **Biomolecules** - Carbohydrates: Nomenclature, classification and stereochemistry; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides; Lipids: Definition and major classes of storage and structural lipids; fatty acids structure and functions, essential fatty acids, triacylglycerols: structure, functions and properties, phosphoglycerides; Proteins structures, properties, and classification of amino acids, isoelectric point, conformation of protein - primary, secondary, tertiary and quaternary structure, peptide bond, Ramachandran plot,

Protein denaturation and biological roles of proteins. Nucleic acids: Chemistry of DNA and RNA. Absorbance and Beer-Lambert's law.

PLANT ECOLOGY (12 MARKS)

- Basic Principles of ecology and ecological factors - Ecology: Definition, Basic concepts; Levels of organization, Concept of Autecology and Synecology. Abiotic and biotic Components and their inter-relationships and dynamism, homeostasis.
- Population ecology. Population ecology: Characteristics and population growth, population regulation, growth curves, life history strategies; r and k selection. Ecological Speciation.
- Ecological adaptations – Xerophyte, Halophyte, Hydrophyte, Epiphytes
- Ecosystem: Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids.
- Functional Aspects of Ecosystem and Phytogeography Principles and models of energy flow; Biomass production and productivity; Ecological efficiencies; Biogeochemical cycles of carbon, nitrogen and phosphorus.

PHYTOGEOGRAPHY (8 MARKS)

- Endemism -Definition, theories and types (with example); Factors governing endemism; Endemism in Peninsular India

PRACTICAL

Plant Physiology

- Determination of osmotic potential of plant cell sap by plasmolytic method (using *Rhoeo* epidermal peel).
- Determination of amount of water absorption, retention and transpiration by an excised petiolate *Colocasia/Alocasia* leaf.
- Study of the effect of humidity and light on the rate of transpiration in excised twig/leaf.
- Study the effect of KNO₃ on stomatal opening.
- Determination of the effect of CO₂ concentration on the rate of photosynthesis using molar solution of bicarbonate and by measurement of volume of O₂ liberation.
- Colorimetric/spectrophotometric estimation of sugar by DNS method.
- Determination of soil pH, Conductivity and Texture.
- Comparison of bulk density and porosity of soils of three different habitats.
- Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
- Study of Ecological adaptations with respect to anatomy of: *Ipomoea aquatica* stem, Phyllode of *Acacia auriculiformis*, *Nerium* leaf and *Vanda* root.

[NB. Practical attendance should have 20 Marks (2 marks for each practical), 5 Marks for Laboratory Note Book and 5 Marks for Viva-voce during CA/Internal Assessment]

MAJOR COURSE - 11

Course Name : Plant Physiology and Biochemistry, Plant Ecology and Phytogeography-II
Course Code : BSCBOTMJ602

Course Type: Major (Theoretical & Practical)	Course Details: MJC-11		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

- ❖ Assess dormancy and germination in plants
- ❖ Assess dormancy and germination in plants
- ❖ Students acquire the adequate knowledge of metabolism in plants.
- ❖ To acquire adequate knowledge about translocation in plants, carbon dioxide concentrating mechanisms, growth regulators and flowering of plants.
- ❖ To know the plants response to various stress condition
- ❖ To gather the detail in-depth knowledge on plant tissue culture
- ❖ To study the community ecology and plant environment interaction, ecological succession, biodiversity conservation and environmental pollution.
- ❖ Students acquire the adequate knowledge on biomes and phytogeographical regions of India

