Four-year Undergraduate Programme
Subject: Botany
Semester: First
Course code: *BOT-C-01 (Th)*
Course Name: *Plant and Microbial Diversity*

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Bacteria and Viruses:** Bacteria: General features, cell structure, reproduction, conjugation, transformation, and transduction; introduction to Archaebacteria Viruses: General features, replication, reproduction (Lytic and Lysogenic life cycles), RNA virus (TMV), DNA virus (Cauliflower Mosaic Virus).	6	10
Unit 2	**Algae:** General features, cell structure, range of thallus structure, reproduction, and classification; a brief account on *Nostoc*, *Oedogonium*, and *Chara*	6	10
Unit 3	**Fungi & Lichens:** General features, distribution of fungi and its current status in the living world, reproduction, and classification (Anisworth, 1973); a brief account of *Mucor*, *Ascobolus*, and *Agaricus*; a brief account on lichens: structure, types, and economic importance	9	12
Unit 4	**Bryophytes and Pteridophytes:** Bryophytes: General features, adaptation to land habits, classification, and evolutionary trends; a brief account on *Marchantia* and *Polytrichum* Pteridophytes: General features, classification, reproduction, evolutionary trends (stellar evolution), and affinities; a brief account on *Lycopodium*, *Selaginella*, and *Pteris*	12	14
Unit 5	**Gymnosperms and Angiosperms:** Gymnosperms: General features, classification, reproduction, evolutionary trends, and affinities; a brief account on *Cycas*, and *Gnetum* Angiosperms: General features, Concept of an artificial, natural, and phylogenetic system of classification. Floral parts and inflorescence; Brief accounts on Lamiaceae and Orchidaceae	12	14

BOT-C-01 (Pr) [Credit: 01]		
1. Study of structure of TMV and Bacteriophage (electron micrographs/models). 2. Study of morphology of *Nostoc*, *Oedogonium*, *Chara* (Temporary preparation of slides). 3. Study of *Mucor*, *Ascobolus, Agaricus* (Temporary preparation of slides) 4. Study of vegetative and reproductive parts of *Marchantia* and *Polytrichum*(preparation of slides). 5. Study of *Lycopodium/ Selaginella* (morphology, strobilus, and spores), *Adiantum/ Pteris* (morphology). 6. Study of *Cycas*/ *Pinus* and *Gnetum* (morphology, leaf/ needle, megasporophyll and microsporophyll) 7. Study of leaf venations in dicots and monocots (at least two specimens each) 8. Study of different types of inflorescences and fruits.	30	40

Reading list:

1. Bhatnagar SP, Moitra A (1996) Gymnosperms. New Delhi, Delhi: New Age International (P) Ltd Publishers.
2. Campbell NA, Reece JB (2008) Biology, 8th edition, Pearson Benjamin Cummings, San Francisco.
3. Evert RF, Eichhorn SE (2012) Raven Biology of Plants, 8th edition, New York, NY: W.H. Freeman and Company.
4. Ingrouille M, Eddie B (2006) Plants: Evolution and Diversity. Cambridge University Press.
5. Kumar HD (1999) Introductory Phycology, 2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.
6. Parihar NS (1991) An Introduction to Embryophyta. Vol. II. Pteridophytes. Prayagraj: U.P.: Central Book Depot.
7. Pelczar MJ (2001) Microbiology, 5th edition. New Delhi, Delhi: Tata McGraw-Hill Co.
8. Puri P (1985) Bryophytes. New Delhi, Delhi, Atma Ram and Sons.
9. Sethi IK, Walia SK (2018) Text book of Fungi and Their Allies. 2nd Edition, Med tech Publishers, Delhi.
10. Singh G (2019) Plant Systematics: An Integrated Approach. 4th edition. CRC Press, Taylor and Francis Group.

11. Singh V, Pandey PC, Jain DK (2001) A Text Book of Botany. Meerut, UP: Rastogi and Co.
12. Tortora GJ, Funke BR, Case CL (2007) Microbiology. San Francisco, U.S.A: Pearson Benjamin Cummings.
13. Vashishta PC, Sinha AK, Kumar A (2010) Pteridophyta. New Delhi, Delhi: S. Chand & Co Ltd.
14. Webster J, Weber R (2007) Introduction to Fungi. Cambridge, Cambridge University Press.

Graduate Attributes

Course Objective:

This paper will explain the diversity of Bacteria, Viruses, Algae, Fungi & Lichen, Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms on the planet, and how they may be related to each other. The emphasis will also be on the hands-on approach and laboratory techniques for identification of the plant and microbial groups using various morphological features.

Learning outcome:

On successful completion of the course, students will have:

1. Knowledge with the concept of different kingdoms and the theories behind how life began.
2. Basic understanding of the characteristics, distribution, classification, reproduction, and current status of various microbial and plant communities.
3. Good understanding of virus, algae, fungus, bryophyte, and pteridophyte cell structures, dicotyledonous and monocotyledonous leaf venation patterns, and inflorescence and fruit features.
4. Knowledge to identify various groups of organisms in the laboratory through morphological analysis.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: First
Course code: *BOT-M-01 (Th)*
Course Name: *Plant and Microbial Diversity*

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Bacteria and Viruses:** Bacteria: General features, cell structure, reproduction, conjugation, transformation, and transduction; introduction to Archaebacteria Viruses: General features, replication, reproduction (Lytic and Lysogenic life cycles), RNA virus (TMV), DNA virus (Cauliflower Mosaic Virus).	6	10
Unit 2	**Algae:** General features, cell structure, range of thallus structure, reproduction, and classification; a brief account on *Nostoc*, *Oedogonium*, and *Chara*	6	10
Unit 3	**Fungi & Lichens:** General features, distribution of fungi and its current status in the living world, reproduction, and classification (Anisworth, 1973); a brief account of *Mucor*, *Ascobolus*, and *Agaricus*; a brief account on lichens: structure, types, and economic importance	9	12
Unit 4	**Bryophytes and Pteridophytes:** Bryophytes: General features, adaptation to land habits, classification, and evolutionary trends; a brief account on *Marchantia* and *Polytrichum* Pteridophytes: General features, classification, reproduction, evolutionary trends (stellar evolution), and affinities; a brief account on *Lycopodium*, *Selaginella*, and *Pteris*	12	14
Unit 5	**Gymnosperms and Angiosperms:** Gymnosperms: General features, classification, reproduction, evolutionary trends, and affinities; a brief account on *Cycas*, and *Gnetum* Angiosperms: General features, Concept of an artificial, natural, and phylogenetic system of classification. Floral parts and inflorescence; Brief accounts on Lamiaceae and Orchidaceae	12	14

BOT-M-01 (Pr) [Credit: 01]		
9. Study of structure of TMV and Bacteriophage (electron micrographs/models). *10.* Study of morphology of *Nostoc*, *Oedogonium*, *Chara* (Temporary preparation of slides). 11. Study of *Mucor*, *Ascobolus, Agaricus* (Temporary preparation of slides) 12. Study of vegetative and reproductive parts of *Marchantia* and *Polytrichum*(preparation of slides). 13. Study of *Lycopodium/ Selaginella* (morphology, strobilus, and spores), *Adiantum/ Pteris* (morphology). 14. Study of *Cycas*/ *Pinus* and *Gnetum* (morphology, leaf/ needle, megasporophyll and microsporophyll) 15. Study of leaf venations in dicots and monocots (at least two specimens each) 16. Study of different types of inflorescences and fruits.	30	40

Reading list:

15. Bhatnagar SP, Moitra A (1996) Gymnosperms. New Delhi, Delhi: New Age International (P) Ltd Publishers.
16. Campbell NA, Reece JB (2008) Biology, 8th edition, Pearson Benjamin Cummings, San Francisco.
17. Evert RF, Eichhorn SE (2012) Raven Biology of Plants, 8th edition, New York, NY: W.H. Freeman and Company.
18. Ingrouille M, Eddie B (2006) Plants: Evolution and Diversity. Cambridge University Press.
19. Kumar HD (1999) Introductory Phycology, 2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.
20. Parihar NS (1991) An Introduction to Embryophyta. Vol. II. Pteridophytes. Prayagraj: U.P.: Central Book Depot.
21. Pelczar MJ (2001) Microbiology, 5th edition. New Delhi, Delhi: Tata McGraw-Hill Co.
22. Puri P (1985) Bryophytes. New Delhi, Delhi, Atma Ram and Sons.
23. Sethi IK, Walia SK (2018) Text book of Fungi and Their Allies. 2nd Edition, Med tech Publishers, Delhi.
24. Singh G (2019) Plant Systematics: An Integrated Approach. 4th edition. CRC Press, Taylor and Francis Group.

25. Singh V, Pandey PC, Jain DK (2001) A Text Book of Botany. Meerut, UP: Rastogi and Co.
26. Tortora GJ, Funke BR, Case CL (2007) Microbiology. San Francisco, U.S.A: Pearson Benjamin Cummings.
27. Vashishta PC, Sinha AK, Kumar A (2010) Pteridophyta. New Delhi, Delhi: S. Chand & Co Ltd.
28. Webster J, Weber R (2007) Introduction to Fungi. Cambridge, Cambridge University Press.

Graduate Attributes

Course Objective:

This paper will explain the diversity of Bacteria, Viruses, Algae, Fungi & Lichen, Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms on the planet, and how they may be related to each other. The emphasis will also be on the hands-on approach and laboratory techniques for identification of the plant and microbial groups using various morphological features.

