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:

- ✓ 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.
- ✓ 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.

UNIT I: PLANT GROUPS (BASIC CONCEPTS) **(15 lectures)**

- 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 **(10 lectures)**

- Historical development in the field of microbiology - (contributions of Antoni van Leuwenhoek, 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 **(17 lectures)**

- 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, T_2 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 anb as causal organisms of plant diseases.
- General characteristics and diseases due to Prions and Viroids.

UNIT IV: BASIC IMMUNOLOGY (ONLY OUTLINE) **(3 lectures)**

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.

PRACTICALS

- 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)

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

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, Vol-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.
- ✓ The students will develop conceptual skill about identifying plants and microbes.

UNIT I: PLANT GROUPS (BASIC CONCEPTS) **(15 lectures)**

- ➢ 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 **(10 lectures)**

- Historical development in the field of microbiology - (contributions of Antoni van Leuwenhoek, 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 **(17 lectures)**

- 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).
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- Structure of TMV, T_2 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 anb as causal organisms of plant diseases.
- General characteristics and diseases due to Prions and Viroids.

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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.

PRACTICALS

- 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)

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

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. Advanced Botany Vol-1 and Vol-2, By Sanjeev Pandey, Books and Allied (P) Ltd.

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
- ✓ Device new methods and strategies to contribute to mushroom production.

UNIT 1: **(10 lectures)**

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: **(15 lectures)**

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

UNIT 3: **(12 lectures)**

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

UNIT 4: **(8 lectures)**

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.

Bibliography

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 **(30 lectures)**

- 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:

- ✓ Combination of theoretical and practical components of this paper will provide comprehensive information and insight into the fascinating world of cryptogams and plant fossils.
- ✓ The students will learn the major patterns of diversity among cryptogams along with their characters.
- ✓ 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.

UNIT I: ALGAE **(15 lectures)**

- 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 cultivationand production of algal food.

UNIT II: BRYOLOGY **(10 lectures)**

- 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 **(12 lectures)**

- 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 **(8 lectures)**

- 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.

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

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. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
4. Cryptoganic Botany Vol-1 By G. M. Smith
5. Algae By O.P. Sharma.
6. E. M. Gifford and A. S. Foster. 1988. Morphology and Evolution of Vascular Plants.
7. N. S. Parihar: An Introduction to Embryophyta Vol-I and II. Central Book. Allahabad.
8. K. R. Sporne : The Morphology of Pteridophytes. B. S. Publications. Calcutta
9. P. C. Vasistha. 1980 Botany for degree student Pteridophyta. S. Chand & Company Pvt. Ltd. Rashid. 1976. An Introduction to Pteridophyta. Vikas Publishing . New Delhi.
10. 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:

- The students will learn the major patterns of diversity among cryptogams along with their characters.
- 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.

UNIT I: ALGAE **(15 lectures)**

- 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 cultivationand production of algal food.

UNIT II: BRYOLOGY **(10 lectures)**

- 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 **(12 lectures)**

- 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 **(8 lectures)**

- 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.

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2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

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2. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
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6. E. M. Gifford and A. S. Foster. 1988. Morphology and Evolution of Vascular Plants.
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10. 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
- Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers and vesicular arbuscular mycorrhizal (VAM).

UNIT-1 **(10 lectures)**

- 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 **(10 lectures)**

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

UNIT- 3 **(10 lectures)**

- 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 **(15 lectures)**

- 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.

Bibliography

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. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
4. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.

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 andmethods of uses) Trees – *Saraca asoka* (Ashoka), *Terminalia arjuna* (Arjuna), *Terminalia chebula* (Hartaki),	20
	Terminalia bellerica (Bahera), *Emblica officinale* (Amla), *Alstonia scholaris* (Chhatim), *Moringa oleifera* (drumstick/sajina plant), *Azadirachta india* (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), *Cinanamomum zeylanicum* (Darchini), *Foeniculum vulgare* (Fennel/sounf/Mouri), *Piper nigrum* (Pepper), *Ferula foetida* (Asafoetida/Hing), *Cuminum cyminum* (Cumin), *Coriandrumsativum* (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 **(10 lectures)**

- 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 sewardiana* reconstruction (*Bucklandia* stem, *Ptilophyllum* leaf, *Weltrichia* male organ, *Williamsonia* female organ).

UNIT II: MYCOLOGY **(18 lectures)**

- 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 f*orma 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 **(17 lectures)**

- 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.

PRACTICALS

- 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.*

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

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

UNIT I: GYMNOSPERMS **(10 lectures)**

- 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 **(20 lectures)**

- 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 **(15 lectures)**

- 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); Concpets of LD_{50}, ID_{50}, EC_{50} and MIC; Genetic engineering for disease resistance.

PRACTICALS

- 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.

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

Bibliography

1. College Botany Vol. –II. - Gangulee and Kar, New Central Book Agency, Kolkata.
2. Introduction to Fungi. Webster, J. Cambridge University Press.
3. Introduction to Fungi, Dubey, H. C. Vikas Publishing House.
4. Introduction to Mycology. Alexopoulas, C. J., Mims, C. W. and Blackwell Wiley. Bastern Limited, New Delhi.
5. Introductory Mycology. R. S. Mehrotra and Aneja, K. R. New Age International.
6. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
7. Plant Pathology. Agrios R. N. Academic Press.
8. Plant Pathology, Mehrotra, R. S. Tata Mc Graw Hill Publishing Company. New Delhi
9. Stewart, W. N. & G. W. Rothwell. 1993. Palaeobotany and Evolution of Plants. Cambridge University Press.

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 **(10 lectures)**

- 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 **(20 lectures)**

- 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 **(15 lectures)**

- 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.

PRACTICALS

- 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.

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

Bibliography

1. Introduction to Fungi. Webster, J. Cambridge University Press.
2. College Botany Vol. –II. - Gangulee and Kar, New Central Book Agency, Kolkata.
3. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
4. 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 **(20 lectures)**

- Roots, stems and leaves: Their structures with reference to modification with examples; Phyllotaxi 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 **(15 lectures)**

- 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 **(10 lectures)**

- 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.

PRACTICALS

- 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)

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

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. Evaluate the adaptive and protective systems of plants.
4. To know about medicinal properties and uses of plants by folklore and ayurveda system.

UNIT I: ANATOMY OF ANGIOSPERMS **(25 lectures)**

- 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; Stelar 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 tylosoids; 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 *Boerrhavia*, *Bignonia*, *Dracaena*, *Tinospora*.

UNIT II: ECONOMIC BOTANY **(10 lectures)**

- 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 **(10 lectures)**

- 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 sominifera (*Aswagandha), *Andrographis paniculata* (kalmegh), *Zingiber* (Ginger), *Curcuma* (Turmeric), *Bacopa monnieri* (Bramhi), , *Digitalis purpurea* (foxglove), *Papaver sominferum* (Afeem) and *Cannabis sativa* (Marijuana).

PRACTICALS

- 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 thickennings 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).

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

Bibliography
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 Benjammin/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.
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. Evaluate the Important herbaria and botanical gardens

UNIT I: PLANT MORPHOLOGY **(12 lectures)**
- 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 **(13 lectures)**
- 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 **(20 lectures)**
- 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 - artifitial, 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.
- Diagonostic 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.

PRACTICALS

- 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).

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation or Poster preparation: 10 marks
3. Attendance and interaction in class: 5 marks
4. Practical skills & laboratory record: 5 marks

Bibliography

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. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
5. Fahn, 1982. Plant Anatomy. John Willey.
6. 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. Examine the cultivation of different vegetables in nursery and gardening

UNIT I: HORTICULTURE **(20 lectures)**

- Types and classification (annuals, perennials, climbers and trees) of Horticultural crops.
- Studies on ornamental (*Gladiolus* and *Chrysanthemum*), fruits (Orange and Cashew), vegetables (Carrot and Cabbage), medicinal (Tulsi and mint) and aromatic (Clove) plants.
- Identification, salient features, management for cultivation and marketing of ornamental plants (Rose, Marigold, Tuberose, Gulmohar, Lagerstroemia and Areca palm.
- Management for cultivation and marketing of vegetables (Potato and Brinjal) and fruit crops (Mango and Banana).

UNIT II: NURSERY AND GARDENING **(25 lectures)**

- 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.