PLANT PHYSIOLOGY

- **Phytohormones and Photoperiodism** - Definition and types, bioassay (auxin only), Chemical nature and physiological roles of: Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. General account of cell signaling and secondary messenger (cAMP and Calmodulin); Photoperiodism, flowering stimulus, physicochemical nature of phytochrome, role of phytochromes in flowering, florigen concept, vernalization.
- **Seed Physiology** - Seed germination - different phases of seed germination, seed dormancy (types, significance and breaking of seed dormancy).
- **Tropism and Plant Movements** – Types of plant movements (tropic, nastic, tactic); Mechanisms and physiological basis of phototropism, gravitropism, thigmotropism, hydrotropism, and chemotropism; Nastic movements (nyctinasty, thigmonasty) and role of hormones, turgor pressure, and pulvinus.
- **Stress Physiology** – Plant responses to abiotic (drought, salinity, temperature, oxidative) and biotic (pathogen, herbivory) stresses; Mechanisms of stress tolerance and adaptation; Stress perception and signal transduction pathways; Role of phytohormones (ABA, SA, JA, ET); Osmolytes (proline, glycine betaine), Reactive Oxygen Species (ROS) and detox systems (SOD, CAT, APX); Stress-responsive genes and proteins (DREB, LEA, HSPs, and PR proteins).
- **In vitro Morphogenesis** - Historical perspective; Formulation of nutrient media (MS-Medium); Sterilization, role of vitamins and hormones; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Organ culture, Embryo culture; Anther and triploid culture, Callus culture, Protoplast isolation, culture and fusion; Tissue culture; applications including micropropagation, androgenesis, production of virus free plants, secondary; metabolite production, haploids, triploids and hybrids and germplasm conservation, Cryopreservation; Plant Tissue culture repositories.

BIOCHEMISTRY

Plant Metabolism

- Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, Lineweaver–Burk equation, enzyme inhibition and factors affecting enzyme activity.
- Carbon Metabolism – Respiration, Respiratory quotient (RQ), Glycolysis, Fermentation, oxidative decarboxylation, Krebs cycle, electron transport system, oxidative phosphorylation and chemiosmotic hypothesis, Glyoxylate cycle, Gluconeogenesis.
- Nitrogen metabolism - nitrate assimilation, nitrogen fixing organisms (free living, symbiotic and associative diazotrophs), Mechanism of nitrogen fixation – both asymbiotic and symbiotic. Mechanism of nodule formation and concept of *nod* and *nif* genes. GS-GOGAT pathway for ammonia assimilation. Definition and examples of transamination, deamination and decarboxylation reactions of amino acids.
- Lipid Metabolism – β -oxidation of even carbon fatty acids (Palmitic acid).

PLANT ECOLOGY

- Plant Communities and Ecosystem Community characteristics: analytical and synthetic characters; diversity indices – definition and examples of dominance index and important statistical index; Concept of ecological amplitude; Habitat and niche; Ecotone and edge effect;
- Ecological Succession: processes, Primary vs Secondary succession; Sere, Seral stages of succession; types (Hydrosere, Xerosere); climax community concept – Poly climax and Mono climax theory. Successional Model – Facilitation, inhibition, tolerance
- Biodiversity and conservation (hot spots, mega-diversity zones, IUCN status and IUCN threatened species), conservation (in-situ-, ex-situ conservation and cryopreservation). National forest, sanctuary and Biosphere reserves of India
- Pollution: Definition causes and remedies with respect to air, water and noise pollution.

PHYTOGEOGRAPHY

- Terrestrial Biomes, Principles; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phyto-geographical division of India (After Independence); Vegetation characteristic of Eastern Himalayas and Sunderban.

PRACTICAL

- Determination of the rate of respiration in different parts of a plant. (2 Marks)
- Determination of RQ of germinating carbohydrate, protein and oil rich seeds to understand the relation of RQ with the respiratory substrate. (2 Marks)
- Determination of α -amylase activity of germinating seeds. (4 Marks)
- Preparation of liquid and solid MS medium; inoculation of sterilized seeds in the prepared media. Micropropagation through shoot-tip culture. (4 Marks)
- Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed). (3 Marks)
- Analyses of diversity indices (Simpson index and/ Shannon diversity index) and evenness of herbaceous or tree vegetation of nearby grassland/forest area by using the relative density, relative frequency, relative dominance and Important Value Index of those areas; Representation of IVI through Polygraphs. (5 Marks)

[NB. Practical attendance should have 20 Marks, 5 Marks for Laboratory Note Book and 5 Marks for Viva-voce during CA/Internal Assessment]