Learning outcome:

On successful completion of the course, students will have:

5. Knowledge with the concept of different kingdoms and the theories behind how life began.
6. Basic understanding of the characteristics, distribution, classification, reproduction, and current status of various microbial and plant communities.
7. Good understanding of virus, algae, fungus, bryophyte, and pteridophyte cell structures, dicotyledonous and monocotyledonous leaf venation patterns, and inflorescence and fruit features.
8. Knowledge to identify various groups of organisms in the laboratory through morphological analysis.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: First
Course code: *SEC-01 (Th)*
Course Name: *Mushroom Cultivation & Vermicomposting*

THEORY [Total marks: 75 (40+20+15)] Credit: 03 (2+1)			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Introduction, history, nutritional and medicinal value of edible mushrooms. Poisonous mushrooms, types of edible mushrooms available in india, Volvariella volvacca, Pleurotus citrinopileatus, Agaricus bisporus	10	08
Unit 2	Cultivation technology: infrastructure substrates (locally available), polythene bag, vessels. Inoculation book, inoculation loop, low cost stove,culture rack, mushroom unit. Pure culture medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation, paddy straw, sugarcane crash, maize straw, banana leaves. Low cost technology and composting technology in mushroom production.	20	12
Unit 3	Storage and nutrition: short term storage, long term storage (canning, pickles, papads), drying storage in salt solutions. Nutrition – proteins, amino acids, mineral elements, carbohydrates, Crude fiber content – Vitamins.	15	08
Unit 4	Food preparation: Types of food prepared from mushrooms research centres. National level and regional level. Cost benefit ratio – marketing in india and abroad , export value.	10	06
Unit 5	Eartworm cultivation, Vermicompost production and application as organic fertilizer.	05	06

Four-year Undergraduate Programme
Subject: Botany
Semester: Second
Course Name: Cell Biology
Course code: *BOT-C-02 (Th)*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**The cell:** Cell as a unit of structure and function; cell theory, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory); Cytoskeleton	8	10
Unit 2	**Cell wall and plasma membrane:** Structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport.	10	14
Unit 3	**Cell organelles:** Nucleus: Structure-nuclear envelope, Organization of chromatin, Nucleolus, Ribosome, Chloroplast, Mitochondria, Peroxisomes, Endoplasmic Reticulum, Golgi Apparatus, and Lysosomes.	10	14
Unit 4	**Cell Division:** Types of cell division, stages of mitosis and meiosis; phages of eukaryotic cell cycle, regulation of cell cycle-checkpoints, role of protein kinases	9	12
Unit 5	**Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA	8	10

BOT-C-02 (Pr) [Credit: 01]		
1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins. 2. Study of plant cell structure with the help of epidermal peel mount of Onion/ *Rhoeo*/ *Crinum*. 3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* and *Vallisnaria*leaf. 4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/ pollen grains). 5. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique. 6. Study different stages of mitosis and meiosis.	30	40

Reading list:

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
2. Campbell MK (2012) Biochemistry, 7th Edition. Published by Cengage Learning
3. Campbell PN, Smith AD (2011) Biochemistry Illustrated, 4th Edition, Published by Churchill Livingstone.
4. Cooper GM, Hausman RE (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Hardin J, Becker G, Skliensmith LJ (2012) Becker's World of the Cell, Pearson EducationInc. U.S.A. 8th Edition.
6. Karp G (2010) Cell Biology, John Wiley & Sons, U.S.A. 6th Edition.
7. Nelson DL, Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company.
8. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd Edition, W.H. Freeman.

Graduate Attributes

Course Objective:

This paper will explain biomolecules, the basic building blocks of living organisms, with a focus on their structural organization, molecule properties, biological roles, and functions. The emphasis will be on the relationship between the structure and function of various biomolecules at the chemical level with a biological perspective, as well as a hands-on approach and laboratory techniques.

Learning outcome:

On successful completion of the course, students will be:

1. Able to obtain knowledge of structure, classification, and physicochemical properties of biomolecules and enzymes.
2. Detailed knowledge of the structure, properties, and functions of a cell and its components.
3. Acquainted with practical knowledge of properties of cell and cell membranes, DNA staining techniques, and microscopy of the plant cell.
4. Able to identify various biomolecules in the laboratory by qualitative tests of biomolecules.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Second
Course Name: *Cell Biology*
Course code: *BOT-M-02 (Th)*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**The cell:** Cell as a unit of structure and function; cell theory, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory); Cytoskeleton	8	10
Unit 2	**Cell wall and plasma membrane:** Structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport.	10	14
Unit 3	**Cell organelles:** Nucleus: Structure-nuclear envelope, Organization of chromatin, Nucleolus, Ribosome, Chloroplast, Mitochondria, Peroxisomes, Endoplasmic Reticulum, Golgi Apparatus, and Lysosomes.	10	14
Unit 5	**Cell Division:** Types of cell division, stages of mitosis and meiosis; phages of eukaryotic cell cycle, regulation of cell cycle-checkpoints, role of protein kinases	9	12
Unit 6	**Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA	8	10

BOT-M-02 (Pr)		
7. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins. 8. Study of plant cell structure with the help of epidermal peel mount of Onion/ *Rhoeo*/ *Crinum*. 9. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* and *Vallisnaria*leaf. 10. Counting the cells per unit volume with the help of haemocytometer. (Yeast/ pollen grains). 11. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique. 12. Study different stages of mitosis and meiosis.	30	40

Reading list:

9. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
10. Campbell MK (2012) Biochemistry, 7th Edition. Published by Cengage Learning
11. Campbell PN, Smith AD (2011) Biochemistry Illustrated, 4th Edition, Published by Churchill Livingstone.
12. Cooper GM, Hausman RE (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
13. Hardin J, Becker G, Skliensmith LJ (2012) Becker's World of the Cell, Pearson EducationInc. U.S.A. 8th Edition.
14. Karp G (2010) Cell Biology, John Wiley & Sons, U.S.A. 6th Edition.
15. Nelson DL, Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company.
16. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd Edition, W.H. Freeman.

Graduate Attributes

Course Objective:

This paper will explain biomolecules, the basic building blocks of living organisms, with a focus on their structural organization, molecule properties, biological roles, and functions. The emphasis will be on the relationship between the structure and function of various biomolecules at the chemical level with a biological perspective, as well as a hands-on approach and laboratory techniques.

Learning outcome:

On successful completion of the course, students will be:

5. Able to obtain knowledge of structure, classification, and physicochemical properties of biomolecules and enzymes.
6. Detailed knowledge of the structure, properties, and functions of a cell and its components.
7. Acquainted with practical knowledge of properties of cell and cell membranes, DNA staining techniques, and microscopy of the plant cell.
8. Able to identify various biomolecules in the laboratory by qualitative tests of biomolecules.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Third
Course code: *BOT-C-03 (Th)*
Course Name: *Morphology and Anatomy of Angiosperms*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to Plant Morphology and Anatomy:** Morphology of inflorescence, stamens and carpel, fruit; Telome theory, phyllode theory; Role of morphology in plant taxonomy. Plant anatomy: Application in systematic.	6	10
Unit 2	**Tissue and Tissue Systems:** Classification of tissues; Simple and complex tissue, Tissue systems, Pits and plasmodesmata; Types of vascular bundles; Endodermis, exodermis and origin of lateral root. Hydathodes, cavities, lithocysts and laticifers;Ergastic substances.	7	8
Unit 3	**Structure and Development of Plant Body:** Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryonic development. Origin and development of leaves; Structure of dicot and monocot stem, root and leaf; Kranz anatomy.	5	8
Unit 4	**Apical meristems:** Concept of organization ofshoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Organization of root apex (Apical cell theory, Histogen theory); Quiescent centre; Root cap.	11	14
Unit 5	**Vascular Cambium and Wood:** Structure, function and seasonal activity of cambium; Secondary growth in stem and root. Sapwood and heartwood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm and lenticels.	11	12

Unit 6	**Adaptive and Protective Systems:** Epidermis, cuticle, trichomes (uni-and multicellular, glandular and nonglandular,), classification of stomata; Anatomical adaptations of xerophytes and hydrophytes.	5	8

Four-year Undergraduate Programme
Subject: Botany
Semester: Third
Course code: *BOT-C-04 (Th)*
Course Name: *Phylogeny and Palaeobotany*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Phylogeny of Angiosperms Classification, cladistics and angiosperm diversity:** Components of major systems of classification: Cronquist (1981), Takhtajan's System (2009), Thorne (2007); Basis of APG Classification, APG IV (2016), emphasis on major clades; Concepts of palaeo-herbs and eudicots (tricolpates). Cladistics: Components methodology and implications;	6	10
Unit 2	**Angiosperm diversity:** General characteristics, phylogeny and evolutionary trends in Magnollidae, Asteridae, Alismatidae, and Liliidae (sensu Cronquist, 1981)..	7	8
Unit 3	**Palaeobotany :** Geological time scale with dominant plant groups through ages. Plant Fossils : Types: Body fossil (Micro- and Mega-fossils), Trace fossil, Chemical fossil, Index fossil, Different modes of preservation (Schopf, 1975), Conditions favouring fossilization, Nomenclature and Reconstruction. Principle of fossil dating(abriefidea), Importance of fossil study	5	8
Unit 4	**Fossil Pteridophytes**: Structural features, Geological distribution and Evolutionary significance of Rhynia, Lepidodendron (Reconstructed), Calamites (Reconstructed).	11	14
Unit 5	**Fossil gymnosperms:** Structural features and Geological distribution of reconstructed genera Lyginopteris, Williamsonia, Cordaites.	11	12
Unit 6	**Indian Gondwana System:** Three folds division with major mega fossil assemblages.	5	8

BOT-C-03 (Pr) [Credit: 01]		
1. Study of special types of inflorescences – Cyathium, Hypanthodium, Verticillaster, Hypanthium. Study of special types of fruits- Spurious fruits (*Dillenia*); Aggregate fruits (Custard apple, fragaria, *Michelia*, Periwinkles, *Polyalthia*); Multiple fruits (Pineapple, Jack fruits). 2. Study of anatomical details through permanent slides/temporary stain mounts / macerations / museum specimens with the help of suitable examples. 3. Apical meristem of root, shoot and vascular cambium (permanent slides/ photographs) 4. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular. 5. Root anatomy: monocot and dicot 6. Stem anatomy: monocot and dicot 7. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy). 8. Adaptive Anatomy: xerophytes, hydrophytes. 9. Morphological study: Ptilophyllum and Glossopteris leaf fossils . 10. Study from permanent slides: T.S. of stem of Rhynia, Lepidodendron, Calamites, Lyginopteris, Cordaites. 11. Morphological study of Primitive angiospermic flower: Magnolia flower	30	40

Reading list:

1. Dickison WC (2000) Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Evert RF (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.
3. Fahn A (1974) Plant Anatomy. Pergmon Press, USA.
4. Mauseth JD (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

Graduate Attributes

Course Objective :

This paper will explain the detailed account on the morphological and anatomical features of Angiosperms.