Bibliography

1. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
2. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
3. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.

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
- ✓ Understand extra nuclear genetic material and non-Mendelian inheritance patterns
- ✓ Understanding statistical principles and methods
- ✓ Apply knowledge of cell biology to understand biological processes and phenomena

UNIT 1: GENETICS **(12 lectures)**

- **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).

UNIT 2: PLANT BREEDING **(10 lectures)**

- **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).

UNIT 3: BIOSTATISTICS **(13 lectures)**

- **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.

UNIT 4: CELL BIOLOGY **(10 lectures)**

- **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.

PRACTICALS

- 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)

CA for Practical: FM 30: Each Practical bears 4 marks for attendance; 5 marks for Laboratory Note Book; 5 marks for Viva-voce.

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 statistical techniques to interpret results and draw conclusions
- ✓ Develop skills in using statistical software and tools
- ✓ Apply cell biology principles to understand biological processes and phenomena

UNIT 1: GENETICS **(15 lectures)**

- **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.

UNIT 2: PLANT BREEDING **(10 lectures)**

- **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).

UNIT 3: BIOSTATISTICS **(10 lectures)**

- **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.

UNIT 4: CELL BIOLOGY **(10 lectures)**

- **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).

PRACTICALS

- 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-carmine 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.

CA for Practical: FM 30: Each Practical bears 4 marks for attendance; 5 marks for Laboratory Note Book; 5 marks for Viva-voce.

Bibliography

1. The Cell: A Molecular Approach, Geoffrey M. Cooper, Kenneth Adams, Sinauer Associates / Oxford University Press, 9th edition, 2022
2. Essential Cell Biology, Bruce Alberts, Karen Hopkin, Dennis Bray, Alexander Johnson, W. W. Norton & Company, 6th edition, 2022
3. Karp's Cell and Molecular Biology, Gerald Karp, Janet Iwasa, Wallace Marshall, Wiley, 8th edition, 2022
4. Genes XVIII, Benjamin Lewin, Jones & Bartlett Learning, 18th edition, 2024
5. Principles of Genetics, D. P. Snustad, M. J. Simmons, Wiley, 14th edition, 2024
6. I-Genetics: A Molecular Approach, Peter J. Russell, Pearson Education, 4th edition, 2021
7. Advanced Botany Volume 2, Sanjeev Pandey, Books & Allied (P) Ltd., 1st Edition, 2022
8. Plant Breeding: Principles and Methods, B.D. Singh, MedTech Science Press (India), 12th Edition, 2022
9. Biostatistics: A Foundation for Analysis in the Health Sciences, Wayne W. Daniel, Chad L. Cross, John Wiley & Sons, 11th Edition, 2019

MAJOR COURSE - 9

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

<table>
<tr><td colspan="2">Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-9</td><td colspan="2">L-T-P: 3 – 0 – 4</td></tr>
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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
- ✓ Understand plant genetic engineering: Learn how to introduce desirable traits into plants using genetic engineering
- ✓ Develop skills in plant breeding: Understand methods of crop improvement, including selection, hybridization, and genetic modification.

UNIT 1: MOLECULAR BIOLOGY **(25 lectures)**

- **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.

UNIT 2: PLANT BIOTECHNOLOGY **(20 lectures)**

- 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.

PRACTICALS

- 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

CA for Practical: FM 30: Each Practical bears 4 marks for attendance; 5 marks for Laboratory Note Book; 5 marks for Viva-voce

Bibliography

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 Biotechnology: Principles and Applications, Bernard R. Glick, Cheryl L. Patten, ASM Press, 6th Edition, 2022
4. Quantitative Cell Biology, M. Huang et al., Academic Press, 1st Edition, 2024
5. Advanced Botany Volume 2, Sanjeev Pandey, Books & Allied (P) Ltd., 1st Edition, 2022
6. 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:

- ✓ 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.

UNIT 1: ECONOMIC BOTANY **(25 lectures)**

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).

UNIT 2: PHARMACOGNOSY **(20 lectures)**

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), *Cinnamomum aromaticum* (inner bark).

PRACTICALS

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

CA for Practical - FM 30: (Each Practical bears 3 marks for attendance for Sl. 1 to 5 & 5 marks for Sl. 6 i.e. for attendance 20 marks; 5 marks for Laboratory Note Book; 5 marks for Viva-voce

Bibliography

1. Kochhar S. L. Economic Botany in the Tropics, Sec edition, MacMillan India Ltd.
2. Sanjeev Pandey, Advance Botany, Volume-1, 2nd Edn, Pub. Books and Allied (P) Ltd. Kolkata.
3. Singh Pandey and Jain. Economic Botany. Rastogi Publication.
4. 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 be equipped to evaluate photosynthetic efficiency in plants, contributing to research in crop productivity, climate adaptation, and carbon sequestration strategies.
- ✓ 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.

UNIT 1: PLANT PHYSIOLOGY **(20 lectures)**

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; Role of GOGAT for N_2 absorption; 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.

UNIT 2: BIOCHEMISTRY **(15 lectures)**

- **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**.**

UNIT 3: PLANT ECOLOGY & PHYTOGEOGRAPHY **(10 lectures)**

- 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, basic concept on biodiversity.
- 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: Principles and Models of energy flow; Biomass production and productivity; Ecological efficiencies; Biogeochemical cycles of carbon, nitrogen and phosphorus.
- Phytogeography: Endemism; Definition, theories and types (with example); Factors governing endemism; Endemism in Peninsular India.

PRACTICALS

- 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 KNO_3 on stomatal opening.
- Determination of the effect of CO_2 concentration on the rate of photosynthesis using molar solution of bicarbonate and by measurement of volume of O_2 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 auriculoformis*, *Nerium* leaf and *Vanda* root.

CA Practical – FM 30: (Attendance 20 Marks; 2 marks for each practical, 5 Marks for Laboratory Note Book and 5 Marks for Viva-voce.

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
- ✓ Students acquire the adequate knowledge of metabolism in 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

UNIT 1: PLANT PHYSIOLOGY **(20 lectures)**

- 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.

UNIT 2: BIOCHEMISTRY **(15 lectures)**

- 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).

UNIT 3: PLANT ECOLOGY & PHYTOGEOGRAPHY **(10 lectures)**

- 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: 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* and *ex situ* Conservation and Cryopreservation). National Forest, Sanctuary & Biosphere Reserves of India.
- Pollution: Definition causes and remedies with respect to air, water and noise pollution.
- Terrestrial Biomes, Principles; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phyto-geographical regions of India (After Independence); Vegetation characteristic of Eastern Himalayas and Sunderban.

PRACTICALS

- 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)

CA Practical – FM 30: (Attendance 20 Marks; 5 Marks for Laboratory Note Book and 5 Marks for Viva-voce.

Bibliography

1. Conn, E. E. Stumpt, P. K. Bruening, G. and Doi, R. H Cutline of Biochemistry, John Wiley & Sons
2. Lehninger, A. L.; Nelson, D. L. and Cox, M. M. – Principles of Biochemistry. Worth Publishers.
3. Sanjeev Pandey, Advance Botany, Volume-1, 2nd Edn, Pub. Books and Allied (P) Ltd. Kolkata.
4. Salisbury, F. B. and Ross, C. W. – Plant Physiology. Wordsworth Publishing Company.
5. Stryer, L. – Biochemistry, John Wiley & Sons 4. Sarkar &Rakshit – Organic Chemistry.
6. Taiz, L. and Zeiger, E. – Plant Physiology. The Benjamin Cumming Publishing Company.
7. V. K. Jain. Fundamentals of Plant Physiology, S Chand Publication
8. Kormondy, B. J. 1983. Concept of Ecology (Recent edition) Prentice Hall India Ltd. New Delhi.
9. Odum, E. P. fundamentals of Ecology (recent edition) W. B. Sunders & Co. Philadelphia.