SUGGESTED READINGS

1. Conn, E. E. Stumpt, P. K. Bruening, G. and Doi, R. H Cutline of Biochemistry, John Wiley & Sons
2. Ghosh and Mukherjee. Plant Physiology. NCBA
3. Hopkins, W. G. – An Introduction to Plant Physiology, John Wiley & Sons Inc.
4. Lehninger, A. L.; Nelson, D. L. and Cox, M. M. – Principles of Biochemistry. Worth Publishers.
5. Morh, H. Schopfer, P. – Plant Physiology Springer Verlag.
6. Sanjeev Pandey, Advance Botany, Volume-1, 2nd Edn, Pub. Books and Allied (P) Ltd. Kolkata.
7. Salisbury, F. B. and Ross, C. W. – Plant Physiology. Wordsworth Publishing Company.
8. Srivastava, H. S. 1999.plant Physiology, Rastogi Publicaation, Meerut.
9. Stryer, L. – Biochemistry, John Wiley & Sons 4. Sarkar &Rakshit – Organic Chemistry.
10. Taiz, L. and Zeiger, E. – Plant Physiology. The Benjamin Cumming Publishing Company.
11. V. K. Jain. Fundamentals of Plant Physiology, S Chand Publication
12. Dash, M. C. Fundamentals of Ecology. Tata Mc. Graw Hil Publishing Company Ltd.
13. Kormondy, B. J. 1983. Concept of Ecology (Recent edition) Prentice Hall India Ltd. New Delhi.
14. Odum, E. P. fundamentals of Ecology (recent edition) W. B. Sanders & Co. Philadelphia.
15. Sharma, P. D. Geology and Environment (10th edition). Rastogi Publications. Meerut.
16. Plant Ecology. R. Mishra. Oxford & IBH.

MAJOR COURSE - 12

Course Name : Plant Systematics and Reproductive Biology

Course Code : BSCBOTMJ603

Course Type: Major (Theoretical & Practical)	Course Details: MJC-12		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

On completion of this course, the students will be able to:

- ❖ Classify Plant systematics and recognize the importance of herbarium and Virtual Herbarium
- ❖ Evaluate the Important herbaria and botanical gardens
- ❖ Interpret the rules of ICN in botanical nomenclature
- ❖ Assess terms and concepts related to Phylogenetic Systematics
- ❖ Generalize the characters of the families according to Bentham & Hooker's system of classification
- ❖ Recall the history of reproductive biology of angiosperms & recognize the importance of genetic and molecular aspects of flower development
- ❖ Understand structure and functions of anther wall and pollen wall
- ❖ Evaluate the special structures of Ovule
- ❖ Solve Self-incompatibility in Pollination and fertilization & relate between Embryo, Endosperm and Seed

PLANT SYSTEMATICS

- **Introduction to systematics;** Plant identification, Classification, Nomenclature. Evidences from palynology (sculptures and NPC), embryology, cytology, phytochemistry and molecular data. Field inventory; Importance of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: intended (yolked) and bracketed keys.
- **Plant classification** - Artificial, natural and phylogenetic approach, concept of molecular chronometers, Basic concept of Numerical taxonomy (Definition of Operational Taxonomic Units (OTU), Phenon, Phenogram); Phenetics vs. Cladistics; Rankless system of phylogenetic systematic
- **Taxonomic Hierarchy:** Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concepts (biological, morphological, evolutionary). Modes of speciation. Problems with species concepts.
- Principles and rules (ICBN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.
- Outline of the system of classification – Linnaeus (1753), Bentham and Hooker (1862-83), Takhtajan (1997); Principles of Angiosperm Phylogeny Group (APG IV) classification.
- Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades, synapomorphy, symplesiomorphy, apomorphy, lineage sorting, serial homology etc).
- Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).
- **Salient features of the following families with examples from common Indian species and economic importance. [Evolutionary trends need to be briefly discussed in case of families marked with asterisks].**
- **Dicotyledons:** Magnoliaceae*, Ranunculaceae, Malvaceae, Brassicaceae, Fabaceae, Apiaceae,

Cucurbitaceae, Euphorbiaceae, Apocynaceae (as per APGIV), Solanaceae, Scrophulariaceae, Lamiaceae, Verbinaceae, Acanthaceae, Rubiaceae, Asteraceae (Compositae)*.

