

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



**NEP FYUGP CURRICULUM
BOTANY HONOURS/
BOTANY HONOURS WITH RESEARCH**

For Undergraduate Courses under Vinoba Bhave University, Hazaribag

Under NEP - 2020

Implemented from academic Session 2025-2026

& onwards

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- ii. **Prof. A. K. Panigrahi,**
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4. Special Invitee Members

- i. **Prof. E. N. Siddiqui**
Ex Head, Dept. of Botany, VBU
- ii. **Prof. M.A. Mallick**
Ex Head, Dept. of Botany, VBU
- iii. **Dr. P. K. Mishra**
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Semester – I

MAJOR COURSE: MJ- 01. MICROBIOLOGY AND ALGAE (Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

The course aims to:

- Familiarize students with the classification, morphology and importance of microorganisms.
- Provide an overview of algal diversity, classification, and evolutionary significance.
- Develop understanding of morphology, reproduction, and life cycles of major algal groups.

Course Learning Outcomes:

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

1. Explain the historical development and scope of microbiology, including contributions of pioneers.
2. Describe the structure, physiology, and reproduction of major groups of microorganisms (bacteria, viruses and algae).
3. Demonstrate fundamental microbiological laboratory skills such as aseptic techniques, culture methods, staining, and microscopy.
4. Differentiate between beneficial and harmful roles of microbes in environment, industry, agriculture, and health.
5. Recall and classify algae based on morphology, reproduction, and phylogenetic relationships.
6. Describe the structure, life cycles, and ecological significance of major algal groups

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.

**COURSE CONTENT
THEORY
LECTURES – 45**

Full marks: 75

Time 03 Hrs.

UNIT 1: Viruses

(4 lectures)

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

UNIT 2: Bacteria, Cyanobacteria and Mycoplasma

(6 lectures)

Discovery, general characteristics and cell structures

UNIT 3: Algae

(5 lectures)

General characteristics; Classification proposed by F.E. Fritsch. Significant contribution of important Phycologists: F.E. Fristch, G.M. Smith, H Kumar, MOP Iyengar

UNIT 4: Cyanophyta

(5 lectures)

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

UNIT 5: Chlorophyta

(5 lectures)

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

UNIT 6: Charophyta

(5 lectures)

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

UNIT 7: Xanthophyta

(5 lectures)

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

UNIT 8: Phaeophyta

(5 lectures)

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

UNIT 9: Rhodophyta

(5 lectures)

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

Suggested readings

1. Textbook of Microbiology – Ananthanarayan & Paniker 11th Edition, 2023, Universities Press.
2. Microbiology – D.K. Maheshwari, R.C. Dubey Revised Edition, 2022, S. Chand & Company.
3. Textbook of Microbiology – C.P. Baveja 6th Edition, 2021, Arya Publications.
4. Prescott's Microbiology – Joanne Willey, Kathleen Sandman, Dorothy Wood 12th Edition, 2023, McGraw-Hill Education.
5. Brock Biology of Microorganisms – Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, 16th Edition, 2021, Pearson.
6. Microbiology: An Introduction – Gerard J. Tortora, Berdell R. Funke, Christine L. Case 14th Edition, 2023, Pearson.
7. Textbook of Algae – O.P. Sharma 4th Edition, 2021, McGraw-Hill Education (India).
8. Algae – D.V. Singh & R.P. Singh, 2nd Edition, 2020, Rastogi Publications.
9. The Biology of Algae – F.E. Round, 2nd Edition, 1984 (still widely cited for algal biology), Cambridge University Press.
10. Algae: Anatomy, Biochemistry, and Biotechnology – B. S. Kristina & B. S. Satish Kumar, 3rd Edition, 2018, CRC Press.
11. Gangulee, H.C. and Kar, A.K. 2012, College Botany Volume-II

PRACTICALS

30 Hrs.

Microbiology

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

Algae

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

PRACTICAL EXAMINATION

Full Marks: 25

Pass Marks: 10

Time: 3 Hrs.