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
- ✓ Understand structure and functions of anther wall and pollen wall
- ✓ Evaluate the special structures of Ovule

UNIT 1: PLANT SYSTEMATICS **(35 lectures)**

- Introduction To Systematics: Plant identification, Classification, Nomenclature. Evidences from Palynology (sculptures and NPC), 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: Artifitial, natural and phylogenetic approach. Outline of the system of Classification – Linnaeus (1753), Bentham and Hooker (1862-83), Takhtajan (1997); Principles of Angiosperm Phylogeny Group (APG IV) Classification.
- Taxonomic Hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Basic concept of Numerical Taxonomy, OTU, Phenon, Phenogram; Phenetics vs. Cladistics.
- Principles and rules (ICBN/ICN); Typification, Author Citation, Valid Publication, Rejection Of Names, Principle Of Priority and its Limitations; Names of hybrids.
- Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades, synapomorphy, symplesiomorphy, apomorphy, lineage sorting, serial homology etc).
- **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 astericks).**
- **Dicotyledons:** Magnoliaceae*, Ranunculaceae, Malvaceae, Brassicaceae, Fabaceae, Apiaceae, Cucurbitaceae, Euphorbiaceae, Apocynaceae (as per APGIV), Solanaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Rubiaceae, Asteraceae (Compositae)*.
- **Monocotyledons:** Alismataceae*, Liliaceae, Poaceae, Orchidaceae*.

UNIT 2: REPRODUCTIVE BIOLOGY **(10 lectures)**

- Introduction to Reproductive Biology - Definition and scope of reproductive biology; 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.

PRACTICALS

- 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, Leguminosae, Euphorbiaceae, Apocynaceae, Solanaceae, Scrophulariaceae, Lamiaceae, Verbenaceae, Acanthaceae, Rubiaceae, Asteraceae, Poaceae **(Take at least one genus from each family)**
- Compulsory Field Visit/Educational Tour (atleast one) for all students at Local/BSI/within the state or outside the state to be decided by the college authority **(NB. 10 Marks for Field Visit followed by Field Report submission will be awarded during Continuous Assessment).**
- Mounting of properly dried and pressed specimen of at least 20 wild plants on herbarium sheets with proper Labels and Tags.
- Microscopic examination of Pollen germination in *Catharanthus roseus*.
- Study of exine sculptures by temporary slide preparation in *Hibiscus* sp. (Malvaceae) and Asteraceae.
- Construction of plant phylogenetic tree using any one locus (eg., rbcL, ITS, trnL etc) with various phylogenetic methods (Neighbour Joining, Maximum Likelihood etc).

CA Practical: FM 30: Attendance 10 Marks; Field Visit & Report Submission: 10 Marks; 5 Marks for Laboratory Note Book and 5 Marks for Viva-voce

Bibliography

1. College Botany Vol. III. New Central Book Agency. Calcutta.
2. Datta, S. C. 1991. Systematic Botany. Wiley Eastern Ltd. New Delhi, Calcutta.
3. Naik, V. N. Taxonomy of Angiosperms. Tata Mc. Graw Hill Publishers Co. 1981. New Delhi
4. Plant Groups. (Recent Edition). H. Mukherjee. New Central Book Agency.
5. Plant Systematics. Gurucharan Singh. 2005 (2nd Edition). Oxford & IBH.
6. Plant Systematics. Simpson. 2006. Elsivier. 11. S. K. Mukherjee. 1984.

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 develop hands-on skills in horticultural practices, post-harvest handling, and processing.
- ✓ Students will be able to identify and solve problems related to horticulture and post-harvest management.

UNIT 1: HORTICULTURE **(20 lectures)**

- ➢ 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.
- ➢ Propagation Methods: Asexual (Grafting, Cutting, Layering, Budding), Sexual (Seed Propagation), Bonsai Production.
- ➢ Cultivation, processing and marketing of products of major medicinal plants (*Senna*, Ashwagandga, Amla, Vetiver, *Aloe vera*).

UNIT 2: POST HARVESTING TECHNOLOGY **(25 lectures)**

- Post-harvest Technology - Importance and overview of post -harvest handling; Principles and methods of preservation and processing : Methods of minimizing loses 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.

PRACTICALS

- Methods of Vegetative propagation – Cuttings, grafting, gooting and layering.
- Disease Management – Integrated Pest Management practices (A field study).
- Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at IARI or other suitable locations. **(At least one field visit is to be carried out and it will carry 10 marks during Continuous Assessment; a report is to be submitted by students).**
- Cold storage techniques for fruits and vegetables.
- Visit to some nearby cold-storage facility (Optional).

CA Practical: FM 30: Attendance 10 Marks; Field Visit & Report Submission: 10 Marks; 5 Marks for Laboratory Note Book and 5 Marks for Viva-voce

Bibliography

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. Ramaswamy, H. (2015). Post-harvest Technologies of Fruits and Vegetables. DEStech Publications, Inc.. Pp 311

Guidelines /Modalities for Summer Internship under Curriculum and Credit Framework for Undergraduate Programmes

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	---

1. About the Internship:

The internship is an integral component of the academic programme and is designed to provide students with exposure to real-world work environments, research settings, and community engagement opportunities. Students are required to complete the internship during the designated period and submit all required documents for evaluation within the stipulated timeline.

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.

2. Scope of Internship:

Students will undergo internship at Home Institutions (from departments excepting the parent departments), University, Academic and research Institutions, 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 department (own college) and **Mentor** from host department/Institution/Organization.

Activities to be performed under internship should follow the syllabus of discipline concerned. (**link:** https://www.knu.ac.in/syllabus)

3. Nodal Officer and Research & Development (R&D) Cell

The **R&D Cell** of each affiliated institution shall oversee implementation of the Internship Programme through a designated **Nodal Officer**, appointed by the Principal/ TIC of the concerned Institution. Affiliated colleges are to develop an **online internship registration system** on their college websites to facilitate the process for students.

4. Duration of Internship

- **60 Working Hours (**preferably offline)
- Equivalent to **2 Credits**
- **From the completion of the 4thsem (ESE) exam till the commencement of the 6th semester Examinations (ESE) –** subject to prior approval of the Principal/TIC of the college / Head or Coordinator in case of University Department

5. Report Submission Requirements

Each student must submit:

a) **Internship Report** (3000–5000 words)
b) **Internship Completion Certificate** issued by Supervisor and Mentor certifying the performance and attendance of the intern.
c) **Self-Assessment and Feedback Form**
d) **COPY OF DECLARATION FORM regarding IPR issue**
e) **COPY OF DECLARATION FORM FROM STUDENT**
f) Any additional documents if required by the college/university.

6. Evaluation Process

- **Continuous Assessment (CA): 30 Marks**
  - To be assessed by **Supervisor** in consultation with the Mentor
  - Based on attendance, performance, and report quality

- **End Semester Evaluation (ESE): 20 Marks**
  - To be conducted at the home institution
  - Through seminar presentation and/or viva-voce
  - To be assessed by **ATLEAST two Internal Examiners** from the Home institution (concerned Colleges) comprising of supervisor and another teacher nominated by the R& D Cell of the concerned college

All evaluation processes including mark submission for SI601 must be completed by 10th July - 2026 (For the session -2025-26 only) and consecutive years

7. Compliance

All UG students are directed to strictly adhere to these guidelines.
Non-completion of the internship will result in **withholding of results/degree award** as per University regulations.

SEMESTER- VII

MAJOR COURSE - 14

Course Name : Evolutionary and Advanced Aspects of Plant Groups
Course Code : BSCBOTMJ701

Course Type: Major (Theoretical & Practical)	Course Details: MJC-14			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 evolutionary relationships: Students will comprehend the phylogenetic relationships among major plant groups, including algae, bryophytes, pteridophytes, gymnosperms, and angiosperms.
- ✓ Explain evolutionary trends: Students will explain the evolutionary trends and innovations that led to the diversification of plant groups.
- ✓ Apply knowledge to real-world scenarios: Students will apply their understanding of plant evolution and diversity to address real-world issues, such as conservation and sustainability.
- ✓ Evaluate phylogenetic concepts: Students will critically evaluate phylogenetic concepts, such as monophyly, parsimony, and molecular clock, in the context of plant evolution.

UNIT 1: ORIGINS AND EARLY EVOLUTION **(11 lectures)**

- ➢ Evolution of Life and Life Forms - Origin of life and early evolution; Evolution of cellular structures, functions and multicellularity; Mechanisms of speciation; Adaptive radiation and convergent evolution.
- ➢ Ancestral Lineage: Study of Charophycean green algae (Charales) as the closest relatives to land plants. Fundamental Transition: The shift from aquatic, haplontic (dominant haploid) life cycles to haplodiplontic life cycles. The First Land Plants: Evidence of early land plants (cryptospores) from the Ordovician period (approx. 470 mya). Key Adaptations for Terrestrialization: Development of the waxy cuticle, stomata for gas exchange, and sporopollenin for spore protection.

