

**UNIVERSITY DEPARTMENT OF BOTANY
VINOBA BHAVE UNIVERSITY
HAZARIBAG**



**FOUR YEAR BACHELOR'S DEGREE
PROGRAMME WITH HONOURS/ RESEARCH**

(B.Sc BOTANY)

SYLLABUS (w.e.f. 2022-26)

Implemented from academic Session

2022-2026

Vinoba Bhave University, Hazaribag

NOTIFICATION

On the recommendation of H.O.D. Univ. Deptt. of Botany, VBU., Hazaribag vide letter no. VBU/Bot-54, dated 26.06.2023, the Vice-Chancellor is pleased to constitute the Board of Courses of studies for Four Years Under Graduate Programme (FYUGP) in the Department of Botany, consisting of the following members:-

- | | | |
|---|---|-----------------|
| 1. ✓ Dr. S.C. Jain, H.O.D., Botany, VBU., Hazaribag | - | Chairman |
| 2. Dr. R.K. Jha, Associate Prof. Ranchi University, Ranchi | - | External Expert |
| 3. Prof. (Dr.) E.N. Siddique, (Retd.) Deptt. of Botany, VBU., Hazaribag | - | Special Invitee |
| 4. Dr. Avinash Kumar, Univ. Deptt. of Botany, VBU., Hazaribag | - | Member |
| 5. Dr. Mina Srivastava, Annada College, Hazaribag | - | Member |
| 6. Dr. Sangita Horo, K.B. Women's College, Hazaribag | - | Special Invitee |
| 7. Dr. Umakant Singh, St. Columba's College, Hazaribag | - | Special Invitee |

T.A./D.A. will be paid as per university rules to the external members.

By order of the Vice-Chancellor
Sd/-
Registrar

Memo No:-VBU/Esstt./.....1937...../2023

Dated 13.07.2023

Copy to:-

1. The Person Concerned.
2. Registrar, Ranchi, University, Ranchi.
3. The H.O.D., Botany, VBU., Hazaribag.
4. The Finance Officer, VBU., Hazaribag.
5. In-charge Esstt. Section, VBU., Hazaribag.
6. The PA to VC/FA/R. for Kind information to VC/FA/R.

Registrar

13/07/23

Members of Board of Studies for preparing Provisional Syllabus of Four- Year Undergraduate Programme (FYUGP)

1. Chairman-

Dr. Suresh Chand Jain

Assistant Professor & Head
University Department of Botany,
Vinoba Bhave University, Hazaribag

2. Internal Member-

i. **Dr. Avinash Kumar**

Assistant Professor
University Department of Botany,
Vinoba Bhave University, Hazaribag

ii. **Dr. Mina Srivastva**

Assistant Professor & H.O.D
Department of Botany,
Annanda College, Hazaribag

iii. **Dr. Sangita Horo**

Assistant Professor & H.O.D
Department of Botany,
K. B.Women's College, Hazaribag

iv. **Dr. Umakant Singh**

Assistant Professor
Department of Botany,
St. Columba's College, Hazaribag

3. External Expert

i. **Prof. E. N. Siddiqui**

University Professor (Retd.)
University Department of Botany,
Vinoba Bhave University, Hazaribag

ii. **Dr. Radha Krishna Jha**

Associate Professor
University Department of Botany,
Ranchi University, Ranchi.

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Semester - I
MAJOR COURSE: MJ- 01.
MICROBIOLOGY AND ALGAE
(Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

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

1. To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Students would understand the classification, characteristic features, cell structure and growth and reproduction in viruses, bacteria and economic importance.
2. Students would understand the general characteristics, morphology, life cycle under classification of algae proposed by Fritsch.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks):

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY
Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: Viruses (6 classes)

Discovery, living & non-living characterization, general structure with special reference to bacteriophage and TMV.

UNIT 2: Bacteria, Cyanobacteria and Mycoplasma (6 classes)

Discovery, general characteristics and cell structures

UNIT 3: Algae (5 classes)

General characteristics; Classification proposed by Fritsch.

UNIT 4: Cyanophyta (5 classes)

General characteristics; morphology and life cycle of *Nostoc*.

UNIT 5: Chlorophyta (8 classes)

General characteristics; morphology and life cycle of *Volvox*.

UNIT 6: Charophyta (7 classes)

General characteristics; morphology and life cycle of *Chara*.

UNIT 7: Xanthophyta (8 classes)

General characteristics; morphology and life cycle of *Vaucheria*.

UNIT 8: Phaeophyta (8 classes)

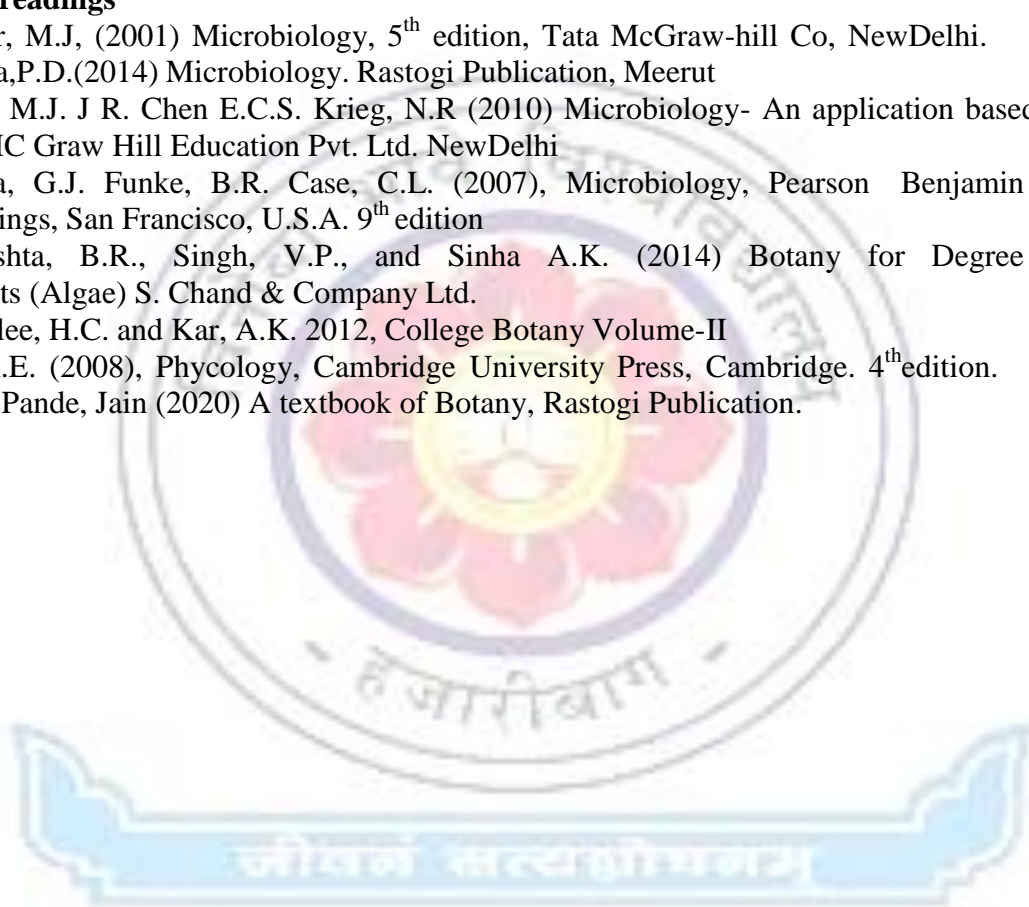
General characteristics; morphology and life cycle of *Ectocarpus*.

UNIT 9: Rhodophyta (7 classes)

General characteristics; morphology and life cycle of *Batrachospermum*.

Suggested readings

1. Pelczar, M.J, (2001) Microbiology, 5th edition, Tata McGraw-hill Co, NewDelhi.
2. Sharma,P.D.(2014) Microbiology. Rastogi Publication, Meerut
3. Pelzar. M.J. J R. Chen E.C.S. Krieg, N.R (2010) Microbiology- An application based approach, Tata MC Graw Hill Education Pvt. Ltd. NewDelhi
4. Tortora, G.J. Funke, B.R. Case, C.L. (2007), Microbiology, Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition
5. Vashishta, B.R., Singh, V.P., and Sinha A.K. (2014) Botany for Degree Students (Algae) S. Chand & Company Ltd.
6. Gangulee, H.C. and Kar, A.K. 2012, College Botany Volume-II
7. Lee, R.E. (2008), Phycology, Cambridge University Press, Cambridge. 4th edition.
8. Singh, Pande, Jain (2020) A textbook of Botany, Rastogi Publication.



Semester - II
MAJOR COURSE: MJ-02.
FUNGI, PLANT PATHOLOGY AND BRYOPHYTA
(Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

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

1. To gain knowledge of diversity, life forms, life cycles, morphology of fungi, symbiotic associations and diseases of plants and their control.
2. To introduce students with general characters and life cycle of bryophytes and their usefulness to mankind.
3. To introduce the evolution of gametophyte and sporophyte in bryophytes.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Students would understand the classification of fungus given by Ainsworth, lichens as symbiotic associations.
2. Application of fungus in food industry.
3. Clear views of general symptoms of different plant diseases, stages involved in development of disease and their control measures.
4. To learn the organ formation in early land plants and information on the ecological and economic importance of bryophytes

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY
Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: Introduction to true fungi (2 classes)

Definition, General characteristics and Classification by Ainsworth.

UNIT 2: Mastigomycotina (5 classes)

General characteristics and life cycle of *Synchytrium*

UNIT 3: Zygomycotina (5 classes)

General characteristics and Life Cycle of *Mucor*

UNIT 4: Ascomycotina (5 classes)

General characteristics and life cycle of *Peziza*.