Learning outcome:

1. Knowledge on morphology of angiosperms and developmental biology of plant body.
2. Knowledge on structural and anatomical organization of tissue system in plants and their classification.
3. Practical knowledge on inflorescences and fruits of angiosperms.
4. Practical knowledge on anatomical features of plant body parts.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Third
Course code: *BOT-M-03 (Th)*
Course Name: *Morphology and Anatomy of Angiosperms*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to Plant Morphology and Anatomy:** Morphology of inflorescence, stamens and carpel, fruit; Telome theory, phyllode theory; Role of morphology in plant taxonomy. Plant anatomy: Application in systematic.	6	10
Unit 2	**Tissue and Tissue Systems:** Classification of tissues; Simple and complex tissue, Tissue systems, Pits and plasmodesmata; Types of vascular bundles; Endodermis, exodermis and origin of lateral root. Hydathodes, cavities, lithocysts and laticifers;Ergastic substances.	7	8
Unit 3	**Structure and Development of Plant Body:** Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryonic development. Origin and development of leaves; Structure of dicot and monocot stem, root and leaf; Kranz anatomy.	5	8
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Unit 6	**Adaptive and Protective Systems:** Epidermis, cuticle, trichomes (uni-and multicellular, glandular and nonglandular,), classification of stomata; Anatomical adaptations of xerophytes and hydrophytes.	5	8
BOT-M-03 (Pr) [Credit: 01]			
12. Study of special types of inflorescences – Cyathium, Hypanthodium, Verticillaster, Hypanthium. Study of special types of fruits- Spurious fruits (*Dillenia*); Aggregate fruits (Custard apple, fragaria, *Michelia*, Periwinkles, *Polyalthia*); Multiple fruits (Pineapple, Jack fruits). 13. Study of anatomical details through permanent slides/temporary stain mounts / macerations / museum specimens with the help of suitable examples. 14. Apical meristem of root, shoot and vascular cambium (permanent slides/ photographs) 15. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular. 16. Root anatomy: monocot and dicot 17. Stem anatomy: monocot and dicot 18. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy). 19. Adaptive Anatomy: xerophytes, hydrophytes.		30	40

Reading list:

5. Dickison WC (2000) Integrative Plant Anatomy. Harcourt Academic Press, USA.
6. Evert RF (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.
7. Fahn A (1974) Plant Anatomy. Pergmon Press, USA.
8. Mauseth JD (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

Graduate Attributes

Course Objective :

This paper will explain the detailed account on the morphological and anatomical features of Angiosperms.

Learning outcome:

5. Knowledge on morphology of angiosperms and developmental biology of plant body.
6. Knowledge on structural and anatomical organization of tissue system in plants and their classification.
7. Practical knowledge on inflorescences and fruits of angiosperms.
8. Practical knowledge on anatomical features of plant body parts.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Course code: *BOT-C-05 (Th)*
Course Name: *Mycology and Phytopathology*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to Fungi:** General characteristics of fungi; hyphal forms; Cell and Cell wall composition; Nutrition; Origin of fungi; Classification of Fungi (Alexopoulos, 1962 & Ainsworth, 1973); General characteristics of Myxomycota and Eumycota; Symbiotic fungi (Lichen & Mycorrhiza): Structural organization and types.	10	10
Unit 2	**Lower Fungi: Mastigomycotina&Zygomycotina:** Characteristic features; Reproduction; Heterothallism; Life cycle with reference to *Synchytrium, Phytophthora* and *Mucor*	6	8
Unit 3	**Higher fungi: Ascomycotina&Basidiomycotina:** Characteristic features; Reproduction; Different fruiting bodies; Life cycle with reference to *Aspergillus, Peziza, Puccinia* and *Agaricus*	6	12
Unit 4	**Fungi Imperfecti: Deuteromycotina:** General characteristics; Thallus organization; Reproduction; Heterokaryosis & Parasexuality; Classification with special reference to *Alternaria* and *Colletotrichum*	5	8
Unit 5	**Phytopathology:** Concept of plant disease; Symptoms of plant diseases; Etiology and disease cycle; Host-pathogens interaction; Control of plant diseases and quarantine; Bacterial diseases - Citrus canker and angular leaf spot of cotton. Viral diseases - Tobacco Mosaic viruses, vein clearing. Fungal diseases - Early blight of potato, Black stem rust of wheat, White rust of crucifers	10	12
Unit 6	**Applied Mycology:** Role of fungi in biotechnology; food industry (Flavour & texture, Fermentation, Organic acids & Enzymes); Pharmaceutical (Secondary metabolites); Agriculture (Biofertilizers & Biological control); Mushroom cultivation; Medical mycology.	8	10

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Course code: *BOT-C-06 (Th)*
Course Name: *Plant Physiology*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Plant-water relations:** Water Potential and its components; Water absorption by roots: aquaporins; Pathway of water movement: symplast, apoplast, transmembrane pathways; Ascent of sap: Mechanisms, cohesion-tension theory, root pressure, guttation; Transpiration: Factors affecting transpiration, anti-transpirants, mechanism of stomatal movement.	5	8
Unit 2	**Mineral nutrition and nutrient uptake:** Criteria for essentiality of mineral elements, macro and micronutrients, nutrient solutions for plant growth experiments, roles of essential elements, mineral deficiency symptoms, chelating agents, Ion antagonism and toxicity. Transport of ions across cell membrane: Passive and active absorption, electrochemical gradient, facilitated diffusion, carrier systems, proton ATPase pump and ion flux, uniport, symport, antiport..	10	10
Unit 3	**Translocation of organic solutes:** Phloem as the path of organic solute translocation: Experimental evidences, Mechanisms of solute transport, Pressure-Flow Model and Munch's hypothesis, Phloem loading and unloading, Source - sink relationship.	4	8
Unit 4	**Plant growth regulators (PGRs):** Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid; Synthetic PGRs; Application of PGRs in agriculture and horticulture.	10	14

Unit 5	**Physiology of flowering and seed dormancy:** Photoperiodism: SDPs and LDPs, flowering stimulus, florigen concept; Vernalization; Photoreceptors: Phytochrome, crytochrome and phototropin; low energy responses (LER) and high irradiance responses (HIR); Seed dormancy: Significances, causes of dormancy, mechanisms to break dormancy.	8	12
Unit 6	**Plant stress physiology:** Abiotic and biotic stress: Plants' responses to drought, water logging, salinity, heavy metals, freezing, heat stress and pathogen attack. Effect of ROS on metabolism; Stress mitigation strategies (Enzymatic and non-enzymatic).	8	8

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Course code: *BOT-C-07* (Th)
Course Name: *Plant Resources and Economic Botany*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Origin of Cultivated Plants:** Centres of Origin, their importance with reference to Vavilov's work. Introductions, domestication, and loss of crop genetic diversity; evolution of new crops/varieties, importance of germplasm diversity and conservation. Classification of plant resources on the basis of their uses.	6	8
Unit 2	**Food and Food Adjuncts:** Cereals and millets: Rice and wheat (origin, morphology, processing, post-harvest management & uses); Brief account of millets and their climatic and nutritional importance. Legumes: Origin, morphology, cultivation, uses and commercial Spices: Listing of important spices, their family and part used. Economic importance with special reference to Assam Beverages: Tea, Coffee (morphology, processing, cultivation, Types & uses).	12	14
Unit 3	**Plants and Plant Products of Industrial Value:** Oils and Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, soybean, and mustard. Essential Oils: General account, extraction methods, comparison with fatty oils & their uses. Non edible oil yielding trees and importance as biofuel. Sugar and starches. Natural Rubber and Para rubber. fibres; morphology, extraction and uses.	12	14

Unit 4	**Drug-yielding plants:** Therapeutic and habit- forming drugs with special reference to C*inchona, Digitalis, Aloe vera* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards).	5	8
Unit 5	**Forest Products:** Forest and forest products. Timber and Non-Timber Forest Products (NTFP), Forest types of Assam and their conservation strategies; Community forestry.	5	8
Unit 6	**Ethnobotany Hours:**Definition, concept and scope; relevance of ethnobotany in the present context; Traditional knowledge and IPR.	5	8

BOT-C-04 (Pr) [Credit: 01]		
1. Study of vegetative and reproductive structures of Mastigomycotina (*Phytophthora*) and Zygomycotina (*Mucor/Rhizopus*) by temporary mounts and through permanent slides. 2. Study of vegetative and reproductive structures of Ascomycotina (*Aspergillus* and *Penicillium*/*Peziza*) and Basidiomyctina (*Agaricus* and *Puccinia*) by temporary mounts and through permanent slides. 3. Study of vegetative and reproductive structures of Deuteromycotina (*Alternaria* and *Colletotrichum/ Fusarium*) by temporary mounts and through permanent slides; Study of thallus and reproductive structures of lichen and mycorrhiza through permanent slides/ photographs. 4. Study of symptoms of locally available plant diseases caused by fungi, bacteria, and virus by preparation of disease album and bottle specimens. 5. Applied mycology: Photographs/report onfungi used in medicine, fungi used as biological control agents, fungi used in industry, fungi causing human infections	30	40

Reading list:

1. Agrios GN (1997) Plant Pathology, 4thedition, Academic Press, U.K.
2. Alexopoulos CJ, Mims CW, Blackwell M (1996) Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. GanguleeHC, KarAK. College Botany, Vol. II., New Central Book Agency, Kolkata.
4. Hait G (2022) A Textbook of Plant Pathology: Principles and Diseases. Global Net Publication, India.
5. HaitG, BhattacharyaK, GhoshAK (2011) Text Book of Botany, Vol. I & II., New Central Book Agency, Kolkata.
6. MitraJN, MitraD, ChowdhuryS. Studies in Botany. Vol. I., Moulik Library, Kolkata.
7. Pandey BP (2020) Plant Pathology - Pathogen and plant disease. S. Chand and Company Limited, New Delhi, India.
8. Sethi IK, Walia SK (2011) Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
9. Sharma PD (2011) Plant Pathology, Rastogi Publication, Meerut, India.
10. Webster J, Weber R (2007) Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.

BOT-C-05 (Pr) [Credit: 01]		
1. Slide preparation and Gram staining of bacteria (urd bacteria, nodule bacteria) 2. Slide preparation and study of *Nostoc*, *Anabaena*, *Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*, *Colletotrichum*, *Cladosporium* 3. Pure culture isolation of soil bacteria/fungi through serial dilution plating and subsequent sub-culturing methods, population estimation by CFU and haemocytometer. **4.** Measurement of microbial cells/spores with the help of micrometers or inbuilt software in microscopic camera**.** 5. Study on symptoms of plant viral diseases 6. Endospore staining of soil bacteria with malachite green 7. Collection and study of diseases caused by virus, bacteria and fungi in crop plants	30	40

Reading list:

1. Aneja KR, Jain P, Aneza R (2021) A Textbook of Basic and Applied Microbiology. New Age International Publisher.
2. Aneja KR (2022) Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology. New Age International Publisher
3. Bhattacharya IK, Bhattacharya RN (2017) Fundamentals of Microbiology.
4. Pelczar MJ (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
5. Sharma PD (2009) Microbiology. latest edition, Rastogi Publication, Meerut.
6. Singh RS (2017) Plant Diseases.
7. Wiley JM, Sherwood LM and Woolverton CJ (2013) Prescott's Microbiology. McGraw Hill International.