UNIT 2: EVOLUTION OF PROTISTS, CRYPTOGAMS AND FUNGI **(9 lectures)**

- ➢ Algae – Distributions of Algae; Characteristics of each class with typical examples according to Fristch (1935) and according to Round 1977); Viridiplantae and evolution of embryophytes, Evolutionary Relationship among algae according to A. K. Khan et al. (2020).
- ➢ Fungi – Evolution of fungal groups: Stramenopiles**,** chytrids, zygomycetes, glomeromycetes, ascomycetes, and basidiomycetes; Sex hormones in fungi (Sexuality in lower fungi, with emphasis on *Achlya*).

UNIT 3: CRYPTOGAMS **(11 lectures)**

- ➢ Origin of Bryophytes (Theories of Progressive and Retrogressive evolution); Overall thallus organization and evolutionary aspects with emphasis on photosynthetic tissue; sterile tissue, spore dispersal mechanism, peristome etc; Chemical constituents of Bryophytes (brief knowledge about the inorganic, primary and secondary metabolites of bryophytes);
- ➢ Origin and evolution of pteridophytes with special reference to primitive rootless forms (Rhyniopsida) and the affinity and evolutionary significance of Trimerophytopsida; Soral evolution in ferns. Cytological and developmental aspects of apogamy and apospory.

UNIT 4: EVOLUTION OF SEED PLANTS (SPERMATOPHYTES) **(6 lectures)**

- ➢ Seed Habit: Transition from heterospory to true seeds (integumented megasporangia) to protect the embryo with emphasis on pre-pollen and pre-ovules and evidences.

- Progymnosperms: Study of *Archaeopteris* (early woody plants) and *Runcaria* (transitional fossils).

UNIT 5: EVOLUTION OF FLOWERING PLANTS (ANGIOSPERMS) **(8 lectures)**

- Origin of Flowers: Evolution of specialized reproductive organs (carpels, stamens) in the Cretaceous period. Thoeries and concepts regarding origin and evolution of Angiosperms; Co-evolution of flower structure and diversity in relation to insects.
- Major Angiosperm Groups: Basal angiosperms (ANA grade), Monocots, and Eudicots.

PRACTICALS

- Morphological and Anatomical Studies: Study of plant specimens (herbarium sheets, preserved specimens, or living plants) to understand morphological and anatomical features of different plant groups; Preparation of slides to study anatomical features, such as stomata, trichomes, and vascular tissues (RLS and TLS using *Pinus* stem).
- Phylogenetic Analysis: Construction of phylogenetic trees using morphological and molecular data (using common conserved sequences); Analysis of phylogenetic relationships among plant groups using MEGA program.
- Plant Identification and Classification: Identification of plant specimens using keys, floras, and monographs; Classification of plants into different taxonomic ranks (family, genus and species).

Format for Conducting CA (30 Marks) Practical Examination

5. Assessment based on practical topics (class test): 10 marks
6. PPT/Poster preparation: 10 marks
7. Attendance and Participation in class: 5 marks
8. Practical skills, laboratory reports: 5 marks

Bibliography

1. Plant Systematics: An Integrated Approach by Gurcharan Singh
2. Evolutionary Biology of Plants by Karl J. Niklas
3. Plant Evolution: An Introduction to the History of Plant Life by Karl J. Niklas and Bruce H. Tiffney
4. Plant Systematics: A Phylogenetic Approach by Walter S. Judd et al.
5. Plant Diversity and Evolution: Genotypic and Phenotypic Variation in Higher Plants edited by R. J. Henry
6. Evolutionary Plant Biology by Roshan Kumar and A. K. Jain

MAJOR COURSE - 15

Course Name : Research Methodology & Ethics

Course Code : BSCBOTMJ702

Course Type: Major (Theoretical & Practical)	Course Details: MJC-15			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:

By the end of the course, students will be able to:

- ✓ Explain basic concepts, types, and processes of research.
- ✓ Formulate research problems and objectives.
- ✓ Select and apply appropriate research designs and methods.
- ✓ Collect, analyze, and interpret data.
- ✓ Prepare a structured research report/proposal.
- ✓ Use proper citation and referencing styles.
- ✓ Identify and apply principles of research ethics.
- ✓ Utilize digital tools for literature review and data analysis.

UNIT I: BASIC CONCEPTS OF RESEARCH **(10 lectures)**

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

UNIT II: DATA COLLECTION AND DOCUMENTATION OF OBSERVATIONS **(7 lectures)**

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

UNIT III: OVERVIEW OF BIOLOGICAL PROBLEMS **(10 lectures)**

Key biology research areas-Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics; Model organisms in biology (*E. Coli; Saccharomyces cerevisiae; Neurospora crassa; Chlamydomonus; Drossophila; C. elegans, Oryza sativa; Arabidopsis thaliana*).

UNIT IV: ETHICS AND ART OF SCIENTIFIC WRITING **(18 lectures)**

Authors, acknowledgements, reproducibility, plagiarism, Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references (a brief idea about reference management systems); Power-point presentation; Poster presentation; Use of AI in scientific writing and ethics; Introduction to copyright-academic misconduct/plagiarism; IPR and Copyright (Intellectual property rights, patents and fair use of published material).

PRACTICALS

- Study of model organisms (morphology, ecological & genetic behaviour of *E. Coli; Saccharomyces cerevisiae; Chlamydomonus; Oryza sativa*
- The art of imaging of samples through microphotography and field photography.
- Poster presentation on defined topics.
- Technical writing on topics assigned.
- Difference between Research Article, Review, Monograpgs etc.
- Curation of relevant scientific literature from Google Scholar and relevant AI

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation: 10 marks
3. Attendance and Participation in class: 5 marks
4. Submission-Technical writing on topics assigned: 5 marks

Bibliography

1. Research Methodology – S. Sachdeva (UGC/NEP aligned UG text)
2. Research Methodology: A Step-by-Step Guide for Beginners – Ranjit Kumar
3. Research Methodology and Publication Ethics – B. Shadaksharappa
4. Fundamentals of Research and Publication Ethics – G. Trivedi & R. M. Sharma
5. Qualitative Inquiry and Research Design – John W. Creswell
6. The Oxford Textbook of Clinical Research Ethics – Emanuel et al.

MAJOR COURSE - 16

Course Name : Current Trends in Plant Science -I

Course Code : BSCBOTMJ703

<table>
<tr><td colspan="2">Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-16</td><td colspan="2">L-T-P: 3 – 0 – 4</td></tr>
<tr><td rowspan="3">Credit: 5</td><td rowspan="3">Full Marks: 100</td><td colspan="2">CA Marks</td><td colspan="2">ESE Marks</td></tr>
<tr><td>Practical</td><td>Theoretical</td><td>Practical</td><td>Theoretical</td></tr>
<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
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Course Learning Outcomes:

By the end of this paper, students will be able to:

- ✓ Explain modern trends in plant diversity, classification, and biodiversity conservation.
- ✓ Describe recent advances in plant physiology, including photosynthesis, hormones, and stress responses.
- ✓ Discuss plant–environment interactions and impacts of climate change on plant systems.

UNIT 1: BASIC PRINCIPLES OF PLANT PHYSIOLOGY **(15 lectures)**

- Photosynthesis and Carbon Metabolism: Sucrose and starch Biosynthesis, Photosynthetic efficiency, Carbon dioxide concentrating mechanisms (CCM-I, CCM-II and CCM-III); Carbon isotope discrimination by C3, C4 and CAM plants; Behavioural change of Rubisco in response to increased global CO_2 concentration.
- Respiration: Respiratory inhibitors, uncouplers and Ionophores; Pentose Phosphate Pathway; Shuttle transport pathways for NADH transport from cytosol to mitochondrial matrix; Anapleurotic reactions; Glyoxylate cycle; Alternate pathways of mitochondrial electron transports in plants; Gluconeogenesis, Futile cycle.