UNIT 5: Basidiomycotina (5 classes)

General characteristics and life cycle of *Puccinia*.

UNIT 6: Deuteromycotina (5 classes)

General characteristics and Life cycle of *Alternaria*..

UNIT 7: Applied mycology (3 classes)

Application of fungi in fermentation (production of ethyl alcohol), antibiotics (production of penicillin) and food industry, IPM and Biopesticides.

UNIT 8: Symbiotic associations (4 classes)

Lichen – Occurrence; General characteristics; types and Economic Importance

UNIT 9: Plant diseases- Introduction, classification, general symptoms, stages in the development of disease and various control measures; role of quarantine **(5 classes)**

UNIT 10: General symptoms; etiology and control of following diseases- (6 classes)

1. Citrus canker
2. Red rot of sugarcane
3. Early blight of potato
4. White rust of crucifers
5. Late blight of potato
6. Little leaf of brinjal
7. Loose smut of wheat

UNIT 11: Bryophytes (15 classes)

General characteristics and life cycle of

1. *Marchantia*
2. *Anthoceros*
3. *Sphagnum*
3. Evolution of Gametophyte and Sporophyte in Bryophytes.
4. Ecological and economic importance of bryophytes.

Suggested readings

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K
2. Alexopoulos, C.J., Mims, C.W, Blackwell, M. (1996).Introductory Mycology, John Wiley & Sons (Asia) Singapore, 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge, 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and their Allies,Macmillan Publishers India Ltd.
5. Sharma, P.D, (2011), Plant Pathology, Rastogi Publication, Meerut, India.
6. Singh, Pande, Jain (2020) A textbook of Botany, Rastogi Publication

MAJOR COURSE: MJ-03
PRACTICALS-I (Credit course: Prt.- 04)

Microbiology

1. Structure of Bacteriophage and TMV by photographs.
2. Forms of Bacteria by slides/ photographs.
3. Gram staining technique.

Algae

1. Study of vegetative and reproductive structures of *Nostoc*, *Volvox*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus* and *Batrachospermum* by preparing temporary slides and also by permanent slides.

Fungi

1. *Synchytrium*: study of asexual stage from temporary mounts and sexual structure through permanent slides
2. *Peziza* : section through ascocarp.
3. Temporary slides of spores of *Puccinia*, *Alternaria*, *Mucor*

Plant Pathology

1. Local trip for identification of various diseases with disease name, host name and causal organisms (included in syllabus)
2. Preparation of herbarium for the various diseases (included in syllabus)
3. Study of all diseases through permanent slides
4. Temporary slides preparation of early blight of potato, late blight of potato and white rust of crucifer.

Bryophyta

1. Study of genus *Marchantia*, *Anthoceros* and *Sphagnum* by preparing temporary slides and also by permanent slides

Botanical Excursion

Practical examination

Full marks: 100 Pass marks: 40

Time: 03 Hrs.

1. Preparation of temporary slides of any two algae/ fungus/fungal diseases included in the syllabus. 25 marks
2. To detect the gram positive and gram negative bacteria through gram staining technique.
Or Structure of bacteriophage and TMV through photographs
Or Preparation of temporary slides of any two bryophytes 20 marks
3. Spotting (5 x4 marks) 20 marks
4. Viva voce 15 marks
5. Class records/ Herbarium/ Chart 20marks

Semester - III

MAJOR COURSE: MJ-04

PTERIDOPHYTA, GYMNOSPERMS AND PALAEOBOTANY

(Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

On successful completion of this course the student should be able to:

1. To introduce students with general characters and life cycle of archegoniates and their usefulness to mankind.
2. To study palaeobotanical fossil plants and geological time scale.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. To learn the organ formation in early land plants that resulted to diversity of species of "Pteridophytes" and "Gymnosperms".
2. Information on the ecological and economic importance of pteridophytes and gymnosperms will help to understand their role in ecosystem functioning.
3. Knowledge of fossil plants formed in different era.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY **Lectures 60**

Full marks: 100

Time: 03 Hrs.

UNIT 1: Pteridophyta (25 classes)

- A) General views on Origin and evolution of pteridophytes, general characteristics of Pteridophytes
- B) Classification, Morphology, Anatomy and Reproduction (developmental stages not included) of- *Lycopodium*, *Selaginella* and *Equisetum*; Ecological and economic importance of pteridophytes.
- C) Apogamy and Apospory.
- D) Heterospory and Seed habit
- E) Stelar evolution.

UNIT 2: Gymnosperms (15 classes)

1. General characteristics of gymnosperms
2. Morphology, Anatomy and Reproduction (Developmental details not to be included) of *Pinus*, *Gnetum*
3. Ecological and economic importance of gymnosperms.

UNIT 3: Paleobotany (20 classes)

1. Introduction, Definition and objectives of Palaeobotanical studies, Nomenclature of Fossils, Process and types of Fossilization, Geological Time-Scale; General characteristics features of *Rhynia*.

Suggested Reading

1. Parihar, N.S, (1991), An introduction to Embryophyta : Vol. 1. Bryophyta, Central Book Deposit, Allahabad.
2. Raven, P.H., Johnson, G.B.Losos, J.B.,Singer, S.R. (2005), Biology, TataMc Graw Hill, Delhi.
3. Vander – poorteri 2009 Introduction to Bryophyta, COP.
4. Vashistha, P.C., Sinha, A.K.Kumar, A.(2010), Pteridophyta. S.Chand, Delhi,India
5. Prasad, C. (2013) An Introduction to Pteridophyta, Emkay Publication, NewDelhi, India.
6. Bhatnagar, S.P. &Moitra, A.(1996), Gymnosperms, New Age International (P) Ltd Publishers, New Delhi, India.
7. Stewart, N.W. and Roothwell, G.W. (2020): Palaeobotany and the evolution of Plants, 2nd Edition
8. Arnold, C.A., (2020): An Introduction to Palaeobotany, Surjeet Publications



MAJOR COURSE: MJ-05
PRACTICALS-II (Credit course: Prt.- 04)

PRACTICALS

Archegoniates

1. Study of genus *Lycopodium*, *Selaginella* and *Equisetum* by preparing temporary slides and also by permanent slides.
2. To study stelar evolution in pteridophytes.
3. Study of genus *Pinus* and *Gnetum* by preparing temporary slides and also hyperpermanent slides

Palaeobotany

1. Study of fossil plants included in the syllabus by permanent/ slides/ photographs/ rock specimens

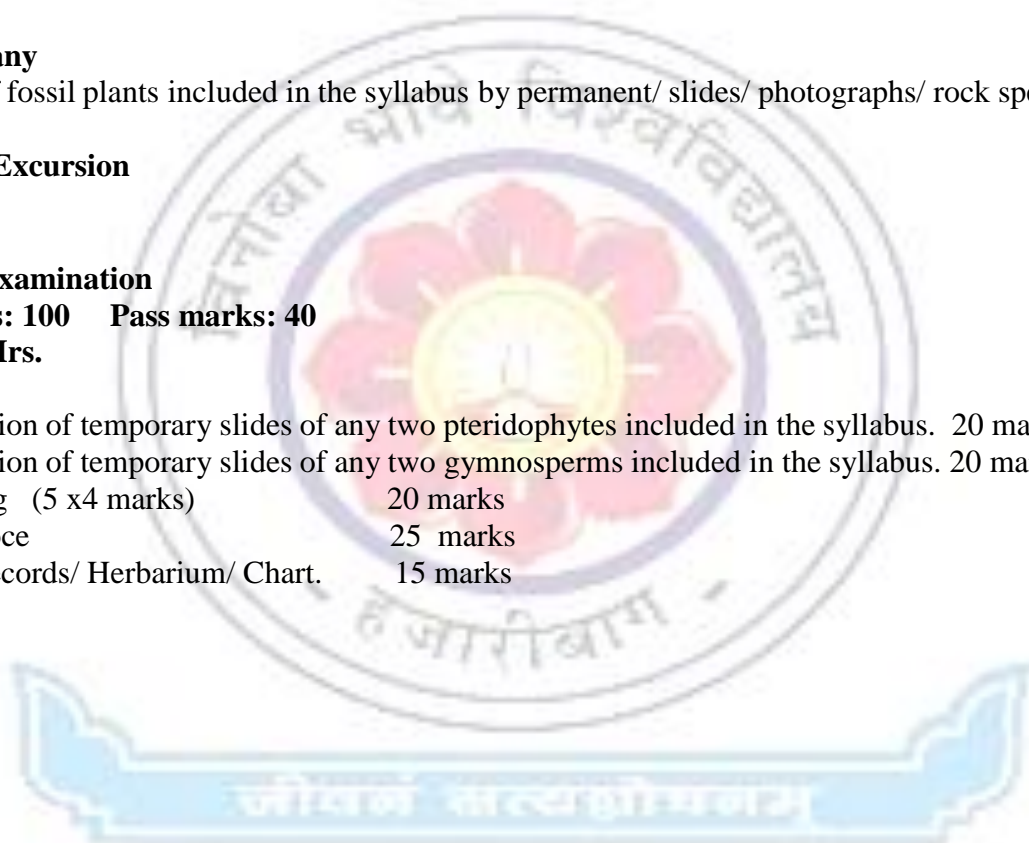
Botanical Excursion

Practical examination

Full marks: 100 Pass marks: 40

Time: 03 Hrs.

1. Preparation of temporary slides of any two pteridophytes included in the syllabus. 20 marks
2. Preparation of temporary slides of any two gymnosperms included in the syllabus. 20 marks
3. Spotting (5 x4 marks) 20 marks
4. Viva voce 25 marks
5. Class records/ Herbarium/ Chart. 15 marks



Semester IV

MAJOR COURSE: MJ- 06. SYSTEMATICS AND TAXONOMY (Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. To gain the knowledge of taxonomy and phylogeny of plants.