BOT-C-06 (Pr) [Credit: 01]		
1.Determination of osmotic potential of plant cell sap using the plasmolytic method. 2.Measurement of water potential of potato tuber tissues. 3.Study of stomatal distribution and frequency on leaves. 4.Demonstration of ascent of sap/transpiration pull. 5.Preparation of Hoagland's solution and identification of nutrient deficiency symptoms. 6.Determination of pH of soil/water samples. 7.Separation of photosynthetic pigments (chlorophyll a, b, carotenoids) by paper chromatography. 8.Effect of light intensity and CO 9.concentration on the rate of photosynthesis (using Wilmott's bubbler). 10.Demonstration of aerobic and anaerobic respiration. 11.Measurement of the rate of respiration (R.Q.) using a manometer. 12.Detection of heat generation during respiration. 13.Effect of auxins, gibberellins, and cytokinins on plant growth, seed germination, or rooting. 14.Demonstration of geotropism, phototropism, and hydrotropism.	30	40

Reading list:

1. V.K. Jain - *Fundamentals of Plant Physiology* (20th Edition, 2022).
2. Taiz, L., Zeiger, E., Møller, I.M., & Murphy, A. - *Plant Physiology and Development* (7th Edition).
3. Devlin, R.M. & Witham, F.H. - Plant Physiology (4th Edition, CBS Publishers).
4. Noggle, G.R. & Fritz, G.J. - Introductory Plant Physiology (2nd Edition, Prentice-Hall).
5. Gangulee, H.C., Kar, A.K. - College Botany, Vol. II.
6. Srivastava, H.N. - Plant Physiology and Biochemistry (Pradeep Publications).
7. Vinesh - Practical Botany (Plant Physiology, Plant Biochemistry & Metabolism).

Graduate Attributes

Course Objective:

1. To give concise knowledge on basic microbiology and plant physiology

2. To give practical knowledge on handling of microorganisms
3. To inculcate knowledge on usefulness of microorganisms for sustainable development

Learning outcome:

1. Knowledge on microbial diversity and distribution in different habitats
2. Knowledge on ecological and economic importance of microorganisms in our day-to-day life
3. Knowledge on growth, reproduction and life cycles of viruses and microorganisms
4. Knowledge on genetic recombination of bacteria
5. Practical knowledge on microscopy, slide preparation, staining and morphological study of microorganisms
6. Knowledge on pathogenic microorganisms, host-pathogen interaction, and immunity
7. Practical knowledge on isolation and pure culture of bacteria/fungi from soil samples

Graduate Attribute

Course Objective:

This paper will explain the general characteristics and reproductive procedures of fungi from different groups such as Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina. The paper will also focus on the basic idea of host-pathogen interaction during disease development, along with symptomology and the disease cycle of common fungal, bacterial, and viral diseases. Furthermore, the role of fungi in various biotechnological aspects, pharmaceutics, and agriculture will be highlighted.

Learning outcome:

On successful completion of the course, students will have:

1. Perform experimental procedures to measure vital plant functions such as transpiration, osmosis, and respiration.
2. Properly handle lab apparatuses (respirometer, potometer, chromatography setup) and observe aseptic techniques.
3. Explain the movement of sap, absorption of water, and transpiration mechanisms in plants.
4. Isolate pigments and determine enzymatic activities, directly linking metabolic pathways to plant growth.
5. Determination of osmotic potential of vacuolar sap by plasmolytic method; Study of stomatal distribution and stomatal index; Measurement of rate of transpiration (using Ganong’s potometer or Farmer's potometer).
6. Study of respiratory quotient (RQ) using Ganong's respirometer; Demonstration of anaerobic respiration.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Course code: BOT-C-08 (Th)
Course Name: INTERNSHIP
Credit: 04
Total marks: 100

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Course code: *BOT-M-04 (Th)*
Course Name: *Plant Ecology and Climate Change*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Ecology and Ecosystem:** Ecology: Basic concepts, Levels of organization, Inter-relationships between the living world and the environment. Ecosystem: Structure, functions, and types, trophic organisation, food chains and food webs, ecological pyramids, homeostasis.	8	8
Unit 2	**Ecological Factors:** Climatic, Edaphic and Biotic Factors, Factorial interactions, Plant adaptation to environmental factors (light, temperature, wind, and fire); autotrophy, heterotrophy; symbiosis, commensalism, ammensalism, parasitism, parasitoidism. Aquatic ecology- concept.	8	8
Unit 3	**Population ecology:** Population characteristics, Growth curve, Lotka-Volterra model, population regulation, *r* and *k*-selection. Types of ecological speciation, Ecological equivalents.	7	12
Unit 4	**Plant communities:** Plant Community: Basic concept, types, characters (analytical and synthetic), Dynamics: succession – processes, types, models; climax concepts, Habitat and Niche: concept &types.	7	12
Unit 5	**Functional Ecology:** Principles and models of energy flow; Production and productivity; Ecological efficiencies; Ecological energetics; Biogeochemical cycles (C, N and P).	7	10

Unit 6	**Climate Change:** Climate change: Basic concepts; global warming, causes and consequences (Rise in Sea levels, Glacier melting, Biodiversity Loss), Adaptation, Mitigation, Global and National Efforts, Concept on Sustainable Development, Sustainable Development Goals (SDGs).	8	10

BOT-M-04 (Pr) [Credit: 01]		
1. Determination of minimal quadrate size and number for the study of herbaceous vegetation in the college campus by species area curve method (species to be listed). 2. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus. 3. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. 4. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter. 5. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. a) Study of morphological adaptations of hydrophytes and xerophytes (four each). b) Study of biotic interactions of the following: Stem parasite, Root parasite, Epiphytes, Predation (Insectivorous plants). 7. Local field visit to nearby areas to familiarise students with various plant communities. 8. Soil respiration study in two agricultural systems to determine the CO_2 evolution.	30	40

1. Ambasht and Ambasht (2002) A text book of Plant Ecology. CBS publisher and Distributors.
2. Bhattacharya K, Ghosh AK, HaitG (2017) A Text Book of Botany. New Central Book Agency (P), Kolkata, India.
3. Bowmen WD, Hacker SD, Cain ML (2018) Ecology, Oxford University Press.
4. Deka U, Dutta T (2022) Plant Ecology and Phytogeography. Asian Humanitities Press, Guwahati, Assam.
5. KapurP, GovilSR (2000, 2007). Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi (India).
6. Misra R (1968, Reprinted in 2019). Ecology Workbook. Scientific Publishers (India), Jodhpur
7. OdumEP (2005) Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
8. Sharma PD (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
9. Verma PS, Agarwal VK (2003) Environmental Biology-Principles of Ecology. S Chand & Company Ltd. Ramnagar, New delhi-110055.
10. Wilkinson DM (2007) Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

Graduate Attributes

Course Objective:

This course will provide an understanding on ecology and ecosystems, biotic and abiotic interactions, ecosystem processes, terrestrial and aquatic environment, population and community interactions, plant distribution and effect of climate change on natural environment. Emphasis will be given on the hands-on approach, field, and laboratory techniques.

Learning outcome:

On successful completion of the course, students will:

1. Understand the concept of ecology, ecosystems, and importance of factors.
2. Understand the population, community, biodiversity, and conservation strategies.
3. Understand the science of climate change and sustainable developmentstrategies
4. Know the adaptation and mitigation against climate change-induced phenomena.

Reading list:

29. Bhatnagar SP, Moitra A (1996) Gymnosperms. New Delhi, Delhi: New Age International (P) Ltd Publishers.
30. Campbell NA, Reece JB (2008) Biology, 8th edition, Pearson Benjamin Cummings, San Francisco.
31. Evert RF, Eichhorn SE (2012) Raven Biology of Plants, 8th edition, New York, NY: W.H. Freeman and Company.
32. Ingrouille M, Eddie B (2006) Plants: Evolution and Diversity. Cambridge University Press.
33. Kumar HD (1999) Introductory Phycology, 2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.
34. Parihar NS (1991) An Introduction to Embryophyta. Vol. II. Pteridophytes. Prayagraj: U.P.: Central Book Depot.
35. Pelczar MJ (2001) Microbiology, 5th edition. New Delhi, Delhi: Tata McGraw-Hill Co.
36. Puri P (1985) Bryophytes. New Delhi, Delhi, Atma Ram and Sons.
37. Sethi IK, Walia SK (2018) Text book of Fungi and Their Allies. 2nd Edition, Med tech Publishers, Delhi.
38. Singh G (2019) Plant Systematics: An Integrated Approach. 4th edition. CRC Press, Taylor and Francis Group.

Four-year Undergraduate Programme
Subject: Botany
Semester: Fifth
Course code: *BOT-C-09 (Th)*
Course Name: *Genetics*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Mendelian genetics and its extension:** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; pedigree analysis; Incomplete dominance and codominance; Multiple alleligm, Lethal alleles, Epistasis, Pleiotropy, Penetrance and Expressivity, Numericals; Polygenic inheritance.	13	14
Unit 2	**Extrachromosomal Inheritance:** Chloroplast mutation: Variation in Four o'clock plant; Mitochondrial inheritance in yeast; Infective heredity-Kappa particles in *Paramecium*	4	6
Unit 3	**Linkage, crossing over and chromosome mapping:** Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Numerical based on gene mapping; Sex Linkage.	8	10
Unit 4	**Variation in chromosome number and structure:** Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy.	6	8
Unit 5	**Fine structure of gene and Gene mutations:** Classical vs molecular concepts of gene; Ciston, Racon, Muton, rII locus; Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents). Role of Transposons in mutation. DNA repair mechanisms	10	12

Unit 6	**Unit 6. Population and Evolutionary Genetics:** Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, mutation, genetic drift. Genetic variation and Speciation.	4	10

Four-year Undergraduate Programme
Subject: Botany
Semester: Fifth
Course code: *BOT-C-10 (Th)*
Course Name: *Molecular Biology*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Nucleic acids: Carriers of genetic information:** Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.	3	4
Unit 2	**The Structures of DNA and RNA / Genetic Material:** DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. Organelle DNA - mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.	8	12
Unit 3	**The replication of DNA, Central dogma and genetic code:** Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi- conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA; Enzymes involved in DNA replication.	10	12
Unit 4	**Transcription:** Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.	10	12

Unit 5	**Processing and modification of RNA:** Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' poly A tail); Ribozymes; RNA editing and mRNA transport.	7	10
Unit 6	**Translation:** Ribosome structure and assembly, mRNA; structure of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Inhibitors of protein synthesis; Post-translational modifications of proteins.	7	10

Four-year Undergraduate Programme
Subject: Botany
Semester: Fifth
Course code: *BOT-C-11 (Th)*
Course Name: *Plant Ecology and Climate Change*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Ecology and Ecosystem:** Ecology: Basic concepts, Levels of organization, Inter-relationships between the living world and the environment. Ecosystem: Structure, functions, and types, trophic organisation, food chains and food webs, ecological pyramids, homeostasis.	8	8
Unit 2	**Ecological Factors:** Climatic, Edaphic and Biotic Factors, Factorial interactions, Plant adaptation to environmental factors (light, temperature, wind, and fire); autotrophy, heterotrophy; symbiosis, commensalism, ammensalism, parasitism, parasitoidism. Aquatic ecology- concept.	8	8
Unit 3	**Population ecology:** Population characteristics, Growth curve, Lotka-Volterra model, population regulation, *r* and *k*-selection. Types of ecological speciation, Ecological equivalents.	7	12
Unit 4	**Plant communities:** Plant Community: Basic concept, types, characters (analytical and synthetic), Dynamics: succession – processes, types, models; climax concepts, Habitat and Niche: concept &types.	7	12
Unit 5	**Functional Ecology:** Principles and models of energy flow; Production and productivity; Ecological efficiencies; Ecological energetics; Biogeochemical cycles (C, N and P).	7	10
Unit 6	**Climate Change:** Climate change: Basic concepts; global warming, causes and consequences (Rise in Sea levels, Glacier melting, Biodiversity Loss), Adaptation, Mitigation, Global and National Efforts, Concept on Sustainable Development, Sustainable Development Goals (SDGs).	8	10