1. Prepare a temporary slide and comment on it with a well labelled diagram of any one of the following genus: *Nostoc*, *Volvox*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus* and *Batrachospermum* (6)
2. Gram Staining Technique **or**
Study through photographs or by permanent slides- TMV structure / bacteriophage/ forms of bacteria. (6)
2 X 2 = (4)
3. Spotting (5)
4. Record (5)
5. Viva-Voce (4)

Semester – II

MAJOR COURSE: MJ-02. FUNGI AND PLANT PATHOLOGY (Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

The course aims to:

- Introduce the diversity, structure, reproduction, and ecological roles of fungi.
- Familiarize students with economically important fungi (useful and harmful) and lichens.
- Provide understanding of the basic principles of plant pathology and host–pathogen interactions.
- Develop knowledge of major plant diseases, their causal organisms, symptoms, and control measures.
- Highlight modern approaches in disease management, including biocontrol, resistant varieties, and integrated pest management.

Course Learning Outcomes:

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

1. Understand the classification of fungus given by Gwynne-Vaughan and B Barnes, and Ainsworth.
2. Explain the general characteristics, structure, life cycles, classification, and ecological significance of fungi.
3. Application of fungus in food industry.
4. Describe the structure, thallus organization, and symbiotic relationship between fungal and algal partners.
5. Distinguish major types of lichens (crustose, foliose, fruticose, etc.) based on morphology and anatomy.
6. Discuss the uses of lichens in medicine, dyes, perfumes, food, and bio-monitoring.
7. Recognize and describe major groups of plant pathogenic fungi, their mode of infection, and survival strategies.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

UNIT 1: Introduction to fungi	(2 lectures)
Definition, General characteristics and Classification by Gwynne-Vaughan and B Barnes, Ainsworth.	
UNIT 2: Mastigomycotina	(5 lectures)
General characteristics and life cycle of <i>Synchytrium</i>	
UNIT 3: Zygomycotina	(5 lectures)
General characteristics and life cycle of <i>Mucor</i>	
UNIT 4: Ascomycotina	(5 lectures)
General characteristics and life cycle of <i>Peziza</i> , <i>Erysiphe</i> .	
UNIT 5: Basidiomycotina	(5 lectures)
General characteristics and life cycle of <i>Puccinia</i> .	
UNIT 6: Deuteromycotina	(4 lectures)
General characteristics and life cycle of <i>Alternaria</i> .	
UNIT 7: Applied mycology	(3 lectures)
Application of fungi in fermentation (production of ethyl alcohol), antibiotics (production of penicillin) and food industry, IPM and Biopesticides.	
UNIT 8: Symbiotic associations	(4 lectures)
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 lectures)
UNIT 10: General symptoms; etiology and control of following diseases-	(7 lectures)
1. Citrus canker	
2. Red rot of sugarcane	
3. Early blight of potato	
4. White rust of crucifers	
5. Black rust of wheat	

Suggested readings

1. Introductory Mycology – C.J. Alexopoulos & C.W. Mims (Indian edition available), 4th Edition, 2007 (*latest, classic text*)
2. Textbook of Fungi – O.P. Sharma, 2nd Edition, 2021
3. Fungi and Allied Organisms – C.J. Alexopoulos (Indian Reprint), Latest Reprint, 2020
4. Plant Pathology – P.D. Sharma, 5th Edition, 2021, Rastogi Publications
5. Plant Pathology – R.S. Mehrotra & A. Aggarwal, 3rd Edition, 2017, Tata McGraw-Hill Education
6. Introductory Plant Pathology – N. G. Rangaswami & A. Mahadevan, Revised Edition, 2018, S. Chand & Company
7. Plant Pathology – George N. Agrios, 6th Edition, 2021, Academic Press
8. Fungal Biology – J.W. Deacon, 4th Edition, 2013, Wiley-Blackwell
9. Introduction to Fungi – John Webster & Roland Weber, 2nd Edition, 2007, Cambridge University Press

PRACTICAL

30 Hrs.

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 the syllabus)
2. Preparation of herbarium for the various diseases (included in the syllabus)
3. Study of all diseases through permanent slides
4. Temporary slides preparation of early blight of potato and white rust of crucifer.

Botanical Excursion

PRACTICAL EXAMINATION

Full Marks: 25

Pass Marks: 10

Time: 3 Hrs.