Course Learning Outcomes:

On successful completion of this course the student should know the:

1. Understanding of systematic, its importance in bioresource utilization and biodiversity management. Nomenclature pattern, Phylogeny, Classification systems of the plants.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: Taxonomic Aids (5 classes)

Herbarium – functions and important herbaria, botanical gardens, Flora and National Park

UNIT 2: Taxonomic Hierarchy (5 classes)

Concept of taxa (species, genus and family)

UNIT 3: Botanical nomenclature (4 classes)

Principles and rules of International code of nomenclature for algae, fungi and plants(ICN); principle of priority, binomial system, type method (Typification), author citation and valid publication.

UNIT 4: System of classification (6 classes)

A. Basic idea of system of classification and its types- Artificial, Natural and Phylogenetic.

B. Bentham and Hooker' system of classification, Hutchinson's system of classification.
Taxonomic evidences from cytology, palynology and phytochemistry.

UNIT 5: Plant taxonomy: (40 classes)

- A. How to describe a flowering plant.
- B. Study of following families

1. Ranunculaceae
2. Fabaceae
3. Apocyanaceae
4. Lamiaceae
5. Verbenaceae
6. Euphorbiaceae
7. Asclepiadaceae
8. Poaceae
9. Orchidaceae

Suggested Readings

1. Pandey, B.P., (2016) .A text of Botany Angiosperms, S. Chand & Company Pvt. Limited
2. Pandey, B.P., (2016) .Taxonomy of Angiosperms, S. Chand & Company Pvt. Limited
3. Pandey, B.P., (2018) Botany for Degree Students (Plant Ecology and Taxonomy) S. Chand & Company Ltd.
4. Subrahmanyam, N.S (2020) Modern Plant taxonomy, Vikas Publication
5. Singh, Pande, Jain (2021) Plant taxonomy, Rastogi Publication, India.
6. Sharma, O.P., (2017). Plant taxonomy, Mc Graw Hill Education. 2nd edition.



MAJOR COURSE: MJ- 07.

PLANT ANATOMY
(Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

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

1. Study of various tissue systems and their development and functions in plants.
2. To know anomalous behavior, plant adaptive and protective systems in plants.

Course Learning Outcomes:

On successful completion of this course the student shall know:

1. Knowledge of various cells and tissues, meristem, epidermal and vascular tissue system in plants.
2. Knowledge of basic structure and organization of plant parts in angiosperms.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks):

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY
Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: Introduction and scope of Plant anatomy (04 classes)

UNIT 2: Tissues (10 classes)

Classification of tissues: Meristematic tissue, permanent tissue and secretory tissue, Theories of shoot apex and root apex organization

UNIT 3: Stem (7 classes)

Types of vascular bundles: Structure of dicot and monocot stem.

UNIT 4: Leaf (6 classes)

Structure of dicot and monocot leaf.

UNIT 5: Root (6 classes)

Structure of dicot and monocot root.

UNIT 6: Vascular cambium (10 classes)

Structure, function and seasonal activity of cambium, Anomalous secondary growth in *Boerhaavia* and *Dracaena*.

UNIT 7: Periderm (7 classes)

Development and composition of periderm, Sapwood, Heartwood.

UNIT 8: Adaptive and protective systems (10 classes)

Epidermal tissue system, cuticle, stomata, trichomes, Anatomical adaptation of xerophytes & hydrophytes.

Suggested Readings

1. Dickison, W.C.(2000). Integrative plant Anatomy. Harcourt Academic Press, USA.
2. Fahn. A.(1974), Plant Anatomy, Pergmon Press. USA
3. Mauseth, J.D.(1998), Plant Anatomy. The Benjamin/ Cummings Publishers,USA.
4. Esau. K.(1977). Anatomy of seed plants. John Wiley & Sons. Inc., Delhi.
5. Pandey, B.P., (2016) .A text of Botany Angiosperms,S. Chand & Company Pvt. Limited



MAJOR COURSE: MJ-08
PRACTICALS-III (Credit course: Prt.- 04)

PRACTICALS

Systematics and Taxonomy

1. Study of morphological details of monocot and dicot plants
2. Study the position, number and arrangement of floral whorls in flowers of dicot and monocot plants
3. Study of families included in the syllabus.
4. Preparation of herbarium.

Plant Anatomy

1. Study of anatomical details of root, stems and leaf by preparing temporary slide and also by permanent slide or by photographs.
2. Study of anomalous structure of *Boerhaavia* stem and *Dracaena* stem by preparing temporary slide and by permanent slide or by photographs.
3. Study of parenchyma, collenchyma, sclerenchyma and different components of Xylem and Phloem by photographs.
4. Adaptive anatomy- xerophytes and hydrophytes by preparing temporary slides.

Botanical Excursion

Practical examination

Full marks: 100 Pass Marks: 40

Time: 03 Hrs.

1. A comparative morphological and anatomical detail studies of monocot and dicot root, stem and leaf by preparing temporary slides.
Or Preparation of temporary slides to show anomalous structure of *Boerhaavia* stem/ *Dracaena* stem 15 marks.
2. Write the comparative Floral character, Floral Formula, Floral Diagram and Systematic position of any two families included in the syllabus 20 marks
3. Spotting (5 x4 marks) 20 marks
4. Viva voce 20 marks
5. Class records/ Herbarium/ Chart. 25 marks

Semester V

MAJOR COURSE: MJ-09 CELL BIOLOGY AND BIOCHEMISTRY (Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. The course will provide insight to the organization of cell, its features and regulation at different levels.
2. Through the study of cell organelles, they will be able to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. This course will be able to demonstrate foundational knowledge in understanding of cell.
2. Understanding of Cell metabolism, chemical composition, physiochemical and functional organization of organelle

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: Microscopy (12 classes)

General features of light microscope and variation in optical microscope, Electron Microscopy: Introduction to Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Field Emission Scanning Electron Microscopy (FE-SEM), Scanning Tunneling Microscopy (STM), Atomic Force Microscope (AFM).

UNIT 2: The Cell (02 classes)

Ultra structure of prokaryotic and eukaryotic cell and their differences.

UNIT 3: Cell wall and plasma membrane (10 classes)

Structure and Function of plant cell wall, Plasma Membrane, Chemical composition of membranes.

UNIT 4: Cell organelles: (10 classes)

Nucleus, Chloroplast, Mitochondria, Endoplasmic reticulum and Ribosomes: Structure & Functions.

UNIT 5: Cell division (06 classes)

Mitosis and Meiosis

UNIT 11: Biomolecules (20 classes)

Carbohydrates: Definition, classification, structure and role of carbohydrates, Role of monosaccharides, disaccharides, oligosaccharides and polysaccharides.

Proteins: Structures of amino acids; Protein structure – primary, secondary, tertiary and quaternary; biological roles of proteins.

Lipids: Types and its function.

Nucleic acids: Structure of nitrogen bases; structure and function of nucleotides; types of nucleic acids; structure of A, B, Z types of DNA; types of RNA; structure of t-RNA.

Enzymes: Definition, History of its discovery, structure of enzyme: holoenzyme, apoenzyme; prosthetic group, cofactor, mechanism of enzyme action, factors affecting enzyme activity.

Vitamins: General characteristics of vitamins, nomenclature and classification of vitamins and its significance

Suggested Readings

1. Karp, G. (2010), Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
2. Hardin, J., Becker, G., Skliensmith, L.J, (2012), Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
3. Cooper, G.M, and Hausman, R.E. 2009 The Cell: A Molecular Approach, 5th edition, ASM Press & Sunderland, Washington, D.C, Sinauer Associates, MA.
4. Becker, W.M, Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. 2009. The world of the cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.
5. Campbell, MK (2012) Biochemistry, 7th ed., published by Cengage Learning.
6. Campbell, P.N. and Smith, A.D (2011) Biochemistry illustrated, 4th ed., Published by Churchill Livingstone.
7. Tymoezko JL, Berg JM and Stryer L (2012) Biochemistry; A short course, 2nd ed. W.H. Freeman.
8. Berg J.M, Tymoezko JL, and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
9. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th ed. W.H. Freeman and Company.

MAJOR COURSE: MJ-10.
CYTOGENETICS AND PLANT BREEDING
(Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

1. The paper will deal with heredity inheritance pattern among the organism.
2. Linkage and genetic recombination.
3. Gene mapping
4. Chromosomal structure.
5. Biometry

Course Learning Outcomes:

1. The unit will enable the students to learn about the use of linkage and recombination frequencies to map genes.
2. The unit will provide an understanding of:
 - Morphology of chromosomes and its relevance in genetics.
 - Chromosomal and their role in genome evolution with special reference to crop plants.
3. Awareness of data calculation and graphical representation.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY
Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: Mendelian genetics & its extension (10 classes)

Mendel's laws of inheritance, Incomplete dominance and co-dominance, Epistasis, Complementary and Duplicate genes.

UNIT 2: Extrachromosomal inheritance (7 classes)

Cytoplasmic inheritance: Variation in four O'clock plant.