Four-year Undergraduate Programme
Subject: Botany
Semester: Fifth
Course code: *BOT-C-12 (Th)*
Course Name: *Plant Metabolism and Biochemistry*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Concepts of metabolism:** Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes; classification, nomenclature, and importance of enzyme; Concept of coenzyme, apoenzyme and prosthetic group; Enzyme inhibition (allosteric, covalent modulation); Isozymes.	6	8
Unit 2	**Carbon assimilation:** Role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centers, photochemical reactions, photosynthetic electron transport, PSI, PSII, CO_2 reduction: C3, C4-pathways, CAM Pathway; Photorespiration.	8	12
Unit 3	**Carbon oxidation and ATP Synthesis:** Glycolysis, oxidative decarboxylation of pyruvate, TCA cycle and regulation, amphibolic pathway, mitochondrial electron transport, oxidative phosphorylation, pentose phosphate pathway; Factors affecting respiration; ATP synthesis: substrate level phosphorylation, chemiosmotic theory, ATP synthase.	10	12
Unit 4	**Carbohydrate, Lipid and Nitrogen metabolism:** Synthesis and catabolism of sucrose, starch and cellulose, Synthesis and breakdown of triglycerides, β-oxidation, gluconeogenesis and its role in mobilisation of lipids during seed germination. Nitrogen assimilation: biological nitrogen fixation, biochemistry of nitrogen fixation, ammonia assimilation.	12	14

Unit 5	**Mechanisms of Signal Transduction:** Receptor-ligand interactions, Second messenger concept, Calcium-calmodulin, MAP kinase cascade, two-component system.	5	8
Unit 6	**Secondary Metabolites:** Shikimate Pathway: Role in biosynthesis of secondary metabolites; Biosynthesis and physiological roles of terpenes, phenols and nitrogenous compounds.	4	6

BOT-C-06 (Pr) [Credit: 02]		
1. Mendel's laws through seed ratios. 2. Chromosome mapping using point test cross data. 3. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1,12:3:1, 9:3:4). 4. Permanent Slides showing Translocation Ring, Photograph showing Laggards and Inversion Bridge. 5. DNA isolation from any plant material. 6. DNA estimation by diphenylamine reagent/UV Spectrophotometry (Demonstration). 7. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication). 8.Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs. 9. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.	30	40

Reading list:

1. Gardner EJ, Simmons MJ, Snustad DP (2015) Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Griffiths AJF, Wessler SR, Carroll SB, Doebley J (2010) Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
3. Klug WS, Cummings MR, Spencer CA (2012) Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Snustad DP, Simmons MJ (2010) Principles of Genetics, John Wiley & Sons Inc., India. 5thedition.

Graduate Attributes

Course Objective:

To gain knowledge on classical and modern concepts of genetics.

Learning outcome:

1. Knowledge of Mendelian and non- Mendelian inheritance in organisms.
2. Knowledge of gene and chromosomal mutations
3. Knowledge of basic concepts of population and evolutionary genetics
4. Ability to work out problems related to Mendel's experiments, Chromosome mapping and gene interaction

BOT-C-07 (Pr) [Credit: 01]		
1. Determination of minimal quadrat size and number for the study of herbaceous vegetation in the college campus by species area curve method (species to be listed). 2.Quantitative analysis of herbaceous vegetation for density and abundance in the college campus. 3. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. 4. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter. 5. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 7. Local field visit to nearby areas to familiarise students with various plant communities. 8. Soil respiration study in two agricultural systems to determine the CO_2 evolution. 9. To compare the rate of respiration by Ganong's respirometer in different parts of plant (Demonstration) 1. Separation of amino acids by paper chromatography 2. Demonstration of Thin layer chromatography (TLC)/Column chromatography 3. Chemical separation of photosynthetic pigments bysolvent method/paper chromatography 4. Quantification of chlorophyll a, b and total chlorophyll and determination of chlorophyll a/b ratio	30	40

1. Ambasht and Ambasht (2002) A text book of Plant Ecology. CBS publisher and Distributors.
2. Bhattacharya K, Ghosh AK, HaitG (2017) A Text Book of Botany. New Central Book Agency (P), Kolkata, India.
3. Bowmen WD, Hacker SD, Cain ML (2018) Ecology, Oxford University Press.
4. Deka U, Dutta T (2022) Plant Ecology and Phytogeography. Asian HumanititiesPress, Guwahati, Assam.
5.KapurP, GovilSR (2000, 2007). Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi (India).
6. Misra R (1968, Reprinted in 2019). Ecology Workbook. Scientific Publishers (India), Jodhpur
7. OdumEP (2005) Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
8. Sharma PD (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
9. Verma PS, Agarwal VK (2003) Environmental Biology-Principles of Ecology. SChand & Company Ltd. Ramnagar, New delhi-110055.
10. Wilkinson DM (2007) Fundamental Processes in Ecology: An Earth SystemsApproach. Oxford University Press. U.S.A.

Graduate Attributes

Course Objective:

This course will provide an understanding on ecology and ecosystems, biotic and abiotic interactions, ecosystem processes, terrestrial and aquatic environment, population and community interactions, plant distribution and effect of climate change on natural environment. Emphasis will be given on the hands-on approach, field, and laboratory techniques.

Learning outcome:

On successful completion of the course, students will:

5. Understand the concept of ecology, ecosystems, and importance of factors.
6. Understand the population, community, biodiversity, and conservation strategies.
7. Understand the science of climate change and sustainable developmentstrategies

Know the adaptation and mitigation against climate change-induced phenomena.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Fifth
Course code: *BOT-M-05 (Th)*
Course Name: *Plant Physiology*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Plant-water relations:** Water Potential and its components; Water absorption by roots: aquaporins; Pathway of water movement: symplast, apoplast, transmembrane pathways; Ascent of sap: Mechanisms, cohesion-tension theory, root pressure, guttation; Transpiration: Factors affecting transpiration, anti-transpirants, mechanism of stomatal movement.	5	8
Unit 2	**Mineral nutrition and nutrient uptake:** Criteria for essentiality of mineral elements, macro and micronutrients, nutrient solutions for plant growth experiments, roles of essential elements, mineral deficiency symptoms, chelating agents, Ion antagonism and toxicity. Transport of ions across cell membrane: Passive and active absorption, electrochemical gradient, facilitated diffusion, carrier systems, proton ATPase pump and ion flux, uniport, symport, antiport..	10	10
Unit 3	**Translocation of organic solutes:** Phloem as the path of organic solute translocation: Experimental evidences, Mechanisms of solute transport, Pressure-Flow Model and Munch's hypothesis, Phloem loading and unloading, Source - sink relationship.	4	8
Unit 4	**Plant growth regulators (PGRs):** Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene, Synthetic PGRs; Application of PGRs in agriculture and horticulture.	10	14

Unit 5	**Physiology of flowering and seed dormancy:** Photoperiodism: SDPs and LDPs, flowering stimulus, florigen concept; Vernalization; Photoreceptors: Phytochrome, crytochrome and phototropin; low energy responses (LER) and high irradiance responses (HIR); Seed dormancy: Significances, causes of dormancy, mechanisms to break dormancy.	8	12
Unit 6	**Plant stress physiology:** Abiotic and biotic stress: Plants' responses to drought, water logging, salinity, heavy metals, freezing, heat stress and pathogen attack. Effect of ROS on metabolism; Stress mitigation strategies (Enzymatic and non-enzymatic).	8	8
BOT-M-05 (Pr) [Credit: 01]			
1. Determination of osmotic potential of plant cell sap by the method of plasmolysis. 2. Determination of water potential of given tissue (e.g., potato tuber) by weight method. 3. Study of the effect of sunlight on the rate of transpiration in excised twig/leaf. 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of mesophyte/ xerophyte. 5. Effect of carbon dioxide concentration on the rate of photosynthesis. 6. To study the effect of different concentrations of IAA on Gram/Pea/Moong root (IAA Bioassay). 7. Determination of seed germination percentage in different physical conditions (Demonstration) 8. To demonstrate water stress by application of PEG/ water withdrawal in germinating seeds /growing plants (Demonstration) 9. Fruit ripening/Rooting from cuttings (Demonstration).		30	40

Reading list:

1. Bajracharya D (1999) Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.
2. Bhatla SC, Lal MA (2018) Plant Physiology, Development and Metabolism. Springer Nature Singapore Pte Ltd.

3. Devlin RM (2017) Outline of Plant Physiology. Medtech: Scientific International Pvt. Ltd.
4. Devlin RM, Witham FH, Blaydes DF (2017) Devlin's Exercises in Plant Physiology. Medtech: Scientific international Pvt. Ltd.
5. Hopkins WG, Huner A (2008) Introduction to Plant Physiology (4th edition). John Wiley and Sons. U.S.A.
6. Kochhar SL, Gujral SK (2021) Plant Physiology: Theory and Applications (2nd edition). Cambridge University Press.
7. Malik CP, Srivastava (2015) Text Book of Plant Physiology. Kalyani Publishers, New Delhi.
8. Salisbury FB, Ross CW (2004) Plant Physiology (4^{th} edition). Cengage Learning India Pvt. Ltd., New Delhi, India.
9. Taiz L, Zeiger E, MØller IM, Murphy A (2015) Plant Physiology and Development (6th edition). Sinauer Associates Inc. USA.

Graduate Attributes

Course Objective:

Students will be able to learn the plant and water relation and thus will be able to elucidate the crucial role of water in diverse physiological functions of plants, by studying this paper. The paper will also highlight the importance of mineral elements in plant physiology and various mechanisms applied to uptake mineral elements by plants. It will provide the basic idea of pathways and mechanisms of translocation of organic solutes synthesised in plant. Furthermore, this paper will explain the role and mechanisms of action of various plant growth regulators as well as physiology of flowering and dormancy of seeds. Additionally, the paper will also focus on the different abiotic and biotic stresses encountered by the plants in their environment as well as various stress mitigation strategies employed by plants to overcome the effects of stress.