1. Prepare a temporary slide and comment on it with a well labelled diagram of any one of the fungi provided to you (as per the syllabus) (6)
2. Prepare a temporary slide of any one of fungal diseases mentioned in your syllabus (describe the pathogen and disease cycle) (6)
3. Spotting 2 X 2 = (4)
4. Record (5)
5. Viva-Voce (4)

Semester – III

MAJOR COURSE: MJ-03 BRYOPHYTA AND PTERIDOPHYTA (Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide students with a comprehensive understanding of the morphology, anatomy, and reproduction of Bryophytes and Pteridophytes.
- To introduce the diversity, classification, and evolutionary trends within Bryophytes and Pteridophytes.
- To develop an appreciation of the ecological roles and economic importance of lower land plants in maintaining ecosystem balance.
- To trace the evolutionary significance of bryophytes as the first land plants and pteridophytes as the first vascular plants.
- To impart knowledge about alternation of generations, heterospory, and the origin of the seed habit.
- To enhance practical skills in collection, preservation, identification, and microscopic study of representative members of Bryophyta and Pteridophyta.
- To encourage scientific thinking about plant diversity and its relevance to environmental sustainability and conservation.

Course Learning Outcomes:

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

1. Explain the distinguishing characters, morphology, anatomy, and life cycles of bryophytes.
2. Classify bryophytes up to the order level with examples.
3. Illustrate the modes of reproduction and alternation of generations in bryophytes.
4. Develop the ability to identify, collect, and prepare permanent slides/specimens of bryophytes.
5. Explain the general characteristics, structure, and life cycles of pteridophytes.
6. Classify pteridophytes into major groups.
7. Discuss gametophyte and sporophyte phases, heterospory, and seed habit evolution.
8. Analyze the role of pteridophytes as the first vascular land plants and their evolutionary link towards seed plants.
9. Gain experience in collection, preservation, and microscopic examination of pteridophyte specimens.

By the end, students will **understand the diversity, life cycles, ecology, and applied aspects** of both Bryophytes and Pteridophytes, linking their evolutionary significance in the plant kingdom.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

UNIT 1: Bryophytes

1. General characteristics, Classification, Morphology, Anatomy and Reproduction (developmental stage not included) **(5 lectures)**
2. Life cycle of:
 - i. *Marchantia* **(3 lectures)**
 - ii. *Anthoceros* **(3 lectures)**
 - iii. *Sphagnum* **(3 lectures)**
3. Evolution of Gametophyte and Sporophyte in Bryophytes, Sterilization of sporogenous tissue. **(4 lectures)**
4. Ecological and economic importance of bryophytes. **(3 lectures)**

UNIT 2: Pteridophyta

1. General views on Origin and evolution of pteridophytes, general characteristics of Pteridophytes. **(4 lectures)**
2. Classification, Morphology, Anatomy and Reproduction (developmental stages not included) of-
 - i. *Lycopodium*, **(3 lectures)**
 - ii. *Selaginella* **(3 lectures)**
 - iii. *Equisetum* **(3 lectures)**
3. Ecological and economic importance of pteridophytes. **(3 lectures)**
4. Apogamy and Apospory. **(2 lectures)**
5. Heterospory and Seed habit **(3 lectures)**
6. Stelar evolution. **(3 lectures)**

Botanical Excursion to Collect Plant Specimen for Laboratory Work

Suggested Reading

1. Vashishta, B.R., Sinha, A.K. & Kumar, Adarsh. Bryophyta. Revised Edition, 2016. S. Chand & Company.
2. O.P. Sharma. Bryophyta. 2nd Edition, 2021. McGraw-Hill Education.
3. Chopra, R.N. & Kumra, P.K. Biology of Bryophytes. 1st Edition, 1988. New Age International.
4. Watson, E.V. The Structure and Life of Bryophytes. 2nd Edition, 1964. Hutchinson University Library.
5. Richardson, D.H.S. The Biology of Mosses. 1981. Blackwell Scientific Publications.
6. Vashishta, B.R., Sinha, A.K. & Kumar, Adarsh. Pteridophyta. Revised Edition, 2016. S. Chand & Company.
7. O.P. Sharma. Pteridophyta. 2nd Edition, 2021. McGraw-Hill Education.
8. Sporne, K.R. The Morphology of Pteridophytes. Reprint Edition, 1991. Hutchinson University Library.
9. Bold, H.C., Alexopoulos, C.J. & Delevoryas, T. Morphology of Plants and Fungi. 5th Edition, 1987. Harper & Row.
10. Gifford, E.M. & Foster, A.S. Morphology and Evolution of Vascular Plants. 3rd Edition, 1989. W.H. Freeman & Company.