UNIT 3: Linkage and Crossing over (8 classes)

Mechanism and significance of Linkage and crossing over

UNIT 4: Variation in chromosome number & structure (10 classes)

Deletion, Duplication, Inversion, Translocation, Euploidy, Aneuploidy

UNIT 5: Mutations and plant breeding (25 classes)

1. Types of mutations
2. Molecular basis of mutations
3. Mutagens– Physical and chemical
4. Role of mutation in crop improvement.
5. Introduction and Objectives of plant breeding
6. Methods of Crop Improvement, Introduction, Selection and Hybridization, Polyploidy breeding
7. Inbreeding, Inbreeding depression and Heterosis
8. Role of Biotechnology in crop improvement for disease and pest resistance
9. Biofortification; Single Cell Protein (SCP)
10. Intellectual Property Rights for Plant Breeding.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics. John Wiley & sons. India 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010) Principles of Genetics, John Wiley & Sons, Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spenser. C.A. (2012). Concepts of Genetics. Benjamin Cummings, USA. 10th edition.
4. Griffiths, A.J.F, Wessler, S.R., Carroll, S.B., Doebley. I. (2010). Introduction to Genetic Analysis. W.H. Freeman and Co., U.S.A., 10th edition.
5. Singh, B.D (2018), Plant breeding; principles and Methods, Kalyani Publishers, 7th edition.
6. Chaudhari, H.K. (1984), Elementary Principles of Plant Breeding Oxford-IBH, 2nd edition.
7. Acquaah, G. (2007) Principles of Plant Genetics & Breeding Blackwell Publishing.
8. Gupta, P.K., (2004) Biotechnology and Genomics. Rastogi Publications, Shivaji Road, Meerut, India. 1st edition.

MAJOR COURSE: MJ-11
PRACTICALS-IV (Credit course: Prt.- 04)

PRACTICAL

Cell biology and biochemistry

1. Study of generalized plant cell of *Hydrilla*
2. To study different electron microscopy through photographs/ in laboratory.
3. Study the microphotograph of nucleus, chloroplast, mitochondria and endoplasmic reticulum
4. Study of different stages of mitosis and meiosis by preparing temporary slides and also by permanent slides.
5. Qualitative tests for carbohydrates, proteins and lipids

Cytogenetics and Plant Breeding

1. Determination of probability by tossing coins.
2. Mendel's laws through seed ratios: Law of segregation and independent assortment.
3. Testing good fit or not by chi-square method.
4. Field visit and report making for the Hybridization techniques- emasculation
5. Field visit and report making of back cross and test cross method of plant breeding.

Practical examination

Full marks: 100 Pass Marks: 40

Time: 03 Hrs.

1. Qualitative tests for carbohydrates and proteins/ lipids
Or testing good fit or not by chi-square method 15 marks
2. Study of different stages of mitosis or meiosis by preparing temporary slides (showing at least two stages in mount) & also by permanent slides. 15 marks
To demonstrate the phenomenon of Law of segregation and independent assortment
Or to study artificial hybridization in bisexual flower. 10 marks
3. Spotting (5 x4 marks) 20 marks
4. Viva voce 20 marks
5. Class records/ Field report/ Chart. 20 marks

Semester VI

MAJOR COURSE: MJ-12. ECOLOGY AND ENVIRONMENTAL SCIENCE (Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE : 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. This course aims to introduce the students to the concepts and principles of ecology, biological diversity, conservation, sustainable development, population, community and ecosystem structure and function, application of these concepts to solve environmental problems. .

Course Learning Outcomes:

On successful completion of this course the student should know:

1. It will acquaint the students with complex interrelationship between organisms and environment; make them understand methods to studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note : There may be subdivision in the question of Group B.

THEORY **Lectures 60**

Full marks: 100

Time: 03 Hrs.

UNIT 1: Introduction, Objectives of Environmental Science, Levels of organization (**7 classes**)

UNIT 2: Biosphere (17 classes)

Atmosphere, Hydrosphere and Lithosphere.

UNIT 4: Plant Communities (8 classes)

Analytic and synthetic characters, Mechanism of succession–Hydrosere & Xerosere, Concept of Climax.

UNIT 5: Ecosystem (12 classes)

Basic concept, Structural and functional components of ecosystem, types of ecosystem, Grass land and Pond ecosystem, Food web and Food chain, Ecological pyramids.

Understanding Ecosystems, Destruction of Ecosystem due to changing pattern of land use, Migration, Transportation, Urbanization, Industrialization and Environmental Impact Assessment.

UNIT 5: Phytogeography (4 classes)

Phytogeographical regions of India; Local Vegetation and Endemism; hotspots.

UNIT 6: Environmental issues (12 classes)

Air pollution, Water pollution, noise pollution – Cause, effect & control, Global warming, greenhouse effect and consequences of climate change
International and National laws for environmental protection and role of judiciary in India,
Environmental summits- Kyoto protocol, Montreal protocol, Earth summit, Ramsar convention.

Suggested Readings

1. Singh, Y.K., (2020). Environmental Science, New Age International Publishers, India
2. Gupta, S. (2018). Environmental Studies, Sahitya Bhawan Publications, Agra
3. Odum, E.P and Barrett, G.W., (2017) Fundamentals of Ecology, 5th Edition, Cengage Learning, New Delhi
4. Shukla, R.S. and Chandel, P.S (2016): A text book of Plant Ecology, S. Chand & Company Pvt. Limited
5. Sharma, P.D (2017): Ecology and Environment, 13th Edition, Rastogi Publications, Meerut
6. Verma, P.S. and Agarwal, V.K., (2000): Environmental Biology: Principles of Ecology, S.Chand Limited
7. Bhatia, A.L., (2010): Textbook of Environmental Biology, I.K International Publishing House Pvt. Ltd.



MAJOR COURSE: MJ- 13.
EMBRYOLOGY AND ECONOMIC BOTANY
(Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

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

1. Brief account of embryology.
2. It emphasizes the plants used as- food for man, fodder for cattle, feed for poultry, plants having medicinal value and also plant source of huge economic value etc.

Course Learning Outcomes:

On successful completion of this course the student shall know

1. The students will learn reproductive biology of angiosperms.
2. The students will learn about the use of crop plants, pulses, oil yielding plants, fiber plants, timber yielding plants, beverages, fruits and vegetables and medicinal plants that are integral to day to day life.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note : There may be subdivision in the question of Group B.

THEORY
Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: Anther (8 classes)

Anther wall: structure and function, microsporogenesis.

UNIT 2: Ovule (12 classes)

Sporogenesis, microsporogenesis and megasporogenesis, Structure and Types of ovule, Male and Female gametophyte - (monosporic, bisporic and tetrasporic)

UNIT 3: Pollination and fertilization (08 classes)

Pollination types and significance, path of pollen tube in pistil; double fertilization and triple fusion.

UNIT 4: Endosperm (7 classes)

Types, development, structure and functions.

UNIT 5: Embryo (8 classes)

Development of dicot embryo and monocot embryo.

UNIT 6: Polyembryony & Apomixis (7 classes)

Introduction, classification; causes & application.

UNIT 7: Economic Botany (10 classes)

1. Morphology, Botanical name, Family, part used & uses of followings:

- a. Cereals-Wheat and Rice (its cultivation also)
- b. Millets and Pulses- Finger Millet and Gram
- c. Oil yielding plants-Mustard and Sunflower
- d. Fibre yielding plant- Cotton and Jute
- e. Beverages-Tea (its cultivation also),
- f. Timber yielding plants-Shisham, Sal
- g. Fruit yielding plants- Mango, Guava, Apple
- h. Vegetables-Potato, Cabbage, Bitter Gourd
- i. Essential oils- Lemongrass oil, Rose oil, Champaca oil
- j. Medicinal plants- Neem, Arjun, Vasaka, Amaltas, Bada gokru, Makoy, Sahjan and Kateli

Suggested Readings

1. Bhojwani, S.S and Bhatnagar, S.P.(2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi 5th edition.
2. Shivanna, K.R. (2013). Pollen Biology and Biotechnology, Oxford and IBHPublishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V.(2000). Development Biology of Flowering plants, Springer,Netherlands.
4. Johri, B.M.I (1984), EmbryologyofAngiosperms, Springer-Verlag,Netherlands.
5. Pandey, B.P., (2016) .A text of Botany Angiosperms,S. Chand & Company Pvt. Limited
6. Kochlar, S.L.,(2016): Economic Botany- A Comprehensive Study,5th Edition, Cambridge University Press India Pvt. Ltd.
7. Sammbamurthy, A.V.S.S and Subrahmanyam, N.S., (2018): CBS Publishers & Distibutors
8. Singh,V., Pande, P.C. and Jain, D.K.,(2018), Economic Botany, 3rd Edition, Rastogi Publications

MAJOR COURSE: MJ- 14.

**MOLECULAR BIOLOGY
(Credit course: Theory- 04)**

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

1. To gain the knowledge of structure and functions of DNA and RNA.

Course Learning Outcomes:

1. Understanding of nucleic acid, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
2. Processing and modification of RNA and translation process, function and regulation of expression.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks):

There will be **two** group of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

**THEORY
Lectures 60**

Full marks: 100

Time: 03 Hrs.

UNIT 1: Nucleic Acids (8 classes)

Historical perspective: DNA as the carrier of genetic information (Griffith's, Hershey & Chase)

UNIT 2: Structure of DNA and RNA (10 classes)

DNA structure, Watson and Crick Model of DNA, Types of DNA, Organization of DNA of prokaryotes, RNA: Structure, types and function, nucleosome model, Chromatin structure – Euchromatin, heterochromatin – Constitutive & Facultative heterochromatic.

UNIT 3: Replication of DNA (8 classes)

Mechanism of DNA replication, Enzymes involved in DNA replication

UNIT 4: Central Dogma and Genetic Code (8 classes)

General account of Central dogma and Genetic code.

UNIT 5: Mechanism of Transcription (8 classes)

Transcription in prokaryotes

UNIT 6: Translation (8 classes)

Process of translation in Prokaryotes.

UNIT 7: Regulation of Gene expression (10 classes)

Regulation of gene expression in Prokaryotes, Operon – inducible system (Lac operon) and repressible system (Trp operon).