- **Monocotyledons:** Alismataceae*, Liliaceae, Poaceae, Orchidaceae*.
- **Eudicots** – Defining features and phylogenetic significance; Comparison with monocots and basal angiosperms; Major clades within Eudicots (core eudicots, rosids, asterids); Examples of representative families and their evolutionary traits.

REPRODUCTIVE BIOLOGY

- Introduction to Reproductive Biology - Definition and scope of reproductive biology; Importance of reproductive biology in understanding plant life cycles; Overview of plant reproductive strategies.
- Structure and development of anther and ovule; Microsporogenesis and megasporogenesis; Microgametogenesis and megagametogenesis (Polygonum type); Types of embryo sacs.
- Pollen morphology (Palynology) - Spore/pollen morphology with reference to polarity, size, shape, symmetry, aperture and sculpture; Importance of Palynology; Melissopalynology.
- Pollination – Types, adaptations, and contrivances of self- and cross-pollination; External pollinating agencies (anemophily, entomophily, etc.).
- Fertilization – Pollen germination, Double fertilization and triple fusion; Endosperm development types.
- Pollen-pistil interaction; Self-incompatibility (GSI and SSI), Concept of S-allele and S-RNase inhibition Model.
- Embryo development in dicots (Crucifer type) and monocots (e.g., Triticum type); Polyembryony.
- Apomixis – Types and significance; Seed development and dispersal mechanisms.

PRACTICAL

- 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, Brassicaceae, Leguminosae, Euphorbiaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbinaceae, Acanthaceae, Rubiaceae, Asteraceae (Compositae)*, Liliaceae, Poaceae, Orchidaceae (**Take at least one genus from each family**)
- Field visit (1 Local field visits/1 Visit to BSI) [**NB. 5 Marks for each Field visit in CA**]
- Mounting of properly dried and pressed specimen of at least 50 wild plants on herbarium sheets with proper Labels and Tags (This should support with Field note book and Field Report). [**NB. 5 Marks for submission in CA**]
- Microscopic examination of Pollen germination in *Catharanthus roseus*.
- Study of exine sculptures by temporary slide preparation in *Hibiscus* and *Impatiens balsamea*.
- Construction of plant phylogenetic tree using any one locus (eg., rbcL, ITS, trnL etc) with various phylogenetic methods (Neighbour Joining, Maximum Likelihood etc).

[NB. Candidate doing all practical will get 5 marks in Internal; Rest 10 Marks of Internal will include Laboratory Note Book preparation (date-wise) and 5 marks for Viva-voce during CA/Internal Assessment)

SUGGESTED READINGS

1. College Botany Vol. III. New Central Book Agency. Calcutta.
2. Datta, S. C. 1991. Systematic Botany. Wiley Eastern Ltd. New Delhi, Calcutta.
3. Good, R. Plant Geography. Oxford & IBH.
4. Judd, Campbell, Kellogg, Stevens. 2003. Phylogeny & Evolution of Vascular Plants. Sinauer Associates Inc. Publishers Sunderland. Massachusetts. USA.
5. Lawrence, G. H. M. 1981. Taxonomy of Vascular Plants. Mc Milian New York.

6. Mitra, J. N. 1974. An Introduction to Systematic Botany and Ecology. The Wall Press.
7. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi
8. Plant Groups. (Recent Edition). H. Mukherjee. New Central Book Agency.
9. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
10. Plant Systematics. Simpson. 2006. Elsevier.
11. S. K. Mukherjee. 1984.
11. Sachdeva, S. K. 1990. Angiosperms, Morphology, Anatomy, Taxonomy, Evolution. Kalyani Publishers, New Delhi.
12. Sporne, K. R. 1974. The Morphology of Angiosperms: The structure and evolution of flowering plants. Hutchinson University Library. London.
13. Stuessy T. F. Plant Taxonomy, The systematic evaluation of Comparative data. Columbia IUniv. Press. Second Edition.
14. Takhtajan, A. 2009. Flowering Plants, Springer.
15. Takhtajan, A. 1986. Diversity & Plant Distribution. Oliver & Boyd.