PRACTICALS

30 Hrs.

Archegoniate

1. Study of genus *Marchantia*, *Anthoceros* and *Sphagnum* by preparing temporary slides and also by permanent slides
2. Study of genus *Lycopodium*, *Selaginella* and *Equisetum* by preparing temporary slides and also by permanent slides.
3. Types of steles in pteridophytes

PRACTICAL EXAMINATION

Full Marks: 25

Pass Marks: 10

Time: 3 Hrs.

1. Prepare a temporary slide and comment on it with a well labelled diagram of any one of the following genera: *Marchantia/ Anthoceros/ Sphagnum* (6)
2. Prepare a temporary slide and comment on it with a well labelled diagram of any one of the following genera: *Lycopodium/ Selaginella/ Equisetum* (6)
3. Spotting 2 X 2 = (4)
4. Record (5)
5. Viva-Voce (4)

**MAJOR COURSE: MJ-04
GYMNOSPERMS AND PALAEOBOTANY
(Credit course: Theory- 03, Practical-01)**

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To introduce students to the morphology, anatomy, reproduction, and classification of gymnosperms.
- To provide knowledge of fossil plants and their role in understanding the evolution of the plant kingdom.
- To develop an understanding of geological time scales, fossilization processes, and types of plant fossils.
- To trace the evolutionary significance of gymnosperms in the transition from seedless vascular plants to angiosperms.
- To make students aware of the ecological and economic importance of gymnosperms.
- To impart practical skills in the study of fossil specimens, slides, and modern gymnosperm representatives.
- To highlight the contribution of palaeobotany in reconstructing Earth's vegetation history and climate change studies.
- To introduce students with general characters and life cycle of archegoniate and their usefulness to mankind.

Course Learning Outcomes:

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

1. Explain the distinguishing characters, morphology, anatomy, and life cycles of gymnosperms.
2. Classify gymnosperms into major groups.
3. Illustrate the reproductive structures, pollination, fertilization in gymnosperms.
4. Describe fossilization processes, types of plant fossils, and methods of fossil study.
5. Interpret the geological time scale and major plant fossil records.
6. Assess the evolutionary trends from early vascular plants to gymnosperms and the origin of angiosperms.

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 behaviour 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.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 3 Hrs.

UNIT 1: Gymnosperms

1. General characteristics and classification of gymnosperms **(02 lectures)**
2. Morphology, Anatomy and Reproduction (Developmental details not to be included) of:
 - i. *Cycas* **(04 lectures)**
 - ii. *Pinus* **(04 lectures)**
 - iii. *Gnetum* **(04 lectures)**
 - iv. *Ginkgo biloba* –as living fossil (only morphological characters) **(04 lectures)**
3. Ecological and economic importance of gymnosperms. **(03 lectures)**

UNIT 2: Paleobotany

1. Introduction, Definition and objectives of Palaeo-botanical studies **(05 lectures)**
2. Geological Time-Scale **(05 lectures)**
3. Nomenclature of Fossils **(04 lectures)**
4. Process and types of Fossilization **(05 lectures)**
5. General characteristics features of *Rhynia*, *Calamites*, *Cycadeoidea* **(05 lectures)**

Suggested Reading

1. Vashishta, B.R., Sinha, A.K. & Kumar, Adarsh. Gymnosperms. Revised Edition, 2016. S. Chand & Company.
2. Inderdeep Kaur & Prem Lal Uniyal, Textbook of Gymnosperms — 2023 edition, Astral (Daya Publishing House).
3. O.P. Sharma. Gymnosperms. 2nd Edition, 2021. McGraw-Hill Education.
4. Sporne, K.R. The Morphology of Gymnosperms. 1965. Hutchinson University Library.
5. Gifford, E.M. & Foster, A.S. Morphology and Evolution of Vascular Plants. 3rd Edition, 1989. W.H. Freeman & Company.
6. Stewart, W.N. & Rothwell, G.W. Paleobotany and the Evolution of Plants. 2nd Edition, 1993. Cambridge University Press.