Suggested Readings

1. George M. Malacinski (2019): Freifelders’s Essentials of Molecular Biology, 4th Edition, Jones & Barlett Student Edition
2. Ramawat, K.G. and Goyal, S. (2018): Molecular Biology and Biotechnology, S. Chand & Company Pvt. Limited
3. Verma, P.S. and Agarwal, V.K (2018): Molecular Biology, S. Chand & Company Pvt. Limited
4. Rastogi, V.B (1987): A Text Book of Genetics. Kedar Nath Ram Nath, Meerut



MAJOR COURSE: MJ-15
PRACTICALS-V (Credit course: Prt.- 04)

PRACTICALS

Ecology and Environmental Science

1. Study of microbial flora of water samples.
2. Study of Plant Community/ Vegetation of College Campus by Quadrate method, Measurement of frequency and density.
3. Study of pond-ecosystem, grassland ecosystem, food web, food chain by photographs
4. Study of water; air and noise pollution by photographs.
5. Project on Waste management for clean and green campus.

Embryology and Economic Botany

1. Study the structure and prepare temporary slides of anther (pollen grains) of ten common plants.
2. Study the germination of pollen grains in easily available plants species.
3. Study the structure of anatropous ovule
4. Dissection of embryo in *Tridax* / tomato/ mustard/ lady's finger
5. Field visit and preparation of herbarium of economically important plants included in the syllabus.

Molecular Biology

1. Study of DNA replication mechanism by photographs
2. Photographs establishing nucleic acid as a genetic material.
3. Project report on regulation of gene expression in prokaryotes

Practical examination

Full marks: 100 Pass Marks: 40

Time: 03 Hrs.

1. Study of Plant Community/ Vegetation of College Campus by Quadrate method and measurement of frequency and density.
Or Embryo dissection (of dicot embryo)
Or germination of pollen grains (in easily available plants species) 15marks
2. Study of microbial flora of water samples
Or identification of any ten specimen of economic importance from syllabus
Or To study and prepare temporary slide for the structure of anthers (pollen grains) and various types of ovule (any two) 20 marks
3. Watson and Crick model of DNA, nucleosome model, polytene and lampbrush chromosome, DNA replication mechanisms, nucleic acid as genetic materials. (any three) 10 marks
4. Spotting (five photographs from syllabus) (5x4 marks) 20 marks
5. Viva voce 15 marks
6. Class records/ Herbarium/ Chart. 20 marks

Semester VII

MAJOR COURSE: MJ-16.

PLANT PHYSIOLOGY AND CELL FRACTIONATION (Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

1. The course aims at making students realize how plants function, namely the importance of water, minerals, hormones, and light in plant growth and development; understand transport mechanisms and translocation in the phloem, and appreciate the commercial applications of plant physiology.
2. Current understanding of regulation and integration of metabolic processes in plants with reference to crop productivity.
3. To gain the knowledge of physiological and biochemical processes in the plant system
4. To gain basic knowledge of cell fractionation.

Course Learning Outcomes:

On successful completion of this course the student should be able to:

1. To understand water and nutrient uptake and movement in plants, role of mineral elements, translocation of sugars. Role of various plant growth regulator as phytochrome, cytochromes and phototropins, and flowering stimulus.
2. Students will gain the knowledge on reproductive strategies in higher plants along with physiology of flowering, molecular and hormonal basis of flowering mechanism.
3. The student will get acquainted with methods and function of cell fractionation.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY **Lectures 60**

Full marks: 100

Time: 03 Hrs.

UNIT 1: Plant water relationship (8 classes)

A. Water Potential, water absorption by roots, pathway of water movement, symplast, apoplast transmembrane pathways, root pressure, guttation.

B. Ascent of sap, cohesion-tension theory, Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

UNIT 2: Mineral nutrition (5 classes)

Essential and beneficial elements macro- and micronutrients, roles of essential elements, Hydroponics, Absorption of mineral elements.

UNIT 3: Phloem Translocation (5 classes)

Mechanism of translocation of food.

UNIT 4: Nitrogen metabolism (3 classes)

Biological nitrogen fixation, reductive amination and transamination

UNIT 5: Carbon assimilation (10 classes)

Historical background, photochemical reactions, photosynthetic electron transport, PSI, PSII, CO₂ reduction, red drop Emerson effect, Quantum Yield, C₃, C₄ Cycle, photorespiration, photophosphorylation.

UNIT 6: Carbon oxidation (8 classes)

Glycolysis, oxidative decarboxylation of pyruvate, TCA Cycle, anaerobic reactions, mitochondrial electron transport.

UNIT 7: Lipid metabolism (4 classes)

Introduction, saturated and unsaturated fatty acids, β - oxidation of fatty acids/ lipids.

UNIT 8: ATP- synthesis (5 classes)

Mechanism of ATP synthesis, substrate level phosphorylation, (oxidative and photophosphorylation).

UNIT 9: Plant growth regulators (5 classes)

Discovery, chemical nature (basic structure), roles of Auxin, Gibberellins and Cytokinin.

UNIT 10: Physiology of flowering (4 classes)

Photoperiodism, florigen concept and vernalization.

UNIT 11: Cell fractionation (3 classes)

General views on the methods for fractionation or separation of macromolecules of the cells – **1.** Centrifugation: principle and its type; **2.** Chromatography: principle and its type; **3.** Electrophoresis: principle and its type.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. JohnWiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Muller, I.M and Murphy, A (2015). Plant Physiology and development. Sinauer Associates Inc. USA 6th edition.
3. Bajracharya D. (1999).Experiments in Plant Physiology-A Laboratory Manual, Narosa Publishing House, New Delhi.

MAJOR COURSE: MJ-17.

PLANT BIOTECHNOLOGY AND NANOBIO TECHNOLOGY
(Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

1. The objective of the course is to give students new knowledge and widening of the knowledge acquired in other course by handling of classical and modern plant biotechnology processes, including tissue culture for healthy plants, plants with improved characteristics.
2. This course explores the use of biotechnology to both generate genetic variation in plants and to understand how factors at the cellular level contribute to the expression of genotypes and hence to phenotypic variation.
3. Understanding of biotechnological processes such as recombinant DNA technology.
4. This knowledge is central to our ability to modify plant responses and properties for global food security and commercial gains in biotechnology and agriculture.
5. To familiarize the students with the fundamental principles of Nanobiotechnology and its various potential application.

Course Learning Outcomes:

1. Learn the basic concepts, principles and processes in plant biotechnology. Have the ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological and agricultural applications.
2. Use basic biotechnological techniques to explore molecular biology of plants.
3. Understand how biotechnology is used to for plant improvement and discuss the biosafety concern and ethical issue of that use.
4. Able to carry out research/investigation independently in specialized area of Nanobiotechnology.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY
Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: Plant Tissue Culture (15 classes)

History: Basic requirement of tissue culture, Technique, Prospect and application, Totipotency, Organogenesis, Embryogenesis, Protoplast Isolation, micropropagation, Somatic hybridization, anther culture, pollen culture, Cryopreservation, Germplasm Conservation.

Unit 2: Recombinant DNA Technology (20 classes)

Tools, Restriction endonucleases, Plasmid, Cloning Vectors: Prokaryotic (pBR322, Ti plasmid); Lambda phage, Cosmid, Concept of Shuttle vector; Eukaryotic Vectors (YAC). Properties, Ti-Plasmid, Process and application of r-DNA technology, electrophoresis as an important tool, construction of genomic and c-DNA library, PCR technology and PCR mediated gene cloning; Blotting – Northern and southern, DNA – finger printing.

Unit 3: Methods of gene transfer (7 classes)

Biological method (Indirect): Agrobacterium-mediated; Physical methods (Direct): Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit 4: Application of Bio-technology (8 classes)

Pest resistant (Bt-cotton), herbicide resistant plants (Roundup Ready soybean), Transgenic crops with improved quality traits (*Flavr savr* tomato, Golden rice), Impact of transgenic crops on society, Role of transgenics in bioremediation (Superbug); edible vaccines; Intellectual Property Right in Biotechnology

Unit 5: Nanobiotechnology (10 classes)

Introduction, application and role of nanotechnology in agriculture, synthesis of drugs and food production; Biopesticides, biofertilizers and DNA based biosensors as nanoparticles.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Gillick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology – Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Willey & Sons Inc. U.S.A.
4. Dubey, R.C. – 2015, A. Text book of Biotechnology, S. Chand & Co. Pvt.Ltd- New Delhi.
5. Ramawat, K.G. & Goyal, Shaily- 2015, Comprehensive Biotechnology-S. Chand & Co. New Delhi
6. Singh, B.D., (2019): Molecular biology and Recombinant DNA Technology, Kalyani Publication.
7. Verma, P.S., and Agarwal, V.K., (2019): Genetic Engineering, S. Chand & Co. Pvt.Ltd- New Delhi.
8. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
9. The 2018-2023 World Outlook for Nanobiotechnology Paperback – December 18, 2017, Icon

group international.

10. Arunava Goswami and Samrat Roy Choudhary, Nanobiotechnology, Basic and Applied Aspects.
11. Clive Jarvis, Nanobiotechnology: An Introduction.
12. H B Singh, S Mishra, L F Fraceto, R D D Lima; Emerging Trends in Agri-Nanotechnology.
13. Elements of X-ray diffraction, B D Cullity- Addison-Wesley Publishing Company, Inc.
14. Encyclopedia of Materials Characterization, C. Richard Brundle and Charles A. Evans, Jr.
15. Willard, Merritt, Dean, Settle - Instrumental Methods of Analysis, 7th edition



MAJOR COURSE: MJ- 18.

APPLIED BOTANY
(Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 75 (ESE: 3 Hrs) = 100

Pass Marks: Th (SIE + ESE) = 40

Course Objectives:

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

1. To gain overall knowledge and become familiar with topics introduced in botany.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Students would come to know the importance of botany and its branches in day to day life.
2. Gain access to ethnobotany, biodiversity conservation, phytochemistry and pharmacognosy of medicinal plants, natural resource management, biofuels, soilless farming and vermiculture.