UNIT 2: CROP PHYSIOLOGY **(10 lectures)**

- Fruit physiology – Physiology of Fruit ripening; stages of fruit growth and development; Ripening changes in Fruit biochemistry; Climacteric and Non-climacteric fruits.
- Weed biology – Definition of weed; diversity of common weeds in the crop fields of rice, mustard, potato and tea; weed control (mechanical; chemical; biological).

UNIT 3: SOIL SCIENCE **(15 lectures)**

- Definition of Soil; Components of Soil and their role in agriculture; Physical properties of soil and their significance; Chemical properties of soil; Cation and anion exchange phenomenon and their importance in agriculture.
- Role of plant nutrients in crop production, Nutrient Use Efficiency, Factors affecting Nutrient Use Efficiency; Tillage – definition, types, effect of tillage on soil health and crop growth; Tilth – definition, characteristics of ideal tilth, modern concept of tillage, minimum, zero and stubble mulch tillage.

UNIT 4: POPULATION ECOLOGY **(5 lectures)**

- Survivor-ship curve and types, Concept of niche and their types, Niche overlap and competition, Theories of population growth, Lotka-Voltera Equation, r- and k-selected K-selected Species; Metapopulation dynamics; GIS and remote sensing (RS) for vegetation mapping.

PRACTICALS

- Effect of plant growth regulator (rice mesocotyle straight growth bioassay of auxin).
- To determine Km and Vmax of α-amylase using starch as substrate (DNS method; source – germinating seeds); Draw Line-Weaver Burk's Plot and determine K_m and V_{max} from the graph.
- Study of vegetation mapping through GIS & RS
- Determination of cation exchange capacity by titration method
- Atleast one local field visit to study common weeds (Field report preparation along with minimum 10 herbarium sheets submission)

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. Submission-report on vegetation mapping: 10 marks
3. Attendance and Participation in class: 5 marks
4. Practical skills, laboratory record: 5 marks

Bibliography

1. Plant Physiology – Lincoln Taiz & Eduardo Zeiger
2. Introduction to Plant Physiology – W. G. Hopkins & N. P. A. Hüner
3. Plant Ecology – P. D. Sharma
4. Fundamentals of Ecology – Eugene P. Odum
5. Lehninger Principles of Biochemistry – Nelson & Cox

MAJOR COURSE - 17

Course Name : Current Trends in Plant Science -II

Course Code : BSCBOTMJ704

Course Type: Major (Theoretical & Practical)	Course Details: MJC-17			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:

By the end of this paper, students will be able to:

- ✓ Explain advanced concepts of plant biotechnology and molecular biology.
- ✓ Apply basic molecular techniques in plant research.
- ✓ Evaluate modern approaches in plant improvement.
- ✓ Demonstrate research skills including experimental design and scientific communication.

UNIT I: ADVANCED PLANT BIOTECHNOLOGY **(15 lectures)**

- Transgenic Plants – Methods of gene identification and isolation (blotting techniques, Library Screening, Transposon tagging, gene amplification strategies); Environmental and socio-biological impacts of GM crops.
- CRISPR/Cas mediated gene knockout and genome editing in plants.
- Omics technologies: genomics, proteomics, metabolomics.
- Molecular markers – Genetic Mapping Vs Physical Mapping, (Genetic Mapping Techniques – RFLP, Ribotyping, SNP, RAPD, AFLP, SSR and their applications); (Physical Mapping – Contig mapping, STS and EST)

UNIT II: PLANT MOLECULAR BIOLOGY **(15 lectures)**

- Lysogeny regulation; gene silencing and epigenetic regulations; histone modifications.
- An outline of plant signal transduction mechanisms (Secondary messengers, Cell surface receptor – GPCR and RLKs), Signalling pathways – cAMP/PKA pathway, Phosphatidyl Inositol pathway, MAP kinase pathway.
- Plant immunity- innate and acquired immunity in plants, mechanisms of Induced Systemic Resistance (ISR) and Systemic Acquired Resistance (SAR), and their roles in plant defense against pathogens.

UNIT IV: ENVIRONMENTAL & APPLIED PLANT SCIENCE **(10 lectures)**

- Phytoremediation: (Phytovolatilization and Phytochelation; chemistry of phytochelatins); Hyperaccumulators and their characteristics.
- Biofuels and plant-based renewable energy – Concept of Bioethanol (biohol) and Biodiesel production; Prospects of oil production from microalgae.

UNIT-IV REPRODUCTIVE BIOLOGY **(5 lectures)**

- Pollen-pistil interaction – Self incompatibility (GSI and SSI – role of S alleles).
- Molecular mechanism of flower development- ABC Model of flowering, flowering stimulus (nature of florigen-brief idea).

PRACTICALS

- DNA isolation from plant tissues (demonstration/experiment).
- Agarose gel electrophoresis for DNA analysis (demonstration).
- Plant tissue culture techniques (callus induction– lab or demo).
- Seminar/presentation on recent advances in Plant Science (for Continuous Assessment).

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. Seminar presentation: 10 marks
3. Attendance and Participation in class: 5 marks
4. Practical skills, laboratory reports: 5 marks

Bibliography

1. Advanced Topics in Biotechnology and Plant Biology – C. P. Malik et al.
2. Plant Biotechnology – B. D. Singh
3. Plant Biology and Biotechnology (Vol. II: Genomics & Biotechnology) – Bir Bahadur et al. (focus on genomics, RNAi, bioinformatics)
4. Plant Genetics and Molecular Biology – Varshney et al. (advanced genomics, transcriptomics, molecular breeding)
5. Plant Biotechnology (Two-Volume Set) – B. D. Prasad et al.
6. Cell and Molecular Biology – Gerald Karp
7. Principles of Biochemistry – Lehninger

MINOR COURSE - 6

Course Name : Plant Physiology, Biochemistry and Plant Ecology

Course Code : BSCBOTMN701

Course Type: Minor (Theoretical & Practical)	Course Details: MNC-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:

By the end of this paper, students will be able to:

- ✓ Explain fundamental processes of plant physiology including water relations, photosynthesis, and respiration.
- ✓ Outline basic biochemical components and metabolic processes in plants.
- ✓ Interpret the role of enzymes and secondary metabolites in plant systems.
- ✓ Discuss ecological principles including ecosystem structure, population, and succession.
- ✓ Analyze the impact of environmental factors and climate change on plant life.

PLANT PHYSIOLOGY

UNIT 1: WATER RELATION AND NUTRITION **(15 lectures)**

- **Water Relations:** Water Potential and its components, water absorption by roots, 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 with special reference to the K^+ /H^+ exchange theory and regulation of stomatal opening and closure.
- **Essential and beneficial elements**: Essential macro- and micronutrients, criteria for essentiality of mineral elements, hydroponics and nutrient culture techniques, uptake, transport and utilization of mineral nutrients, physiological and biochemical roles of essential elements, mineral deficiency symptoms, nutrient toxicity, and diagnosis and management of nutrient disorders in plants.

- **Translocation of photosynthate**: Translocation of photosynthates through the phloem, source-sink relationships and their regulation, phloem loading and unloading mechanisms, pathways of assimilate transport, pressure gradients in the phloem, and the Münch Pressure-Flow Hypothesis as the principal model explaining long-distance transport of assimilates in plants.

UNIT 2: GENERAL PHYSIOLOGY OF PLANTS **(8 lectures)**

- **Photosynthesis:** Photosynthetic apparatus - organization and pigments, basic concept about mechanism of light dependent reactions, Photosynthetic electron transport, Carbon assimilation reactions in C3; C2 cycle and Basic concept of C4 and CAM plants.
- **Phytohormones and Photoperiodism:** Chemical nature and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid and Ethylene. Photoperiodism, flowering stimulus, physicochemical nature of phytochrome, role of phytochromes in flowering, florigen concept, vernalization.
- **Seed Physiology:** Seed dormancy (types, significance and breaking of seed dormancy).