PRACTICALS

30 Hrs.

Archegoniate

1. Study of genus *Cycas*, *Pinus* and *Gnetum* by preparing temporary slides and also by permanent slides.

Palaeobotany

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

Botanical Excursion to study Fossils and collection of Samples

PRACTICAL EXAMINATION

Full Marks: 25

Pass Marks: 10

Time: 3 Hrs.

1. Prepare a temporary slide and comment on any one gymnosperms provided to you. (6)
2. Identify the fossils by slides/ photographs/ rock specimens (6)
3. Spotting 2 X 2 = (4)
4. Record (5)
5. Viva-Voce (4)

Semester IV

MAJOR COURSE: MJ- 05 INDIAN KNOWLEDGE SYSTEM AND PHYTOMEDICINE (Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To introduce students to the traditional and modern aspects of medicinal plants and their uses in healthcare.
- To provide knowledge about important medicinally useful plants, their morphology, distribution, and active constituents.
- To understand the basic concepts of pharmacognosy and ethnobotany.
- To develop awareness about the role of plants in traditional medicine systems such as Ayurveda, Siddha, Unani and Nattuvaidyam.
- To highlight the economic and pharmaceutical importance of medicinal plants.
- To encourage conservation of medicinal plant resources and promote sustainable utilization.
- To gain overall knowledge and become familiar with topics introduced in medicinal botany under Indian knowledge system.

Course Learning Outcomes:

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

1. Explain the significance of medicinal plants in human health, culture, and economy.
2. Identify and describe major medicinally important plant species and their diagnostic features.
3. Recognize ethnobotanical practices and their role in traditional knowledge systems and primary healthcare.
4. Evaluate conservation needs and strategies for protecting endangered and overexploited medicinal plants.
5. To understand and connect up the basics of Indian traditional knowledge with modern perspective.
6. To gain access to ethnobotany and folk medicine, biodiversity conservation, phytochemistry and pharmacognosy of medicinal plants, nursery management, documentation and preservation of IKS.

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.

COURSE CONTENT

THEORY LECTURES - 45

Full marks: 75

Time: 03 Hrs.

UNIT 1: Introduction to Indian Knowledge System (10 lectures)

- Definition, Source and Importance of Indian Knowledge System.
- Contribution of Ancient Indian Scholars in Indian medicinal system: Charaka and Jeevaka.
- Introduction to Integrated Traditional Knowledge: Concept & definition, Nature, Scope and Importance of Traditional knowledge.

UNIT 2: Medicinal Botany (10 lectures)

- History, Scope and importance of medicinal plants; Indigenous medicinal science system - Ayurveda, Siddha, Unani and Nattuvaidyam.

UNIT 3: Conservation of endangered and endemic medicinal plants. (10 lectures)

- Definition:** Endemic and endangered medicinal plants, Red list criteria.
- In situ conservation:** Biosphere reserves, sacred groves, National Parks.
- Ex-situ conservation:** Botanic gardens, ethnomedicinal plants gardens, Propagation of Medicinal Plants in nurseries.
- Traditional Conservation strategies:** Traditional farming with indigenous pest and soil fertility management.

UNIT 4: Ethnobotany and Folk Medicines (10 lectures)

- Ethnobotany in India:** Definition, Methods to study and application of Ethnobotany
- Folk medicines of ethnic communities of India (with special emphasis on Jharkhand tribes).
- Tribal healing practices:** its type and application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases (with special emphasis on Jharkhand tribes)

UNIT 5: Documentation and preservation of IKS (5 lectures)

- Overview of Vedic Literature: Vriskshaayurveda and Charak Samhita
- Approaches and strategies for protection and conservation of IKS
- IKS in ancient and in modern India

Suggested Readings

- Mahadevan, B., Bhat, V.R. & Nagendra Pavana RN, (2022). Introduction to Indian Knowledge System: Concepts and Applications. PHI Learning
- Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Sanskrit Bharti (2006)
- History of science in India Vol-1, Part-I, II, Vol- III, by Sibaji raha et al.
- Trivedi P.C, Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
- Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd Edn., Agrobios, India.
- Sharma, P.D (2017): Ecology and Environment, 13th Edition, Rastogi Publications, Meerut
- Hosetti, B. B and Ramkrishna, S. (2016): Biodiversity- Concepts and Conservation, Aavishkar Publishers, Distributors, Jaipur
- Pimputkar, M. P., Chavan, N. S., Kumbhar, S. S., & Chaudhari, V. S. Indian Knowledge System — 1st Edition, 2024, Himalaya Publishing House.