Learning outcome:

1. Knowledge on mechanisms of water, minerals, and nutrient absorption of plants
2. Knowledge on roles of plant hormones and mechanism of flowering in plants
3. Practical knowledge on effects of growth regulators on plant parts
4. Practical knowledge on determination of osmotic and water potential

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course code: *BOT-C-13 (Th)*
Course Name: *Applied Plant Biology*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Plant Tissue Culture:** Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion.	8	10
Unit 2	**Application of tissue culture:** Micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm conservation.	4	6
Unit 3	**Recombinant DNA technology:** Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).	8	10
Unit 4	**Gene Cloning:** Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR- mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR	9	12
Unit 5	**Methods of gene transfer:** *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics - selectable marker and reporter genes (Luciferase, GUS, GFP).	6	10

Unit 6	**Applications of genetic engineering:** Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug).	10	12

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course code: *BOT-C-14 (Th)*
Course Name: Embryology Of Angiosperm
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Structural organization of flower. Concept of flower as a modified Shoot; Structure of typical flower; Structure of typical Androceium, Structure of tetrasporangiate anther and pollen grain; Structure of typical Gynoecium, Structure of a typical ovule, Types of ovules.	8	10
Unit 2	Pollination and fertilization, Definition, self and cross Pollination, Mechanism in Anemophily (Zea mays), Entomophily (Calotropis) and Hydrophily (Vallisneria). Microsporogensis, and development off male gametophyte, Megasporogenesis and development of female gametophyte: Monosporic (Polygonum) and Bisporic (Allium) 2.5 Fertilization: Entry of pollen tube, double fertilization and triple fusion. Significance of double fertilization	9	12
Unit 3	Sporogenesis and Fertilization: Microsporogensis, and development of male gametophyte, Megasporogenesis and development of female gametophyte: Monosporic (Polygonum) and Bisporic (Allium). Fertilization: Pollen-Pistil interaction, Entry of pollen tube, double fertilization and triple fusion. Significance of double fertilization	8	10
Unit 4	Embryo and Endosperm Development. Structure and development of embryo in Monocotyledons. Structure and development of embryo in Dicotyledons. Development of endosperm. Types of endosperm-Nuclear, Helobial and Cellular.	10	12
Unit 5	Seed and fruit dispersal. Agents of Seed and fruit dispersal. Mechanism of seed and fruit dispersal.	4	6

Unit 6	Polyembryony and Apomixis: Polyembryony Introduction, and significance 5.2 Apomixis Introduction and significance.	6	10

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course code: *BOT-C-15 (Th)*
Course Name: *Plant Systematics*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Significance of Plant systematics:** Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Functions and importance of Herbarium and botanical garden; Important herbaria and botanical gardens of the world and India; Virtual herbarium; Categories and taxonomic hierarchy; Concept of taxa (family, genus, species).	8	8
Unit 2	**Botanical nomenclature:** History, Principles and Rules (ICN); Ranks and names; Typification, Author citation, Effective and Valid publication, Rejection of names, Principle of priority and its limitations.	5	8
Unit 3	**Systems of classification:** Major contributions of Theophrastus, Linnaeus, de Candolle, Hutchinson, Classification systems of Bentham and Hooker, Engler and Prantl, Takhtajan; Brief account of Angiosperm Phylogeny Group (APG) classification.	9	12
Unit 4	**Numerical taxonomy and cladistics:** OTUs, characters, character weighting and coding; Cluster analysis; Phenograms & Cladograms (definitions and differences).	6	8
Unit 5	**Phylogeny of Angiosperms:** Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating	6	10

	evolutionary relationship (phylogenetic tree, cladogram).		
Unit 6	**Angiospermic Families:** Detail study of the following families: Magnoliaceae, Fabaceae, Asteraceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Musaceae, Zingiberaceae, Poaceae.	11	14

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course code: *BOT-C-16 (Th)*
Course Name: *Laboratory and Field Techniques in Plant Science*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Laboratory safety and good practices:** General laboratory safety: dos and don'ts, lab safety measures, code of conduct in laboratory, safe handling of chemicals, glass apparatus, instruments, electrical appliances; First aid practices (acid spills, burns and other injuries), safety symbols, classes/ grades of chemicals, Laboratory waste management..	8	8
Unit 2	**Handling and maintenance of instruments:** Weighing balance, pipettes and micropipettes, magnetic stirrer, autoclave, laminar airflow, pH and conductivity meter (calibrationanduse), Incubator(static and shaker), Luxmeter, hemocytometer, micrometer, spectrophotometer, Agarose gel electrophoresis unit, SDS PAGE unit, centrifuge, distillation unit.	8	12
Unit 3	**Measurements and calculations:** Units of measurements, conversion from one unit to another,Weighing, calculations: Scientific notations, powers; measurement of volumes of liquids.	4	8
Unit 4	**Solutions and Buffers:** Preparation of solutions: stock solution, standard solution. Types of solutions: Normal, Molar, Molal, Percentage, ppm, ppb. Dilution and dilution factors, Acids, Bases, adjustment of pH, Buffers - phosphate, Tris- HCl and Citratebuffer.	6	8
Unit 5	**Microscopy and Culture Techniques:** Microscopes: working principles and types (Light and Electron microscopes), sample and slide preparation: fixation, staining, mounting, preservation(for light and electron microscopy). Basic culture media (NA, NB, PDA , MS), selective and differential media, Culture techniques: plating (streak, spread & pour), serial dilution.	8	12

Unit 6	**Biostatistics, computing and field skills:** Data types-primary and secondary, methods of data collection, sample andsampling methods- merits and demerits; technical and biological replicates; Tabulation and presentation of data, Descriptive statistics - Mean, Median, Mode,Variance, Standard Deviation, Standard error, Coefficient of Variation, MS-Word, Power Point, Excel, concept on biological databases. Collection, Identification, Preparation and Preservation of Herbarium and Museum specimens.	11	12

BOT-C-08 (Pr) [Credit: 02]		
1. Study of germination of pollen grains. 2. Detection of pollen fertility by staining technique. 3. Study of types of ovules (by permanent slide or photograph). 4. Study of dicotyledon and monocotyledon embryo (by permanent slide or photograph). 5. Dissection of dicot embryo. 6. Study of endosperm from developing seeds. 7. Study of self and cross pollinated plants. 8. Study of pollination mechanism (Maize, Calotropis). 9. Dispersal of seeds. 10. Dispersal of Fruits.	30	40

Reading list:

1. Bhojwani S S and Bhatnagar S P. An Embryology of Angiosperms.
2. Maheshwari P. An introduction to Embryology of Angiosperms.
3. Nair P K K. Essentials of Palynology.
4. S. C. Datta. Systematic Botany. New Age International Publishers, New Delhi. (2015).
5. Pandey S N and Ajanta Chadha. Plant Anatomy and Embryology.Vikas Publishing House,Pvt, Ltd, New Delhi

Graduate Attributes

Course Objective:

To gain knowledge on the reproductive structures, pollination, fertilization, embryogenesis and types of endosperms of angiospermic plants.

Learning Outcome:

● Students will understand the role and mechanism of flower in plant production
● Understanding of developmental stages of embryo and endosperm will help the students to produce quality food production as well as quality seed production.
● Knowledge of embryology will help the students to maintain the plant health

BOT-C-09 (Pr) [Credit: 02]		
1. Preparation of solutions- molar, molal, normal, percentage, stock solution and dilution 2. Measurement of pH of solutions using pH meter/ pH strip and preparation of buffers (Phosphate /citrate buffer) 3. Working with instruments - Centrifuge, autoclave, laminar air flow, hot air oven, incubator, light microscope, spectrophotometer/colorimeter, 4. Slide preparation and staining of plant materials. 5. Determination of cell/spore size using micrometer. 6. Preparation of PDA/NA medium for growth and maintenance of fungal/bacterial cultures. 7. Calculation of mean, mode, median, standard deviation using data set. 8. Drawing of tables, graphs and to carry out statistical calculation using Microsoft Excel. 9. Preparation of herbarium specimen: Collection, processing, mounting, and labelling of plant specimen. 10. Study of vegetative and floral characters of locally available angiospermic plants belonging to 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): Fabaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Musaceae, Orchidaceae. 11. Field visits to familiarise students with vegetation of an area and identification of plant species / Visit to Academic or Research Institutions. 12. Mounting of properly dried and pressed specimens of at least 10 (ten) wild plant species with herbarium labels (to be submitted with the record book).	30	40

Reading list:

1. Bisen PS (2014) Laboratory Protocols in Applied Life Sciences, 1st Edition. CRC Press.
2. Danniel WW (1987) Biostatistics. New York, NY: John Wiley Sons.
3. Evert RF, Eichhorn SE, Perry JB (2012) Laboratory Topics in Botany. W.H. Freeman and Company.
4. Jones AM, Reed R, Weyers J (2016) Practical Skills in Biology, 6th Edition, Pearson

5. Mann SP (2016) Introductory Statistics, 9th edition. Hoboken NJ, John Wiley and Sons Inc.
6. Mesh MS, Kebede-Westhead E (2012) Essential Laboratory Skills for Biosciences. John Wiley & Sons, Ltd.
7. Mu P, Plummer DT (2001) Introduction to practical biochemistry. Tata McGraw- Hill Education.
8. Zar ZH (2010) Biostatistical Analysis, 5th Edition, Pearson Prentice Hall, New Jersey, USA.

Graduate Attributes

Course Objective:

This paper will provide basic knowledge and understanding of good laboratory practices, laboratory waste management, understanding hazards and risks to ensure a safe laboratory environment, measurements, units, and common mathematical calculations, sampling and data collection, and instrument operation and maintenance.