MAJOR COURSE - 13

Course Name : Horticulture and Post Harvesting Technology

Course Code : BSCBOTMJ604

Course Type: Major (Theoretical & Practical)	Course Details: MJC-13		L-T-P: 3 – 0 – 4		
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

At the end of the course the students will be able to

- ❖ Students will gain in-depth knowledge of horticultural practices, including plant propagation, nursery management, and crop production.
- ❖ Students will learn about handling, storing, and processing horticultural produce to reduce losses and improve quality.
- ❖ Students will be introduced to traditional Indian practices and techniques in horticulture and post-harvest management, such as Ayurvedic and Unani systems of medicine.
- ❖ Students will develop hands-on skills in horticultural practices, post-harvest handling, and processing.
- ❖ Students will learn to analyze and evaluate the quality of horticultural produce and processed products.
- ❖ Students will be able to identify and solve problems related to horticulture and post-harvest management.

HORTICULTURE

- Horticultural Crops (Conservation and Management) - Scope and importance, Branches of horticulture; Role in rural economy. and employment generation; Importance in food and nutritional security; urban horticulture and ecotourism.
- Horticultural Practices - Types, classification (annuals, perennials, climbers and trees); Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Bonsai Production.
- Ornamental plants, fruits and vegetables, Medicinal and Aromatic plants - Identification and salient features of some ornamental plants [rose, marigold, tuberose], Ornamental flowering trees (Gulmohar, Lagerstroemia and areca palms); Description of plants and their economic

products; Management and marketing of vegetable (Potato and Brinjal) and fruit crops (Mango and Banana); Cultivation, processing and marketing of products of major medicinal plants (*Senna*, *Ashwagandha*, *Amla*, *Vetiver*, *Aloe vera*).

POST HARVESTING TECHNOLOGY

- Post-harvest Technology - Importance and overview of post -harvest handling; Principles and methods of preservation and processing : Methods of minimizing losses during storage and transportation; Harvesting and handling of fruits, cut flowers, vegetables, herbs, storage tissues and organs; Food processing: canning, fruit juice beverages, pickles, jam, jellies, candies, Food additives, labeling; Food irradiation and food safety; Post-harvest diseases and losses by insects: Types of diseases, Source of infection, Factors affecting disease development, Prevention techniques for post -harvest losses, Storage techniques, Biorational approaches; Value addition.

PRACTICAL

1. Methods of Vegetative propagation – Cuttings, grafting, gooting and layering.
2. Disease Management – Integrated Pest Management practices (A field study).
3. Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at IARI or other suitable locations. (*At least 1, compulsory, 10 Marks, It should include a report submission by students*)
4. Cold storage techniques for fruits and vegetables.
5. Visit to some nearby cold-storage facility (Optional).

[NB. Candidate doing all practical will get 10 marks in Internal for attendance; 5 Marks of Internal will include Laboratory Note Book preparation (date-wise) and 5 marks for Viva-voce during CA/Internal Assessment]

SUGGESTED READINGS

1. Mondal S, Nag S, and Das A. “Horticultural Practices and Post Harvest Technology, Books and Allied (P) Ltd.
2. Chakraverty, A., Majumdar, A.S., Raghavan, G.S.V. and Ramaswamy, H.S. (2003). Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea and Spices. Marcel Dekker Inc, NY.
3. Wills, R and Golding, J. (2016). Postharvest :an introduction to the physiology and handling of fruits and vegetables. UNSW Press.
4. Wills, R.B.H., Glasson, W.B. and Mc. Graham, D. (2007). Postharvest: an introduction to the physiology and handling of fruits, vegetables and Ornamentals., CABI, pp 227
5. Ramaswamy, H. (2015). Post-harvest Technologies of Fruits and Vegetables. DEStech Publications, Inc.. Pp 311
6. Mathur, G.K., Rathore, N.S. and Chasta, S.S (2012). Post-Harvest Management and Processing of Fruits and Vegetables. The Energy and Resource Institute. pp 250

Course Name : Summer Internship
Course Code : SI601

Course Type: Summer Internship	Course Details: SIMC-1		L-T-P: 0-0-4		
Credit: 2	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	--	20	--

Introduction:

A key aspect of the new UG programme is induction into actual work situations. All students will also undergo internships / Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions during the summer term.