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5 = 25)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 75 marks) :

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note : There may be subdivision in the question of Group B.

THEORY
Lectures 60

Full marks: 100

Time: 03 Hrs.

UNIT 1: An overview of ethnobotany (4 classes)

History, introduction, definition, branches, scope and importance of ethnobotany

UNIT 2: Biodiversity and its conservation. (13 classes)

Biodiversity- Definition, types, levels, importance, threats and causes of biodiversity loss.

Biodiversity conservation- Methods of conservation (*in situ* and *ex situ* conservation). Role of IUCN green list; Types of data book- Yellow, Blue, Green, Black, Red

Biodiversity Hotspots of India; Laws of biodiversity conservation: Biodiversity act in India, Wetland conservation in India, Role of remote sensing in biodiversity and its conservation.

UNIT 3: Pharmacognosy and Phytochemistry of medicinal plants. (10 classes)

A. Definition, history, scope of pharmacognosy and phytochemistry

B. A brief account on pharmacognosy and phytochemistry aspect and uses of following medicinal plants:-

i. *Atropa belladonna* **ii.** *Centella asiatica* **iii.** *Rauwolfia serpentina* **iv.** *Ocimum sanctum*
v. *Tinospora cordifolia* **vi.** *Azadirachta indica* **vii.** *Withania somnifera* **viii.** *Phyllanthus niruri*

UNIT 4: Natural Resource Management (4 classes)

Definition, Importance, Objectives, Methods and its different approaches; Algal flora as natural resource for sustainable agriculture.

UNIT 5: Soiless farming (5 classes)

Techniques and prospect of soiless farming- Hydroponics, Aquaponics and Aeroponics

UNIT 6: An overview of biofuels (8 classes)

Definition, types, biomass to biofuel processes, biofuel production, advantages and disadvantages

UNIT 7: Mushroom Cultivation (8 classes)

Basic requirement of mushroom cultivation, Techniques and current prospect of mushroom cultivation

UNIT 8: Vermiculture (8 classes)

Methods, preparations, benefits and field application of vermiculture

Suggested Readings

1. Pandey, B.P. (2018): Economic Botany, S. Chand and company Ltd.
2. Sharma, P.D (2017): Ecology and Environment, 13th Edition, Rastogi Publications, Meerut
3. Hosetti, B. B and Ramkrishna, S. (2016): Biodiversity- Concepts and Conservation, Aavishkar Publishers, Distributors, Jaipur
4. Patro, L. (2016): Biodiversity Conservation and Management, Discovery Publishing Pvt. Ltd.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
6. Gupta, P.K., (2004) Biotechnology and Genomics, Rastogi Publications. Shivaji Road Meerut, India, 1st edition.
7. G. S. Randhawa and A. Mukhopadhyay (1986). Floriculture in India, Allied (<https://books.google.co.in/booksid=fABzMgAACAAJ>)
8. Fundamentals of IP for Engineers: K. Bansal & P.
9. Intellectual property right, Deborah, E. BoDcboux, Cengage learning.
10. Electronic resource guide ERc published online by the American Society of Intellectual Property Rights and Development Policy: Report of the Commission on Intellectual Property Rights, London Sepiedber 2002 (Web resources)
11. WIPO Intellectual Property Handbook. Policy, Law and Use (web resource)

MAJOR COURSE: MJ-19
PRACTICALS-VI (Credit course: Prt.- 04)

Plant Physiology and Cell Fractionation

1. Determination of water potential of given tissue (potato tuber) by weight method.
2. Calculation of stomatal frequency from the two surfaces of leaves of a mesophyte.
3. To determine the rate of transpiration by Farmer's and Ganong's potometer.
4. IAA Bioassay experiment on *Avena* coleoptile elongation.
5. Separation of Pigments by Chromatography method.
6. Experiment showing O₂ is evolved during photosynthesis
7. Experiment showing that light is essential for photosynthesis
8. Experiment showing that CO₂ is essential for photosynthesis.
9. Photographs study of cell fractionation tools and techniques.

Plant Biotechnology and Nanobiotechnology

1. Preparation of culture media and inoculation of explants – seeds and leaf meristem.
2. Study of anther, embryo, endosperm culture, micro propagation and somatic hybridization through photographs.
3. Study the principles and functioning of instrument used in biotechnology laboratory- laminar air flow, hot air oven, autoclave, pH meter, weighing machine, centrifuge and bio-oxygen demand incubator.
4. Study of cloning vectors through photographs
5. Project report on application of biotechnology.

Long trip/ excursion/ research institutes visits

Practical examination

Full marks: 100 Pass marks: 40

Time: 03 Hrs.

- i. Preparation of culture media and inoculation of explants
Or anther, embryo, endosperm culture, micropropagation, somatic hybridization, cloning vectors and cell fractionation equipments through photographs. (any three)
15 marks
- ii. Experiment showing CO₂ is essential for photo synthesis
Or Determination of water potential of given tissue (potato tuber) by weight method.
Or Separation of pigments by Chromatography method. 15 marks
- iii. To study the effect of different concentration of IAA on *Avena* coleoptile elongation.
Or Experiment showing O₂ is evolved during photosynthesis
Or To determine the rate of transpiration by Farmer's and Ganong's potometer. 15 marks.
- iv. Spotting (5 x4 marks) 20 marks
- v. Viva voce 15 marks
- vi. Class records and Project Report/ Model/ Chart. 20 marks

Semester VIII

MAJOR COURSE: MJ-20.

RESEARCH



Semester VIII

ADVANCED MAJOR COURSE: AMJ- 01.

RESEARCH METHODOLOGY FOR PLANTS (Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE : 1hr) + 60 (ESE: 3 Hrs) = 75

Pass Marks: Th (MSE + ESE) = 40

Course Objective

1. This course addresses the issues inherent in selecting a research problem and discuss the techniques and tools to be employed in completing a research project.

Course Learning Outcomes

1. Demonstrate the ability to choose methods appropriate to research aims and objectives.
2. Understand the limitations of particular research methods.
3. Develop skills in qualitative and quantitative data analysis and presentation.
4. Develop advanced critical thinking skills.

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5 + 15)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 60 marks) :

There will be **two** group of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY

Lectures 60

Full marks: 100

Time: 03 Hrs

Unit 1: Basic concepts of research (10 lectures)

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

Unit 2: General laboratory practices (12 lectures)

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

Unit 3: Data collection and documentation of observations (6 lectures)

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

Unit 4: Overview of Biological Problems (6 lectures)

History; Key biology research areas, Model organisms in biology (A brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics Transcriptional regulatory network.

Unit 5: Methods to study plant cell/tissue structure (6 lectures)

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

Unit 6: Plant microtechniques (12 lectures)

Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

Unit 7: The art of scientific writing and its presentation (8 lectures)

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation (from syllabus and current science issues). Poster presentation (from syllabus and current science issues). Scientific writing and ethics, Introduction to copyright-academic misconduct/ plagiarism.

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant micro technique and microscopy. Oxford University Press, New York, U.S.A.

ADVANCED MAJOR COURSE: AMJ- 02.

GENOMICS, BIOINFORMATICS AND COMPUTATIONAL BIOLOGY (Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 60 (ESE: 3 Hrs) = 75

Pass Marks: Th (MSE + ESE) = 40

Course Objectives:

1. The students will come to know basic ideas of genomics.
2. To familiarize the students with the fundamental principles of Bioinformatics and Computational biology.
3. Various potential application of Bioinformatics and Computational tools in biology.

Course Learning Outcomes:

1. The students will analyze the wide application of genomics.
2. Ability to carry out research /investigation independently in specialized area of Bioinformatics and Computational Biology.

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5 + 15)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 60 marks) :

There will be **two** group of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY Lectures 60

Full marks: 100

Time: 03 Hrs

UNIT 1: Genomics (30 classes)

1. Organization and structure of genomes, genome size, sequence complexity, introns and exons, Genome structure in prokaryotes, Isolation of chromosome
2. Gene identification and expression, genome annotation, traditional gene identification routes, detecting open read frame, gene ontology, application of genomics analysis, overview of comparative genomics.
3. Application of genomics- Analysis of genomics in plants, role in plant genetics and breeding

UNIT 2: Bioinformatics (30 classes)

1. Bioinformatics: Introduction – genomics – transcriptome – proteome.
Biological databases: Generalized and specialized databases – DNA, protein and carbohydrate databases – nucleic acid sequence databases – premier institutes for databases – nucleic acid codes used in database formats; Collection and down loading of information from databases – literature search.

2. Sequence alignment and its evolutionary basis: Simple alignment and multiple sequence alignment - searching the database for sequence similarity – search programmes with special reference to FASTA, BLAST, CLUSTAL W. Application of bioinformatics in phylogenetic analysis.

UNIT 3: Computational Biology (30 classes)

Computer assisted drug design- concept, methods and practical approaches.

1. Diagrammatic, graphical and tabular representations of data; measures of central tendency: mean, mode and median, dispersion, skewness and kurtosis.
2. Basic concepts of hypothesis testing, two kinds of error, level significance, p value, t-Test for mean and difference between two means, partial t-test., and Chi square test for goodness of fit.