Learning outcome:

On successful completion of the course, students will be:

1. Able tolearnfundamentalskillsimportantforperforminglaboratoryandfieldexperiments.
2. Able to prepare, analysis of data and interpretation of results.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: **Nil**

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course code: *BOT-M-06 (Th)*
Course Name: *Molecular Biology*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Nucleic acids: Carriers of genetic information:** Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.	3	4
Unit 2	**The Structures of DNA and RNA / Genetic Material:** DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, denaturation and re-naturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. Organelle DNA - mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.	8	12
Unit 3	**The replication of DNA, Central dogma and genetic code:** Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi- conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA; Enzymes involved in DNA replication.	10	12
Unit 4	**Transcription:** Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.	10	12

Unit 5	**Processing and modification of RNA:** Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' poly A tail); Ribozymes; RNA editing and mRNA transport.	7	10
Unit 6	**Translation:** Ribosome structure and assembly, mRNA; structure of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Inhibitors of protein synthesis; Post-translational modifications of proteins.	7	10
BOT-M-06 (Pr) [Credit: 01]			
1. DNA isolation from any plant material. 2. DNA estimation by diphenylamine reagent/UV Spectrophotometry (Demonstration). 3. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication). 4. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs. 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.		30	40

Reading list:

1. Griffiths AJF, Wessler SR, Carroll SB, Doebley J (2010) Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
2. Klug WS, Cummings MR, Spencer CA (2009) Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
3. Russell PJ (2010) iGenetics - A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
4. Snustad DP, Simmons MJ (2010) Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
5. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R (2007) Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

Graduate Attributes

Course Objective:

To have detailed knowledge of DNA, RNA and central dogma of molecular biology

Learning outcome:

2. Knowledge of structure, organization, and replication mechanism of DNA
3. Detailed knowledge of central dogma, mechanism of transcription and processing of different types of RNA
4. Knowledge of genetic code, molecular mechanisms associated with various steps in protein synthesis and post translational modifications
5. Ability to isolate genomic DNA from plant samples

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Course code: BOT-C-17 (Th)
Course Name: Ethnobotany, Biostatistics and Bioinformatics
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Basic aspects of Ethnobiology :** Introduction, concept, scope and objectives of ethnobiology; Ethnobotany as an interdisciplinary science; Ethnic groups or Tribals of India, and their lifestyles; Plants used by the tribals: a) Food plants b) Intoxicants and beverages c) Resins and oils; Biopiracy, Intellectual Property Rights.	3	4
Unit 2	**Role of ethnobotany in modern Medicine :** Medico-ethnobotanical sources in India; Role of ethnobotany in modern medicine with special reference to Rauwolfia sepentina, Azadirachta indica, Ocimum sanctum and Vitexnegundo; Role of ethnic groups in conservation of plant genetic resources.	8	12
Unit 3	**Data :** Types of data, Collection of data; Tabular and graphical representation of statistical data. Measures of central tendency: mean; median; mode. Measures of Dispersion: absolute measures and relative measures; range; variance; mean deviation; standard deviation and standard error.	10	12
Unit 4	**Biostatistics :** Definition of probability; Binomial, poison and normal distributions; Hypothesis Testing: null hypothesis	10	12
Unit 5	Alternative hypothesis; confidence level; significance level; t-test, chi-square test; definition of Correlation and regression.	7	10
Unit 6	**Basics of Bioinformatics :** Bioinformatics tools and uses, Biological database GENBANK, NCBI; PDB; BLAST Sequence homology; Detecting open reading frames; Global and local alignment; Multiple sequence analysis; Phylogenetic analysis.	7	10

BOT-C-10 (Pr) [Credit: 01]		
11. Preparation of fungicide (Bordeaux mixture). 12. Identification and description of plants of ethnobotanical value. 13. Identification and description of plants used by tribals for their household. 14. Collection and study of different wild edible fruits. 15. Study of t-test from given data. 16. Study of Chi-square test from given data. 17. Correlation analysis and interpretation. 18.Exploring Biological database 19. Viva-voce covering entire syllabus by External and Internal Examiners. 20. Submission of Practical Record Books.	10	15

Reading list:

1. Cunningham, A.B. (2001). Applied Ethnobotany. Earthscan Publishers Ltd., London & Sterling, VA, USA.

2. Jain, S.K. (1981). Glimpses of Indian Ethnobotany.Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.

3. Jain, S.K. (1989). Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow.

4. Antonisamy, B., Premkumar, P. S., Christopher, S. (2017). Principles and Practice of Biostatistics. India: Elsevier India.

5. Rosner, B. (2016). Fundamentals of Biostatistics. United States: Cengage Learning.

6. Attwood, T. K., & Parry-Smith, D. J. (1999). Introduction to Bioinformatics. Pearson Education.

7. Felsenstein, J. (2004). Inferring Phylogenies.Sinauer Associates.

Graduate Attributes

Course Objective:

To study the basic concept of Ethnobotany, applications of Biostatistics and various aspects of Bioinformatics.

Learning outcome*:*

Students will acquire the skills on ethnobotanical research, statistical analysis of biological data and utilisation of bioinformatics tools. They will also proficiently utilize biological databases for research and applications.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 10)
No. of Non-Contact Classes: Nil

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Course code: BOT-C-18 (Th)
Course Name: Analytical Techniques in Plant Science
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Imaging related techniques :** Principles of microscopy, light microscopy, fluorescence microscopy, confocal microscopy; Use of fluorochromes, Chromosome banding, FISH, chromosome painting, Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.	3	4
Unit 2	**Cell Fractionation and Radioisotopes** Centrifugation – differential and density gradient centrifugation, sucrose density gradient, CsCl2 gradient, analytical centrifugation, ultra centrifugation, marker enzyme. Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment;	8	12
Unit 3	**Spectrophotometry and Chromatography** Spectrophotometry: Principle and its application in biological research; Chromatography: principle, paper chromatography, column chromatography, TLC, GLC, HPLC, ion-exchange chromatography, molecular sieve chromatography.	10	12
Unit 4	**Characterization of proteins and nucleic acids** Mass spectrometry, X-ray diffraction, X-ray crystallography, characterization of proteins and nucleic acids, Electrophoresis: AGE, PAGE, SDS-PAGE.	10	12
Unit 5	**Biostatistics:** Biostatistics, Data, samples, representation of data: tabular and graphical; measures of central tendency: arithmetic mean, median and mode	7	10
Unit 6	Measures of dispersion: mean deviation, standard deviation and standard error; chi square test.	7	10

BOT-C-11 (Pr) [Credit: 01]		
1. Sample preparation techniques for temporary and permanent slide preparation, including fixation, staining and mounting. 2. Observation of electron micrographs or models (SEM/TEM) for bacterial and plant cell structure. 3. Study of fluorescence in isolated chlorophyll pigments. 4. Separation of photosynthetic pigments using paper chromatography or thin layer chromatography. 5. Study of the absorption spectrum of chlorophyll pigments. 6. Quantification of total sugars, proteins or in plant tissue using spectrophotometric methods. 7. Measurement of respiratory quotient (RQ). 8. Isolation genomic DNA from plant plant tissues (e.g., Onionor Grlic).	10	15

Reading list:

1. Ruzin, S. E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York, USA.

2. Plumber, D. T. (1996). An Introduction to Practical Biochemistry, Tata McGraw-Hill Publication Co. Ltd. New Delhi.

3. Dutta, S. (2022). Analytical Techniques in Plant Sciences, Biostatistics and Dissertations (Theory and Practice). Kalyani Publishers, Ludhiana.

Graduate Attributes

Course Objective:

To study the various aspects of analytical techniques in plant science.

Learning outcome*:*

This course will provide a detailed understanding on various concepts of techniques used in plant science.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 10)

No. of Non-Contact Classes: **Nil**

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Course code: BOT-C-19 (Th)
Course Name: Research Methodology
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 04; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Research Problem – Its importance, aims and objectives, literature collection, Methodology (Experimental design / Field data collection). Data presentation and interpretation. Drawing conclusions. Scientific paper writing – Manuscript preparation and presentation	3	4
Unit 2	Research Journals, Impact Factor and paper citation index. Statistical methods in Biology: Mean, Variance, Standard deviation, Standard error, Chisquare and 't'– test.	8	12
Unit 3	Culture of Algae: Media and isolation of pure cultures. Culture and preservation of Fungi. Plant tissue culture methods. Genetic transformation methods (Agrobacterium-mediated and microprojectile / Biolistic methods). Herbarium technique	10	12
Unit 4	Plant Micro technique – Fixatives and staining (single and double). Fixation for histological and histochemical study. Microtomy. Histochemical methods in Pharmacognosy and Forensic Botany. Organoleptic evaluation of market drugs.	10	12
Unit 5	Preparation of Cytological slides for study of Mitosis and Meiosis. Principles of Microscopy (Light microscope, phase contrast, Electron Microscope (SEM & TEM) and Fluorescence microscope)	7	10
Unit 6	Methods of expressing concentration: Physical and chemical methods. Soxhlet extraction, Column chromatography, TLC, High pressure liquid Chromatography (HPLC), Electrophoresis and ELISA. Principles of Fluorescence, UV, Visible, NMR and Atomic Absorption Spectroscopy and Autoradiography. Basic concepts of Recombinant DNA technology. Gene cloning, DNA fingerprinting technique, Polymerase Chain Reacti	7	10

Reading list:

1. Ruzin, S. E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York, USA.

2. Plumber, D. T. (1996). An Introduction to Practical Biochemistry, Tata McGraw-Hill Publication Co. Ltd. New Delhi.

3. Dutta, S. (2022). Analytical Techniques in Plant Sciences, Biostatistics and Dissertations (Theory and Practice). Kalyani Publishers, Ludhiana.

Graduate Attributes

Course Objective:

To study the various aspects of analytical techniques in plant science.

Learning outcome*:*

This course will provide a detailed understanding on various concepts of techniques used in plant science.

Theory Credit: 04

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45)

No. of Contact Classes: 75 (Theory: 45)

No. of Non-Contact Classes: **Nil**

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Course code: *BOT-C-20 (Th)*
Course Name: *Microbiology*
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to microbial world:** History of development of Microbiology as a subject, Germ theory of diseases, Koch postulates, Major groups of microorganisms, Mode of nutrition and metabolic diversity in microbes, Growth and growth curves, Ecological importance of microorganisms.	6	6
Unit 2	**Viruses:** Characteristics of viruses, viroids and prions; Biomolecules and genetic materials of viruses; Baltimore system of classification; Morphological structure of TMV and Corona viruses; Life cycle and reproduction of bacteriophage; Replication of viral RNA and DNA; Viral diseases of common plants and animals	8	10
Unit 3	**Bacteria:** General characteristics of bacteria, shapes and sizes, ultra-cellular structure, major groups of bacteria with their general characteristics; Actinomycetes, Mycoplasma and Rickettsiae; growth and nutrition, reproduction – binary fission and endospore formation, horizontal gene transfer and genetic recombination in bacteria (conjugation, transformation and transduction). Examples of agriculturally and industrially important bacteria.	8	12
Unit 4	**Environmental Microbiology:** Microorganisms in different habitats: Air, soil and water; Soil microorganisms and their role in soil health; Role of microorganisms in biogeochemical cycles (C, N, P and S); Microorganisms in extreme environments (cold desert, hot water spring, marine water, hydrothermal vent, aquifers)	8	8

Unit 5	**Pathogenic microorganisms and Host Immunity:** Bacterial pathogens causing diseases in plants, animals and humans; fungal pathogens causing diseases in agriculturally important crops; host-pathogen interactions; pathogenesis; disease symptoms; host defence mechanisms; Host immunity - immune responses against pathogens; types of immunity; humoral and cell mediated immunity; hypersensitivity and autoimmunity; concept of Rh antigens.	8	12
Unit 6	**Applied Microbiology:** Application of microorganisms in food industries for food fermentation and SCP production; in agriculture for biofertilizer, biopesticides, biocompost production; in pharmaceuticals for insulin and antibiotics production; in industries for alcohol and organic acid productions; citric acid and acetic acid; in genetic engineering for GMO development and other research purposes; in space and oil exploration and in pollution and waste management.	7	12