UNIT 3: BIOCHEMISTRY **(12 lectures)**

- **General Biochemistry:** Types and significance of chemical bonds with special emphasis on weak interactions (hydrogen bonds, van der Waals forces, hydrophobic interactions and ionic interactions), structure and properties of water, biological role of water, pH and buffers, and their significance in biological systems.
- **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**.**
- **Plant Metabolism and Enzymology**: Definition and Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic groups; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory).
- **Carbon Metabolism**: Respiration, Respiratory quotient (RQ), Glycolysis, Fermentation, oxidative decarboxylation of pyruvate, Krebs cycle, electron transport system, oxidative phosphorylation and chemiosmotic hypothesis.
- **Nitrogen Metabolism**: Biological nitrogen fixation, nitrogen-fixing organisms including free-living, symbiotic and associative diazotrophs, nitrogenase complex, mechanism of asymbiotic and symbiotic nitrogen fixation, ammonia assimilation and the significance of nitrogen metabolism in plant growth and productivity.

UNIT 4: PLANT ECOLOGY **(10 lectures)**

- **Ecology:** Definition and basic concepts of ecology, levels of biological organization, autecology and synecology, abiotic and biotic components of ecosystems, ecological factors and their influence on organisms.
- **Ecosystem Ecology:** Structure and functions of ecosystems, trophic organization, food chains and food webs, ecological pyramids, energy flow and energy transfer efficiency in ecosystems, ecosystem productivity and nutrient cycling.
- **Ecological Adaptations**: Morphological, anatomical and physiological adaptations of xerophytes, hydrophytes, halophytes and epiphytes to their respective environments.
- **Biodiversity And Conservation:** Concept and significance of biodiversity, biodiversity hotspots and megadiversity regions, IUCN categories and threatened species, conservation strategies

including in situ conservation, ex situ conservation and cryopreservation, protected area network of India including national parks, wildlife sanctuaries and biosphere reserves.

- **Pollution:** Definition, sources, causes, effects and control measures of air, water and noise pollution, environmental management and sustainable approaches for pollution mitigation.

PRACTICALS

1. Determination of amount of water absorption, retention and transpiration by an excised petiolate *Colocasia*/*Alocasia* leaf.
2. Determination of the effect of CO_2 concentration on the rate of photosynthesis using molar solution of bicarbonate and by measurement of volume of O_2 liberation.
3. Qualitative tests for the identification of – Carbohydrate (Molisch's test), reducing/non-reducing sugar (Fehling's test), Starch (Iodine test), Protein (Biuret test), lipids (Sudan III test).
4. Determination of soil pH, Conductivity and Texture.
5. Comparison of bulk density and porosity of soils of three different habitats.

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10 marks
2. PPT presentation: 10 marks
3. Attendance and Participation in class: 5 marks
4. Practical skills, laboratory reports: 5 marks

Bibliography

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. Sanjeev Pandey, Advance Botany, Volume-1, 2nd Edn, Pub. Books and Allied (P) Ltd. Kolkata.
9. Salisbury, F. B. and Ross, C. W. – Plant Physiology. Wordsworth Publishing Company.
8. 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. Sunders & Co. Philadelphia.
15. Sharma, P. D. Geology and Environment (10th edition). Rastogi Publications. Meerut.
16. Plant Ecology. R. Mishra. Oxford & IBH.

SEMESTER- VIII

MAJOR COURSE - 18

Course Name : Bioinformatics & Instrumentation Biology

Course Code : BSCBOTMJ801

Course Type: Major (Theoretical & Practical)	Course Details: MJC-18			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 be able to

- ✓ Understand fundamentals of bioinformatics and biological databases
- ✓ Perform sequence analysis and BLAST search
- ✓ Interpret phylogenetic relationships
- ✓ Understand principles of biological instruments
- ✓ Interpret experimental data from modern biological instruments

UNIT 1: BIOINFORMATICS **(20 lectures)**

- Introduction to Bioinformatics: Definition, scope, applications in botany; Biological databases (primary vs secondary) and Data types (DNA, RNA, protein structure)
- Biological Databases: Nucleotide databases: (GenBank, EMBL, DDBJ); Protein databases: (Swiss-Prot, TrEMBL); Genome databases; UniProt database
- Sequence Alignment: Pairwise alignment; Global alignment vs Local alignment; Scoring matrix (basic idea); Gap penalty concept; Identity vs similarity; Algorithms (theory only); Multiple Sequence Alignment (Purpose, Applications and ClustalW basic idea only)
- BLAST: (What is BLAST; Types: BLASTn, BLASTp, BLASTx, tBLASTn, tBLASTx
- Homology modelling & Molecular Docking (Basics): Brief idea about PubChem, PyMol, Autodock vina.

UNIT 2: INSTRUMENTATION BIOLOGY **(25 lectures)**

- Microscopy (Principle, Parts, Applications, Differences): Light microscope; Compound microscope; Phase contrast microscope; Fluorescence microscope; Electron microscope (TEM & SEM).
- Spectrophotometry: Beer–Lambert law (concept only); Absorbance vs transmittance; UV-VIS spectrophotometer; Applications in plant biology
- Centrifugation: Principle & Applications; Types (Differential centrifugation, Density gradient centrifugation); RPM vs RCF
- Chromatography (Principle, Rf value, Applications): Paper chromatography; TLC (Thin layer chromatography); Column chromatography; Gas chromatography (basic); HPLC (basic).
- Electrophoresis: Principle; Agarose gel electrophoresis; SDS-PAGE (basic idea); DNA separation; Protein separation -
- RIA & ELISA – Principle, Types and Applications.

PRACTICALS

- Biological Database Search (Retrieve DNA sequence; Retrieve protein sequence; Retrieve gene information)
- BLAST Analysis: BLASTn (DNA vs DNA); LASTp (protein vs protein)
- Phylogenetic Tree Construction: Download sequences; Perform multiple alignment; Generate phylogenetic tree; Interpret relationship
- Chromatography: Rf calculation through paper chromatography of amino acids

- Extraction and spectrophotometric estimation of plant proteins from two proteinaceous seeds - a comparative approach.
- Electrophoresis (SDS-PAGE): Demonstration only
- Visit at any research institute-CSIR-CMERI; NIT Durgapur; Bose Institute; IICB; IIT KGP, etc. (Optional)

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10
2. PPT/Poster preparation or presentation or write-up submission: 10
3. Attendance and Participation in class: 5
4. Practical skills, laboratory reports: 5

Bibliography

1. Principles & Techniques of Biochemistry – Wilson
2. Bioinformatics: Sequence and Genome Analysis – David W. Mount
3. Essential Bioinformatics – Jin Xiong
4. Bioinformatics and Functional Genomics – Jonathan Pevsner
5. Developing Bioinformatics Skills – Gibas & Jambeck

MAJOR COURSE - 19

Course Name : Forestry and Plant Resource Management-I

Course Code : BSCBOTMJ802

Course Type: Major (Theoretical & Practical)	Course Details: MJC-19			L-T-P: 2 – 0 – 4	
Credit: 4	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

Students will be able to:

- ✓ Understand forestry, forest types, functions and resources.
- ✓ Explain forest ecosystem, stratification, succession and biodiversity.
- ✓ Explain social forestry, agroforestry systems and benefits.
- ✓ Understand sustainable management, rotation, protection and forest threats.
- ✓ Explain *in-situ* & *ex-situ* conservation and protection of endangered plants.

UNIT 1: INTRODUCTION TO FORESTRY: **(5 lectures)**

- Definitions of forests and forestry, Forests in pre-historic Era (Eolithic Age to Nuclear Age), Shifting cultivation; Scientific forestry; National Forest Policy (1988); Role of forests in environment, economy, and social well-being.

UNIT 2: SILVICULTURE: **(5 lectures)**

- Principles and practices of silviculture.
- Regeneration of forests: Natural Teak, Sal, Deodar, Chir Pine) and artificial regeneration (*Eucalyptus spp. and Acacia auriculoformis*).
- Silviculture Systems – High Forest and Cppice; Felling cycle.

UNIT 3: FOREST ECOLOGY: **(4 lectures)**

- Forest types of India and West Bengal; Major Trees and climbers in Indian forests.
- Energy flow and nutrient cycling in forest ecosystems.

UNIT 4: FOREST PROTECTION: **(10 lectures)**

- Agencies of forest destruction: Biotic and abiotic factors.
- Forest fires: Causes, prevention, and control.
- Major pests and diseases of forest trees and their management.
- Forest conservation strategies - In-situ: Management of National Parks, Biosphere Reserves, and Sacred Groves, Ex-situ: The role of Seed Banks, Cryopreservation, and Botanical Gardens in preserving genetic diversity.