Suggested Readings

1. Alonso, M.J. and Stepanova, A.N. (2015): Plant Functional Genomics Methods and Protocols, 2nd Edition, Springer Nature.
2. Caldwell, G.A., Williams, S.N., and Caldwell, K.A.(2014): Integrated Genomics, John Wiley Publications
3. Archbald, J. (2018): Genomics A very short Introduction, OUP Oxford
4. Zweiger, G. (2002): Transducing the genome, McGraw- Hill Education
5. Roy, H. and Prasad, D.P.,(2008): Gene and Genomics, Asian Books Private Limited
6. D'costa, S (2015): Advances in Genomics, Callisto Reference
7. Xiong, Essential Bioinformatics, Cambridge University Press.
8. Marketa J Zvelebil, Understanding Bioinformatics, Garland Sciences.
9. Shui Quing Ye, Bioinformatics: A practical approach.
10. Anna Tramantano, Introduction to Bioinformatics.
11. David W Mount, Bioinformatics. CBS.
12. Mani K and Vijayaraj N, Bioinformatics, Kalaikathir Achchagam.

ADVANCED MAJOR COURSE: AMJ-03
PRACTICALS-VII (Credit course: Prt.- 04)

PRACTICAL

Research methodology for plants

1. Experiments based on chemical calculations.
2. Technique of handling micropipettes in laboratory.
3. Data collection and documentation of observations in laboratory as well as field .
4. The art of imaging of samples through microphotography and field photography.
5. Plant microtechnique experiments.
6. Fixing agents and preservative in laboratory:- Squash preparations, clearing, maceration and sectioning; Mounting of an object under some common media.
7. Plant tissue dehydration using graded solvent series for permanent slide preparation.
8. Cytogenetic techniques with squashed plant materials.
9. Powerpoint and poster presentation on assigned topics.

Genomics

1. Learning and application of genomics
2. Techniques of genome sequencing
3. Genome application.
4. Project report submission on various topics of genomics.

Bioinformatics and Computational biology

1. Testing good fit or not by chi-square method.
2. 't- test' significance to find differences between the two different sample.
3. Calculation of standard error to test ratio between two given Mendel's ratio
4. Experiments based on chemical calculations.
5. The art of imaging of samples through microphotography and field photography.
6. Poster presentation on defined topics.
7. Technical writing on topics assigned.

Research lab visits

Practical examination

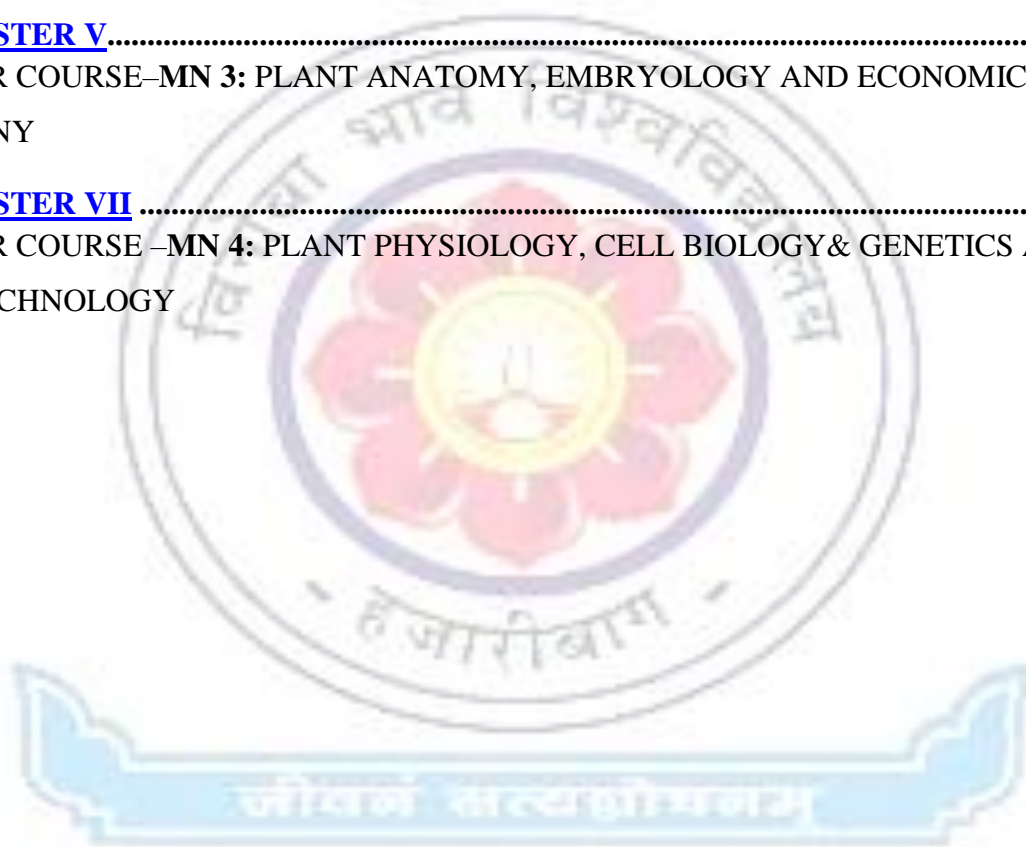
Full marks: 100 Pass Marks: 40

Time: 03 Hrs.

1. Preparation of permanent slides of plant tissues specimens by dehydration methods using graded solvent series.
Or To study different plant materials through maceration techniques (Schultze's method)
Or Preparation of squash of the onion root tips to study all the stages of mitosis. 15 marks
2. Methods for preparing genomic library
Or Preparation of gel electrophoresis (Agarose gel for DNA and RNA).
Or Testing good fit or not by chi-square method. 15 marks
3. Calculation of standard error to test ratio between two given Mendel's ratio
Or Experiments based on chemical calculations
Or 't- test' significance to find differences between the two different sample. 15 marks
4. Spotting (5x4 marks) 20 marks
5. Viva voce 15 marks
6. Class records and Project Report/ Model/ Chart. 20 marks

SYLLABUS OF BOTANY MINOR COURSE- NEP, VINOBA BHAVE UNIVERSITY

<u>SEMESTER I</u>	45-46
MINOR COURSE–MN 1: MICROBES, ALGAE, FUNGI AND ARCHEGONIATES	
<u>SEMESTER III</u>	47-48
MINOR COURSE–MN 2: PLANT ECOLOGY AND TAXONOMY	
<u>SEMESTER V</u>	49-50
MINOR COURSE–MN 3: PLANT ANATOMY, EMBRYOLOGY AND ECONOMIC BOTANY	
<u>SEMESTER VII</u>	51-52
MINOR COURSE –MN 4: PLANT PHYSIOLOGY, CELL BIOLOGY& GENETICS AND BIOTECHNOLOGY	



SEMESTER I

MINOR COURSE–MN 1: MICROBES, ALGAE, FUNGI AND ARCHEGONIATES (Credit course: Theory- 04, Practical- 02)

Marks: 15 (5 Attendance & others + 10 SIE: 1hr) + 60 (ESE: 3 Hrs) = 75

Pass Marks: Th (MSE + ESE) = 30

Course Objectives:

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

1. To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Students would understand the classification, characteristic features, cell structure and growth and reproduction in viruses, bacteria and economic importance.

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5 = 15)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 10 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 60 marks)

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY **Lectures 60**

Full marks: 75

Time: 03 Hrs.

UNIT 1: MICROBES (25 lectures)

1. Virus :- Discovery, general characteristics, nature of virus; Structure of TMV and bacteriophage.
2. Bacteria :- Discovery, general characteristics, types and economic importance.

UNIT 2: ALGAE, FUNGI AND ARHEGONIATES (35 lectures)

1. General characteristics, Morphology, Anatomy and Reproduction of following genus: *Volvox*, *Albugo*, *Marchantia*, *Selaginella*, *Pinus* & General account of Lichens

Suggested Readings

1. Pelczar, M.J, (2001) Microbiology, 5th edition, Tata McGraw-hill Co, NewDelhi.
2. Sharma,P.D.(2014) Microbiology. Rastogi Publication, Meerut
3. Vashishta, B.R., Singh, V.P., and Sinha A.K. (2014) Botany for Degree Students (Alage) S.Chand & Company Ltd.
4. Singh, Pande, Jain (2017-2018) A Text book of Botany Microbiology and Phycology
5. Singh, Pande, Jain (2018) A Text book of Botany 5th edition.

PRACTICALS

1. Structure of Bacteriophage and TMV by photographs.
2. Forms of Bacteria by slides/photographs.
3. Study of vegetative and reproductive structures of *Volvox* and *Albugo* by preparing temporary slides and also by permanent slides.
4. Study of genus of *Marchantia*, *Selaginella* and *Pinus* by preparing temporary slides and also by permanent slides.

PRACTICAL EXAMINATION

Full Marks: 25 Pass Marks: 10

Time: 3 hours

1. Prepare a temporary slide and comment on it with a well labelled diagram of any one of the following genus : *Volvox*, *Albugo*, *Marchantia*, *Selaginella*, *Pinus* (7)
2. Through photographs or by permanent slides- TMV structure / bacteriophage/ forms of bacteria (6)
3. Spotting (two) $2.5 \times 2 = (5)$
4. Record (4)
5. Viva (3)



SEMESTER III

MINOR COURSE–MN 2: PLANT ECOLOGY AND TAXONOMY (Credit course: Theory- 04, Practical- 02)

Marks: 15 (5 Attendance & others + 10 SIE : 1hr) + 60 (ESE: 3 Hrs) = 75

Pass Marks: Th (MSE + ESE) = 30

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. This course aims to introduce the students to the concepts and principles of ecology, biological diversity, conservation, sustainable development, population, community and ecosystem structure and function, application of these concepts to solve environmental problems.
2. To gain the knowledge on the taxonomy, phylogeny of plants.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. It will acquaint the students with complex interrelationship between organisms and environment; make them understand methods to studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
2. What are applications of ecological knowledge for the benefit of anthropogenic society.
3. Understanding of systematics its importance in bioresource utilization and biodiversity management. Nomenclature pattern, Phylogeny, Classification systems of the plants.