BOT-C-12 (Pr) [Credit: 01]		
6. Study of vegetative and reproductive structures of Mastigomycotina (*Phytophthora*) and Zygomycotina (*Mucor/Rhizopus*) by temporary mounts and through permanent slides. 7. Study of vegetative and reproductive structures of Ascomycotina (*Aspergillus* and *Penicillium*/*Peziza*) and Basidiomyctina (*Agaricus* and *Puccinia*) by temporary mounts and through permanent slides. 8. Study of vegetative and reproductive structures of Deuteromycotina (*Alternaria* and *Colletotrichum/ Fusarium*) by temporary mounts and through permanent slides; Study of thallus and reproductive structures of lichen and mycorrhiza through permanent slides/ photographs. 9. Study of symptoms of locally available plant diseases caused by fungi, bacteria, and virus by preparation of disease album and bottle specimens. 10. Applied mycology: Photographs/report onfungi used in medicine, fungi used as biological control agents, fungi used in industry, fungi causing human infections	30	40

Reading list:

11. Agrios GN (1997) Plant Pathology, 4thedition, Academic Press, U.K.
12. Alexopoulos CJ, Mims CW, Blackwell M (1996) Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
13. GanguleeHC, KarAK. College Botany, Vol. II., New Central Book Agency, Kolkata.
14. Hait G (2022) A Textbook of Plant Pathology: Principles and Diseases. Global Net Publication, India.
15. HaitG, BhattacharyaK, GhoshAK (2011) Text Book of Botany, Vol. I & II., New Central Book Agency, Kolkata.
16. MitraJN, MitraD, ChowdhuryS. Studies in Botany. Vol. I., Moulik Library, Kolkata.
17. Pandey BP (2020) Plant Pathology - Pathogen and plant disease. S. Chand and Company Limited, New Delhi, India.
18. Sethi IK, Walia SK (2011) Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
19. Sharma PD (2011) Plant Pathology, Rastogi Publication, Meerut, India.

Webster J, Weber R (2007) Introduction to Fungi, Cambridge University Press,Cambridge. 3rd edition.

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Course code: BOT-M-07 (Th)
Course Name: Analytical Techniques in Plant Science
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Imaging related techniques :** Principles of microscopy, light microscopy, fluorescence microscopy, confocal microscopy; Use of fluorochromes, Chromosome banding, FISH, chromosome painting, Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.	3	4
Unit 2	**Cell Fractionation and Radioisotopes** Centrifugation – differential and density gradient centrifugation, sucrose density gradient, CsCl2 gradient, analytical centrifugation, ultra centrifugation, marker enzyme. Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment;	8	12
Unit 3	**Spectrophotometry and Chromatography** Spectrophotometry: Principle and its application in biological research; Chromatography: principle, paper chromatography, column chromatography, TLC, GLC, HPLC, ion-exchange chromatography, molecular sieve chromatography.	10	12
Unit 4	**Characterization of proteins and nucleic acids** Mass spectrometry, X-ray diffraction, X-ray crystallography, characterization of proteins and nucleic acids, Electrophoresis: AGE, PAGE, SDS-PAGE.	10	12
Unit 5	**Biostatistics:** Biostatistics, Data, samples, representation of data: tabular and graphical; measures of central tendency: arithmetic mean, median and mode	7	10
Unit 6	**Measures of dispersion:** Mean deviation, standard deviation and standard error; chi square test.	7	10

BOT-M-07 (Pr) [Credit: 01]		
1. Sample preparation techniques for temporary and permanent slide preparation, including fixation, staining and mounting. 2. Observation of electron micrographs or models (SEM/TEM) for bacterial and plant cell structure. 3. Study of fluorescence in isolated chlorophyll pigments. 4. Separation of photosynthetic pigments using paper chromatography or thin layer chromatography. 5. Study of the absorption spectrum of chlorophyll pigments. 6. Quantification of total sugars, proteins or in plant tissue using spectrophotometric methods. 7. Measurement of respiratory quotient (RQ). 8. Isolation genomic DNA from plant plant tissues (e.g., Onionor Grlic).	10	15

Reading list:

1. Ruzin, S. E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York, USA.

2. Plumber, D. T. (1996). An Introduction to Practical Biochemistry, Tata McGraw-Hill Publication Co. Ltd. New Delhi.

3. Dutta, S. (2022). Analytical Techniques in Plant Sciences, Biostatistics and Dissertations (Theory and Practice). Kalyani Publishers, Ludhiana.

Graduate Attributes

Course Objective:

To study the various aspects of analytical techniques in plant science.

Learning outcome*:*

This course will provide a detailed understanding on various concepts of techniques used in plant science.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 10)

No. of Non-Contact Classes: **Nil**

Four-year Undergraduate Programme
Subject: Botany
Semester: Eighth
Course code: BOT-C-21 (Th)
Course Name: Plant Biotechnology
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Plant Tissue Culture**: Historical perspective; Composition of media; Role of vitamins and hormones in plant tissue culture; Totipotency; Organogenesis; Embryogenesis; Protoplast isolation, culture and fusion; Micro-propagation; Androgenesis; Haploid production; Virus elimination; Secondary metabolite production; Triploids; Cryopreservation; Germplasm Conservation.	3	4
Unit 2	**Recombinant DNA technology:** Restriction Endonucleases (Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid,; Eukaryotic Vectors (YAC).	8	12
Unit 3	**Gene Cloning:** Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Construction of genomic and cDNA libraries, Screening DNA libraries to obtain gene of interest by genetic selection; Colony hybridization; PCR.	10	12
Unit 4	**Methods of gene transfer:** Agrobacterium-mediated gene transfer, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).	10	12
Unit 5	**Applications of Biotechnology:** Pest resistant plants (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties.	7	10
Unit 6	Role of transgenics in bioremediation (Superbug); edible vaccines; Gentically Engineered Products–Human Growth Hormone, Humulin; Biosafety concerns.	7	10

BOT-C-13 (Pr) [Credit: 01]		
1. Techniques of inoculation under aseptic conditions. 2. Demonstration of various steps of Micropropagation. 3. Isolation of plasmid DNA (Demonstration). 4. Isolation of Protoplasts (Demonstration). 5. Viva-voce covering entire syllabus by External and Internal Examiners. 6. Submission of Practical Record Books.	10	15

Reading list:

1. Trigiano, R. N., & Gray, D. J. (2015). Plant Tissue Culture Concepts and Laboratory Exercises. CRC Press.

2. Bhojwani, S. S., & Razdan, M. K. (1996). Practical Plant Tissue Culture. Oxford & IBH Publishing. 3. Dutta Gupta, S., & Prakash, Y. S. S. (2013). Plant Tissue Culture and Biotechnology: Emerging Trends. Springer.

Graduate Attributes

Course Objective:

To provide students with hands-on experience in areas such as ecology, plant metabolism and biochemistry and plant biotechnology.

Learning outcome*:*

By the end of this course, the students will acquire practical skills in laboratory techniques. These practical competencies will equip students for careers in connection with ecology, plant metabolism and biochemistry and plant biotechnology.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 10)

No. of Non-Contact Classes: **Nil**

Four-year Undergraduate Programe
Subject: Botany
Semester: eighth
Course code: BOT-C-22
Course Name: Dissertation
Total marks:300 (Credit: 12)

Dissertation	=	
Viva-Voce and Presentation	=	
Internal Assessment	=	
Total	=	**300**

Learning Outcome :

On completion of a B.Sc. Botany dissertation, students are typically expected to demonstrate the following:

- **Independent Research Skills**: Ability to conduct independent research, including formulating a testable hypothesis, designing experiments, and executing them with minimal supervision.
- **Scientific Writing and Communication**: Proficiency in preparing a structured research project report using scientific formats. This includes presenting hypotheses and data clearly both in writing and through oral presentations.
- **Data Analysis and Interpretation**: Competence in collecting, organizing, and analyzing quantitative data. This often involves applying biostatistical tools to test hypotheses and derive meaningful conclusions.
- **Technical and Laboratory Proficiency**: Hands-on mastery of advanced laboratory and field techniques, such as microscopy, section-cutting, staining, or using specialized instruments like pH meters and spectrophotometers.
- **Critical Thinking and Problem Solving**: Ability to critically evaluate existing scientific literature, identify gaps in knowledge, and propose creative solutions to real-life biological problems.

  Ethical and Sustainable Practice: Understanding the ethics of scientific research, including issues like plagiarism and responsible citizenship towards environmental sustainability.

Four-year Undergraduate Programme
Subject: Botany
Semester: eighth
Course code: BOT-M-08 (Th)
Course Name: Plant Biotechnology
Existing Base Syllabus: UG CBCS Syllabus

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Plant Tissue Culture**: Historical perspective; Composition of media; Role of vitamins and hormones in plant tissue culture; Totipotency; Organogenesis; Embryogenesis; Protoplast isolation, culture and fusion; Micro-propagation; Androgenesis; Haploid production; Virus elimination; Secondary metabolite production; Triploids; Cryopreservation; Germplasm Conservation.	3	4
Unit 2	**Recombinant DNA technology:** Restriction Endonucleases (Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid,; Eukaryotic Vectors (YAC).	8	12
Unit 3	**Gene Cloning:** Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Construction of genomic and cDNA libraries, Screening DNA libraries to obtain gene of interest by genetic selection; Colony hybridization; PCR.	10	12
Unit 4	**Methods of gene transfer:** Agrobacterium-mediated gene transfer, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).	10	12
Unit 5	**Applications of Biotechnology:** Pest resistant plants (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties.	7	10
Unit 6	Role of transgenics in bioremediation (Superbug); edible vaccines; Gentically Engineered Products–Human Growth Hormone, Humulin; Biosafety concerns.	7	10

BOT-M- 08 (Pr) [Credit: 01]		
1. Techniques of inoculation under aseptic conditions. 2. Demonstration of various steps of Micropropagation. 3. Isolation of plasmid DNA (Demonstration). 4. Isolation of Protoplasts (Demonstration). 5. Viva-voce covering entire syllabus by External and Internal Examiners. 6. Submission of Practical Record Books.	10	15

Reading list:

1. Trigiano, R. N., & Gray, D. J. (2015). Plant Tissue Culture Concepts and Laboratory Exercises. CRC Press.

2. Bhojwani, S. S., & Razdan, M. K. (1996). Practical Plant Tissue Culture. Oxford & IBH Publishing.
3. Dutta Gupta, S., & Prakash, Y. S. S. (2013). Plant Tissue Culture and Biotechnology: Emerging Trends. Springer.

Graduate Attributes

Course Objective:

To provide students with hands-on experience in areas such as ecology, plant metabolism and biochemistry and plant biotechnology.

Learning outcome*:*

By the end of this course, the students will acquire practical skills in laboratory techniques. These practical competencies will equip students for careers in connection with ecology, plant metabolism and biochemistry and plant biotechnology.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 10)

No. of Non-Contact Classes: **Nil**