Students will be provided with opportunities for internships with **home institutions/College, University ,local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations** so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability.

OBJECTIVE :

The internship programs for Employability are to be conceptualized and interactive for building research capabilities/aptitude/skills for

1. Development of project and its execution
2. Decision-making
3. Confidence development
4. Working/coordinating in a team
5. Creative and critical thinking and problem-solving
6. Ethical values
7. Professional development
8. Understanding government/local bodies world of work
9. Reference of resource persons in the field
10. Development of online/ simulation-based module for a virtual research internship
11. Understanding the nuances of building a deep-technology start-up
12. Entrepreneurship
13. Study of the enterprises, farmers, artisans, etc.

Duration of Internship:

60 working Hours for 2 Credits

The course may be conducted during the semester or within one month after completion of 6th Theory ESE (End Semester Examinations) including Evaluation.

Internship Domains:

Related to the major discipline or interdisciplinary with the **at least 5 Activities to be listed (To be prepared by the discipline)**

1. Analytical Techniques – Electrophoresis (Agarose and SDS_PAGE), PCR, plant tissue-culture techniques (micropropagation through shoot-tip culture).
2. Horticulture, Farming, Nursery and Gardening: Practical experience in plant propagation, nursery management, and crop production; Organic farming; Seed physiology; physiology of fruiting; weed management; Floriculture etc.
3. Forest management and Conservation: Field studies on plant ecology, conservation, and biodiversity; Plant identification and authentication; EIA (Environmental Impact Assessment);

- Biodiversity indexing and GIS-based vegetation mapping; Techniques in Green Auditing for institutions and urban ecosystems
4. Pharmacological practices - Phytochemical extraction (Soxhlet apparatus) and testing; Drug evaluation.
 5. Crop-protection - Identification and diagnosis of plant disease (morphology based, microscopic and/or molecular); Designing and applying biocontrol strategies for disease management.
 6. Soil biology (Study of soil pH, conductivity, CEC, Texture, bulk density, porosity, P N K Content, Total Organic Carbon etc); improving soil quality by composting.
 7. Computational Biology (Bioinformatics) - Hands-on training in plant bioinformatics tools and databases with a focus on sequence analysis, phylogenetics, and identification of genes/markers linked to pathogen susceptibility.
 8. Statistical Interpretation of numerical data in Excel; Application of tools like Origin, R/Python or both in statistical analyses.

Internship opportunities/ Organisation:

Students will undergo internship at **home institutions/ College , University , local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations**

Internship may be as field-work training/training in the laboratory under the supervision of Supervisor from the parent institution (own college) and Mentor from host Institution.

For Examination/ Evaluation

- A report within 3000 to 5000 words to be prepared by the intern under the supervision of **Supervisor from the parent institution** (own college) and **Mentor from host Institution**
- Internship Completion Certificate by the Mentors/ Mentor. and Supervisor /Supervisor
- **Self-assessment and feedback form to be submitted by the Intern.**
- CA :30 Marks will be assessed by the **Supervisor from the parent institution as Continuous assessment in consultation with the Mentor, depending upon performance and attendance of the intern, and report**
- ESE: 20 Marks will be assessed by the External and Internal faculty through seminar presentation and/or viva-voce at the parent institution,
- All Evaluation process along with mark capture for the Course :**Summer Internship (SI601) must be completed by June every year.**

Nodal Officer

Internship Programme will be fully organised, executed and monitored by the R&D cell of Institution through a Nodal Officer, Nodal Officer to be appointed by the Vice Chancellor/ Director/ Principal/ Head of the Institution.

If possible, make a registration system for internship program each year in the website of the parent Institutions so that next year onwards students may get help.