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5 = 15)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 10 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 60 marks)

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY **Lectures 60**

Full marks: 75

Time: 03 Hrs.

UNIT 1: PLANT ECOLOGY (30 lectures)

1. Introduction
2. Ecological Adaptation - Hydrophytes & Xerophytes
3. Ecosystem structure- Pond ecosystem and Grassland ecosystem
4. Pollution - Air pollution & Water pollution - Cause and Control

UNIT 2: TAXONOMY (30 lectures)

1. Introduction, Identification, Classification and Nomenclature
2. Taxonomical hierarchy
3. Principles and rules of ICN
4. Bentham and Hooker's system of classification
5. Study of families – Apocynaceae, Poaceae

Suggested Readings

1. Sharma, P.D (2017): Ecology and Environment, 13th Edition, Rastogi Publications, Meerut
2. Odum, E.P and Barrett, G.W., (2017) Fundamentals of Ecology, 5th Edition, Cengage Learning, New Delhi
3. Pandey, B.P., (2018) Botany for Degree Students (Plant Ecology and Taxonomy) S. Chand & Company Ltd.
4. Pandey, B.P., (2016) .A text of Botany Angiosperms, S. Chand & Company Pvt. Limited
5. Pandey, B.P., (2016) .Taxonomy of Angiosperms ,S. Chand & Company Pvt. Limited

PRACTICALS

1. Study of morphological adaptation of hydrophytes and xerophytes.
2. Study of pond ecosystem, grassland ecosystem, air pollution and water pollutions through photographs
3. Study of vegetative and floral characters of families included in the syllabus with floral formula, floral diagram and systematic position.

PRACTICAL EXAMINATION

Full Marks: 25 Pass Marks: 10

Time: 3 hours

1. Prepare a temporary slide on any one of the following and comment on it with a well labelled diagram: Hydrophytes/ Xerophytes (5)
2. Write the Floral character, Floral Formula, Floral Diagram and Systematic position of any one family included in the syllabus. (8)
3. Spotting 2.5 x 2 = (5)
4. Record (4)
5. Viva (3)

SEMESTER V

MINOR COURSE–MN 3: PLANT ANATOMY, EMBRYOLOGY AND ECONOMIC BOTANY

(Credit course: Theory- 04, Practical- 02)

Marks: 15 (5 Attendance & others + 10 SIE: 1hr) + 60 (ESE: 3 Hrs) = 75

Pass Marks: Th (MSE + ESE) = 30

Course Objectives:

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

1. To acquaint the students with internal basic structure and cellular composition of the plant body.
2. Study of various tissue systems and their development and functions in plants.
3. Brief account of embryology.
4. It emphasizes the plants used as- food for man, fodder for cattle, feed for poultry, plants having medicinal value and also plant source of huge economic value etc.

Course Learning Outcomes:

On successful completion of this course the student shall know:

1. Knowledge of various cells and tissues, meristem, epidermal and vascular tissue system in plants.
2. Correlation of structure with morphology and functions.
3. The students will learn about the use of crop plants, pulses, oil yielding plants, fiber plants, timber yielding plants, beverages, fruits and vegetables and medicinal plants that are integral to day to day life.

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5 = 15)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 10 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End Semester Examination (ESE 60 marks)

There will be **two** groups of questions. Group A is compulsory which will contain three questions. Question No.1 will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY

Lectures 60

Full marks: 75

Time: 03 Hrs.

UNIT 1: PLANT ANATOMY (15 lectures)

1. General Characteristics of Meristematic Tissue, Simple & Complex Tissues
2. Vascular Cambium and Wood Structure, Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses.

UNIT 2 :EMBRYOLOGY (25 lectures)

1. Brief account of embryology and contribution of W. Hofmeister and P. Maheswari.
2. Structure of anther and microsporogenesis
3. Structure of Ovule, Types of Ovules
4. Double fertilization, Triple fusion
5. Embryo Sac - Development of *Polygonum* type of embryo sac

UNIT 3: ECONOMIC BOTANY (20 lectures)

1. Morphology, Botanical name, Family name, & uses of followings:
Wheat (cultivation also), Gram, Mustard, Sunflower, Cotton, Tea (cultivation), Shisham, Teak, Mango, Guava, Potato, Cabbage, Lady's finger, Tulsi, Neem and Amla

Suggested Readings

1. Dickison, W.C., (2000). Integrative plant anatomy. Harcourt Academic Press, USA.
2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikash Publishing House. Delhi 5th edition
3. Pandey, B.P., (2016) .A text of Botany Angiosperms, S. Chand & Company Pvt. Limited
4. Kochlar, S.L., (2016): Economic Botany- A Comprehensive Study, 5th Edition, Cambridge University Press India Pvt. Ltd.
5. Sammbamurthy, A.V.S.S and Subrahmanyam, N.S., (2018): CBS Publishers & Distributors
6. Singh, V., Pande, P.C. and Jain, D.K., (2018), Economic Botany, 3rd Edition, Rastogi Publications

PRACTICALS

1. Identification of tissues (parenchyma, collenchyma and sclerenchyma)
2. Study the structure of anatropous ovule and embryo sac.
3. Dissection of embryo in *Tridax*/ tomato/ mustard/ lady's finger
4. Plant identification and uses.

PRACTICAL EXAMINATION

Full Marks: 25

Pass Marks: 10

Time: 3 hours

1. Prepare a temporary slide on any one of the anatomical sections and comment on it with a well labelled diagram **Or** Embryo dissection (7)
2. Through photographs or by permanent slides- Ovule structure/Embryo sac structure (6)
3. Spotting 2.5 X 2 = (5)
4. Record (4)
5. Viva (3)

SEMESTER VII

MINOR COURSE –MN 4: PLANT PHYSIOLOGY, CELL BIOLOGY & GENETICS AND BIOTECHNOLOGY

(Credit course: Theory- 04, Practical- 02)

Marks: 15 (5 Attendance & others + 10 SIE: 1hr) + 60 (ESE: 3 Hrs) = 75

Pass Marks: Th (MSE + ESE) = 30

Course Objectives:

1. The course aims at making students realize how plants function. namely the importance of water, minerals, hormones, and light in plant growth and development.
2. Cell biology study will provide inside into the organization of cell, its features and regulation at different levels.
3. To understand basic ideas of genetics.
4. Understanding of biotechnological processes such as plant tissue culture and recombinant technology

Course Learning Outcomes:

On successful completion of this course the student should be able to:

1. To understand water and nutrient uptake and movement in plants, role of mineral elements, growth regulator and role of light in photosynthesis.
2. This course will be able to demonstrate foundational knowledge in understanding of cell.
3. Learn the basic concepts, principles and processes in plant biotechnology.
4. To understand how biotechnology is used in various fields.

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5 = 15)

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 10 marks (b) Class Attendance Score (CAS) including the behavior of the student towards teachers and other students of the college 5 marks.

End semester examination (ESE 60 marks)

There will be **two** groups of questions. Group **A** is compulsory which will contain three questions. Question no.1 will be **very short answer type (not mcq)** consisting of five questions of 1 mark each. **Question no. 2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.

Note: There may be subdivision in the question of Group B.

THEORY Lectures 60

Full marks: 75

Time: 03 Hrs.

UNIT 1: PLANT PHYSIOLOGY (25 classes)

1. Transpiration- Mechanism & Significance,
2. Photosynthesis- Photophosphorylation, C₃ cycle,
3. Plant growth hormones : Discovery and Role of- Auxin and Gibberellin
4. Mineral nutrition

UNIT 2: CELL BIOLOGY & GENETICS (20 lectures)

1. Ultrastructure of Plant Cell
2. Cell Division-Mitosis, Meiosis
3. Principles of Inheritance, Mendel's Laws and Polyploidy

UNIT 3: BIOTECHNOLOGY (15 classes)

1. Plant Tissue Culture –History, Requirement, Technique & Application.

2. Basic concept of recombinant DNA technology. (cloning vectors and restriction endonucleases)
3. Concept and uses of biotechnology everyday life.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. JohnWiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Muller, I.M and Murphy, A (2015). Plant Physiologyand development. Sinauer Associates Inc. USA 6th edition.
3. Bhattacharya D. (1999). Experiments in Plant Physiology-A LaboratoryManual, Narosa Publishing House, New Delhi.
4. Karp, G. (2010), Cell Biology, John Wiley & Sons,U.S.A. 6th edition
5. Gardner, E.J., Simmons, M.J., Snustad, D.P., (1991). Principles of Genetics. John Wley & Sons. India 8th edition.
6. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory andPractice. Elsevier Science Amsterdam. The Netherlands.
7. Dubey, R.C. (2015), A. Text book of Biotechnology, S. Chand & Co. Pvt.Ltd- New Delhi.

PRACTICALS

1. Determination of rate of transpiration by Farmers's potometer or Ganong's potometer
2. Experiment showing oxygen is evolved during photosynthesis.
3. Experiment showing that carbon dioxide is essential for photosynthesis.
4. Experiment showing that light is essential for photosynthesis.
5. Separation of pigments by chromatography method.
6. Cytological slide preparation to study of different stages of mitosis and meiosis
7. Preparation of culture media and inoculation of explants – seeds and leaf meristem.
8. Study the principles and functioning of instrument used in Microbiology Laboratory- laminar air flow, hot air oven, weighing machine and autoclave.

PRACTICAL EXAMINATION

Full marks: 25 Pass Marks: 10

Time: 03 Hrs.

1. To perform one physiological experiment included in syllabus
Or Preparation of culture media and inoculation of explants. (08)
2. Study the principles and functioning of instruments used in microbiology laboratory
Or cytological slide preparation. (5)
3. Spotting 2.5x2 = (5)
4. Records (4)
5. Viva voce (3)