UNIT 5: SOCIAL AND AGRO-FORESTRY: **(6 lectures)**

- Concepts of Social Forestry, Farm Forestry, and Joint Forest Management (JFM).
- Agro-forestry systems and their importance in rural livelihoods.

PRACTICALS

1. Field Mensuration: Determination of tree height using an Abney level or altimeter and Girth at Breast Height (GBH).
2. Wood Anatomy: Microscopic study (TS, TLS & RLS) of wood structures of economically important timber species (e.g. Teak, Sal, Sissoo).
3. Wood maceration through acid or alkaline hydrolysis.

Format for Conducting CA (30 Marks) Practical Examination

9. Assessment based on practical topics (class test): 10
10. PPT/Poster preparation, presentation and field report submission: 10
11. Attendance and Participation in class: 5
12. Practical skills, laboratory reports: 5

Bibliography

1. Introduction to Forestry by Manikandan
2. Principles of Silviculture by Negi
3. Social Forestry & Agroforestry by Nair

MAJOR COURSE - 20

Course Name : Forestry and Plant Resource Management-II

Course Code : BSCBOTMJ803

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

Course Learning Outcomes:

Students will be able to:

- ✓ Understand national forest policy and joint forest management.
- ✓ Explain biodiversity and conservation methods including protected areas.
- ✓ Identify non-timber forest products and their uses.
- ✓ Understand tribal uses of food, fibre and medicinal plants.
- ✓ Measure tree height, diameter and volume (basic idea).
- ✓ Understand timber harvesting, seasoning and preservation.
- ✓ Explain wildlife conservation, threats and protection.
- ✓ Understand use of remote sensing, GIS and GPS in forestry.

UNIT 1: FOREST RESOURCES **(5 lectures)**

- Major Forest Products (Timber Forest Products (TFP) and Non-Timber Forest Products (NTFP)
- TFP – Hardwood, Ply-wood and Fuelwood (Short notes)
- NFTP - Gum, resin, latex: sources, basic extraction, uses; Tannins & dyes: types and applications ; Essential oils: sources, extraction (steam distillation), uses

UNIT 2: ETHNOBOTANY **(5 lectures)**

- Definition, scope, and contribution of S. K. Jain
- Tribal uses of plants (food, fibre, medicine)
- Wild edible and medicinal plants (Indian examples)
- Link with Ayurveda
- Basic methods of ethnobotanical study (survey, documentation)

UNIT 3: FOREST MENSURATION AND MANAGEMENT: **(10 lectures)**

- Definition of Forest mensuration; Measurement of Height and Girth of trees, Estimation of Volume of logs and volume of standing trees; Increment; Stem analysis.
- Calculation of forest biomass and productivity.
- Essentials of forest management; Bana Mahotsav; Functional Classification of forest; Sustainable Forest Management (SFM); Thinning (Grades); Rehabilitation, Reclamation and Afforestation.

UNIT 4: MODERN FORESTRY TOOLS **(10 lectures)**

- Remote sensing: principle and uses in forest cover mapping (with reference to ISRO)
- GIS: basic concept and applications in resource mapping
- GPS: principle and use in field survey
- Forest inventory basics: sampling and measurement (DBH, height)
- Role in conservation and climate monitoring (basic idea only)

PRACTICALS

- Spot identification with reasons of NTFPs (gum, resin, latex, oils).
- Determination of wood density of oven dried specimen of wood.
- Location mapping of any tree through GPS
- Field Visit: Field visit to a local forest area, identification of trees through photographic documentation and forest management practices (thinning and timber harvesting).

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10
2. PPT/Poster preparation, presentation: 10
3. Attendance and Participation in class: 5
4. Practical skills, laboratory reports: 5

Bibliography

1. Forests and Forestry – National Book Trust, India, Author – K. P. Sagreiya
2. Forest Mensuration by Husch
3. Ethnobotany by S.K. Jain
4. Non-Timber Forest Products byT.P. Nair
5. Wildlife Management byRajesh Gopal
6. Remote Sensing & GIS byGirish Shahapurmath

MAJOR COURSE - 21

Course Name : Applied Botany

Course Code : BSCBOTMJ804

Course Type: Major (Theoretical & Practical)	Course Details: MJC-21			L-T-P: 2 – 0 – 4	
Credit: 4	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	15	20	35

Course Learning Outcomes:

Students will be able to:

- ✓ Explain cell structure, physiological processes, and nitrogen metabolism.
- ✓ Understand plant tissue culture, gene transfer, and crop improvement.
- ✓ Explain mycorrhiza and phytoremediation applications.
- ✓ Describe fermented foods and single cell protein production.
- ✓ Understand biodiversity conservation methods.
- ✓ Explain basics of bioinformatics and IPR.

UNIT 1: PLANT BIOTECHNOLOGY **(15 lectures)**

- Hairy Root Culture: Use of *Agrobacterium rhizogenes* for the induction of hairy roots and stable, high-yield production of secondary metabolites.
- Reporter genes: β-glucuronidase (GUS) and Green Fluorescent Protein (GFP). Selectable marker genes: antibiotic- and herbicide-resistance markers.
- Somaclonal variation: definition, cause, advantage and disadvantages; examples of some somaclonal variants in crop improvements; Detection and characterization of somaclonal variation using molecular markers.
- Concepts and significance of Intellectual Property Rights. Plant Breeders' Rights (PBR). Patenting of biological materials and life forms. Role and provisions of the Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA).

UNIT 2 - MICROBIAL BIOTECHNOLOGY **(15 lectures)**

- Bacterial growth kinetics, microbial spoilage of foods, industrial production of ethanol and penicillin, microbial enzymes and their applications in food processing industries.
- Biodegradable polymers, their production and applications, microbial polysaccharides (exopolysaccharides, EPS) and their industrial significance.
- Bioremediation of hazardous chemicals and environmental pollutants.
- Water microbiology- indicator microorganisms, sewage treatment (primary, secondary, tertiary).

PRACTICALS

- Micro-propagation and hardening of banana plant
- Isolation of microbes from soil or water sample for total plate count.
- Determination of generation time and growth rate of bacterium via turbidimetric method.
- Comparative analysis of water samples through Most Probable Number (MPN)

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10
2. PPTpresentation: 10
3. Attendance and Participation in class: 5
4. Practical skills, laboratory reports: 5

Bibliography

1. Applied Botany – R. Maiti, H.G. Rodriguez, A.K. Thakur
2. Applied Botany – S. Rahi & A.K. Dubey
3. Plant Physiology and Development — Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, Angus S. Murphy — Oxford University Press / Sinauer Associates
4. Introduction to Plant Biotechnology — H. S. Chawla — CBS Publishers & Distributors (India)
5. Plant Biotechnology: The Genetic Manipulation of Plants — Adrian Slater, Nigel Scott, Mark Fowler — Oxford University Press
6. Prescott's Microbiology — Joanne Willey, Linda Sherwood, Christopher Woolverton — McGraw-Hill Education
7. Principles of Fermentation Technology — P.F. Stanbury, A. Whitaker, S.J. Hall — Elsevier / Butterworth-Heinemann
8. Bioinformatics: Sequence and Genome Analysis — David W. Mount — Cold Spring Harbor Laboratory Press

RPC – 1

Course Name: Research Methodology and Ethics

Course Code: BSCBOTRP801

Course Type: RP (Theoretical)	Course Details: RPC-1			L-T-P: 4-0-0	
Credit: 4	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		0	30	0	70

Course Learning Outcomes:

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

- ✓ Understand the concept of research and different types of research in the context of biology
- ✓ Have basic awareness of data analysis-and hypothesis testing procedures
- ✓ Develop laboratory experiment related skills.
- ✓ Analyze the ethical aspects of research
- ✓ Evaluate the different methods of scientific writing and reporting

UNIT 1: RESEARCH DESIGN & FORMULATION **(10 lectures)**

- Problem Identification- Review of literature (literature surfing) and identifying the research gaps; ONOS (One Nation One Subscription).
- Hypothesis Formulation-Types of hypotheses, characteristics of a good hypothesis and hypothesis testing

UNIT 2: DATA COLLECTION METHODS **(10 lectures)**

- Primary Data Collection: Field surveys and laboratory works.
- Secondary Data Collection: from published data (research/review articles)
- Significance of primary data and secondary data

UNIT 3: DATA ANALYSIS & INTERPRETATION **(10 lectures)**

- Significance tests (t-tests, Z-test, ANOVA) with examples; correlation and regression with examples.
- Data Tools: Basic understanding of software tools like SPSS, Excel, R, or Python for data analysis.

UNIT 4: RESEARCH ETHICS & INTEGRITY **(15 lectures)**

- Scientific Misconduct (FFP): Fabrication (making up data), Falsification (manipulating data), and Plagiarism; plagiarism checkers (turnitin and scribbr).
- Publication Ethics: Authorship disputes, conflicts of interest, duplicate/redundant publications and predatory journals.

UNIT 5: FUNDAMENTAL IDEA ON PUBLISHING **(15 lectures)**

- Structure of Research Paper/Thesis: IMRAD format (Introduction, Methods, Results, and Discussion).
- Concept of manuscript and a scientific journal, volume & issue number; Fundamental difference between Research Article and Review Article; Brief knowledge on ResearchGate; Google Scholar; Orcid;Vidwan; Shodh Ganga; SCOPUS; WoS; Impact Factor; Cite Score; H-Index; i-Index; Importance of Peer Review in research.

Bibliography

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Ruzin, S. E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
3. Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
4. Walliman, N. 2011.Research Methods- The Basics. Taylor and Francis, London, New York.
5. C. R. Kothari: Research Methodology, New Age International, 2009
6. Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing". Stage Publications.

RPC – 2

Course Name: Research Project / Dissertation

Course Code: BSCBOTRP802

Course Type: RP (Practical)	Course Details: RPC-2			L-T-P: 0-0-16	
Credit: 8	Full Marks: 200	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		120	0	80	0

Criteria / Guidelines for Research Project

75% marks and attendance is a mandatory requirement for taking research paper in 8th semester as optional. Still depending upon the availability of research scope in the home institution or other institution/research lab final decision can be taken by the Co-Ordinator/HOD of the concerned department. The project report may have the following sections: 1. Preliminary (Title page, declaration, certificate of the supervising teacher, content etc.) 2. Introduction with relevant literature review and objective 3. Materials and Methods 4. Result 5. Discussion 6. Conclusion / Summary 7. References. About 2 - 4 months of duration of the research project is mandatory. The project report should be submitted on typed A4 paper, 12 Font, 1.5 Space in spirally/hard bound form and duly attested by the supervising authority and the Head of the Department on the day of practical examination before a board of two Examiners for End Semester. The viva-voce based on the project is conducted individually.

MINOR COURSE - 7

Course Name : Genetics, Cell & Molecular Biology and Plant Biotechnology

Course Code : BSCBOTMN801

Course Type: Major (Theoretical & Practical)	Course Details: MNC-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:

Students will be able to

- ✓ Explain basic principles of Mendelian inheritance and gene interactions.
- ✓ Describe linkage, mutations, and chromosomal variations.
- ✓ Understand cell structure, organelles, and cell cycle.
- ✓ Explain DNA replication, transcription, and translation.
- ✓ Describe gene regulation in prokaryotes.
- ✓ Understand principles of plant tissue culture and micropropagation.
- ✓ Explain gene transfer methods and transgenic plants.
- ✓ Describe applications of plant biotechnology in crop improvement.

UNIT 1: GENETICS **(20 Lectures)**

- Principles of genetics - Mendelism: History; Mendel's Laws of inheritance; Chromosome theory of inheritance; Incomplete dominance and codominance; Gene Interactions - Multiple alleles, Lethal genes, Epistasis, Complementary gene action.
- Linkage and crossing over – Linkage, Linkage groups, Complete and incomplete linkage, Coupling and Repulsion theory; Linkage and Crossing over, Mechanism of Crossing Over (Breakage and Reunion theories and Holliday Model).
- Mutation and Chromosomal aberration – Definition of mutation, Different types of point mutations; Transition and Transversion; Frame-shift mutation; Spontaneous and Induced Mutations; Physical and chemical mutagens (Base analogs, alkylating agents and UV radiation); Structural and Numerical Aberrations.

UNIT 2: CELL & MOLECULAR BIOLOGY **(10 lectures)**

- Cell structure and organelles: Chloroplast, mitochondria, endoplasmic reticulum and golgi apparatus; Nucleus - Structure and function; nuclear pore complex; nucleolus.
- Cell membrane and transport: Overview of membrane structure and function; fluid mosaic model; Membrane transport – Passive, active and facilitated transport.

UNIT 3: PLANT BIOTECHNOLOGY **(15 lectures)**

- Historical perspective of plant tissue culture; 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, Cryopreservation.

PRACTICALS

- Chi-square test in assessing observed genetic ratios from expected Mendelian ratios.
- Study of plant cell structure with the help of epidermal peel mount of Onion/ *Rhoeo*.
- Study of the movement of chloroplast (Cytoplasmic streaming/ Cyclosis) in the leaves of *Hydrilla*.
- Demonstration of MS media preparation for tissue cultural techniques.

Format for Conducting CA (30 Marks) Practical Examination

1. Assessment based on practical topics (class test): 10
2. PPT/Poster preparation: 10
3. Attendance and Participation in class: 5
4. Practical skills, laboratory reports: 5

Bibliography

1. Molecular Biology of the Cell-Bruce Alberts et al.-W. W. Norton & Company (Cell & Molecular Biology)
2. Introduction to Plant Biotechnology-H. S. Chawla-CBS Publishers & Distributors (Plant Biotechnology)
3. Plant Molecular Genetics and Bioengineering-Walter Suza et al.-Iowa State University Digital Press (open reference)
4. Plant Biotechnology and Molecular Markers-P.S. Srivastava, Alka Narula, Sheela Srivastava-Springer

Theory Classes per Major Paper (KNU Botany Curriculum)
15 teaching weeks per semester

Semester	Paper	Lecture hrs/week	Weeks	Theory Classes
I	MJC-1	3	15	45
II	MJC-2	3	15	45
III	MJC-3	3	15	45
III	MJC-4	3	15	45
IV	MJC-5	3	15	45
IV	MJC-6	3	15	45
V	MJC-7	3	15	45
V	MJC-8	3	15	45
V	MJC-9	3	15	45
VI	MJC-10	3	15	45
VI	MJC-11	3	15	45
VI	MJC-12	3	15	45
VI	MJC-13	3	15	45
VII	MJC-14	3	15	45
VII	MJC-15	3	15	45
VII	MJC-16	3	15	45
VII	MJC-17	3	15	45
VIII	MJC-18	3	15	45
VIII	MJC-19	2	15	30
VIII	MJC-20	2	15	30
VIII	MJC-21	2	15	30

Semester-wise Total Theory Classes

Semester	Major Papers	Total Theory Classes
I	1	45
II	1	45
III	2	90
IV	2	90
V	3	135
VI	4	180
VII	4	180
VIII	4	135

KNU Botany Practical Classes and Research Project Workload
15 teaching weeks per semester
Practical hours (P) are treated as practical classes per week

Semester	Paper	Practical hrs/week	Weeks	Practical Classes
I	MJC-1	4	15	60
II	MJC-2	4	15	60
III	MJC-3	4	15	60
III	MJC-4	4	15	60
IV	MJC-5	4	15	60
IV	MJC-6	4	15	60
V	MJC-7	4	15	60
V	MJC-8	4	15	60
V	MJC-9	4	15	60
VI	MJC-10	4	15	60
VI	MJC-11	4	15	60
VI	MJC-12	4	15	60
VI	MJC-13	4	15	60
VII	MJC-14	4	15	60
VII	MJC-15	4	15	60
VII	MJC-16	4	15	60
VII	MJC-17	4	15	60
VIII	MJC-18	4	15	60
VIII	MJC-19	4	15	60
VIII	MJC-20	4	15	60
VIII	MJC-21	4	15	60
VIII	Research Project (RPC-2)	16	15	240

Semester-wise Total Practical Classes

Semester	Major Practical Classes	Research Project
I	60	-
II	60	-
III	120	-
IV	120	-
V	180	-
VI	240	-
VII	240	-
VIII	240	240 (RPC-2)