9. Sarkar, B. (Ed.) The Basic Handbook of Indian Ethnobotany and Traditional Medicine, Volume 2 — Published 2023, International Academic Publishing House (IAPH).
10. Trivedi, P. C. Medicinal Plants: Traditional Knowledge — I.K. International Publishing House.
11. Kurup, P. N. V. A Handbook on Indian Medicinal Plants — by Central Council for Research in Ayurveda and Siddha.
12. Thapliyal, S., & Nautiyal, V. Practical Pharmacognosy and Phytomedicine — Edition 2021, P.K. Publishers & Distributors.

PRACTICALS

30 Hrs.

1. Botanical description (according to Bentham & Hooker system of classification) of plants mentioned in Vrksa-Ayurveda: Soma valli (*Sarcostemma acidum*), Asvattha (*Ficus religiosa*), Sami (*Prosopis cineraria*), Arka (*Calatropis procera*), etc
2. Identification of ethnobotanical important plants of your locality.
3. e-Herbarium preparation.
4. Nursery techniques: cuttings, layering, grafting and budding.
5. Field visit to herbal gardens, scared groves of tribal communities.

PRACTICALS EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Identification of local medicinal plants (6)
2. Botanical description of plants mentioned in Vrksa-ayurveda
or submission of e-herbarium or
Preparation of panchgavya and jeevamurti (only description) (6)
3. Spotting 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)

MAJOR COURSE: MJ- 06
SYSTEMATICS AND TAXONOMY
(Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide a comprehensive understanding of the principles, history, and importance of plant systematics and taxonomy.
- To introduce concepts of classification, nomenclature, and identification of plants.
- To familiarize students with different systems of classification – artificial, natural, and phylogenetic.
- To develop an understanding of modern approaches in taxonomy, including numerical taxonomy, cytotaxonomy, chemotaxonomy, and molecular taxonomy.
- To impart skills in preparation and use of keys, floras, herbarium techniques, and field identification.
- To promote awareness about the role of taxonomy in biodiversity studies, conservation, and sustainable utilization of plant resources.

Course Learning Outcomes:

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

1. Explain basic principles of systematics and taxonomy, and the importance of classification in understanding plant diversity.
2. Compare and contrast major historical and modern systems of classification (Bentham & Hooker, Engler and Prantl & Hutchinson)
3. Apply rules of nomenclature as per the International Code of Nomenclature (ICN).
4. Use taxonomic tools such as keys, floras, monographs, and herbarium specimens for plant identification.
5. Describe and interpret morphological features of representative families of angiosperms for identification and classification.
6. Demonstrate practical skills in field collection, herbarium preparation, and identification of unknown plant specimens.
7. Integrate modern approaches (cytotaxonomy, chemotaxonomy, molecular taxonomy) with traditional taxonomy for resolving taxonomic ambiguities.
8. Recognize the role of taxonomy in biodiversity conservation, ecosystem management, and bioprospecting.

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.

COURSE CONTENT

THEORY LECTURES - 45

Full marks: 75

Time: 03 Hrs.

UNIT 1: Taxonomic Aids

(5 lectures)

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

UNIT 2: Taxonomic Hierarchy

(5 lectures)

Concept of taxa (species, genus and family).

UNIT 3: Botanical nomenclature

(5 lectures)

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

UNIT 4: System of classification

(10 lectures)

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

B. Bentham and Hooker' system of classification (upto series), Engler and Prantl's, Hutchinson's system of classification (upto series).

UNIT 5: Plant taxonomy:

(20 lectures)

A. How to describe a flowering plant.

B. Study of the following families:

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

Suggested Readings

1. O.P. Sharma – Plant Taxonomy – 2nd Edition, 2021. McGraw-Hill Education.
2. B.K. Verma – Taxonomy of Angiosperms – Revised Edition, 2018. S. Chand & Company.
3. V. Singh – Plant Systematics: Theory and Practice – 3rd Edition, 2010 (Reprint 2022). Oxford & IBH Publishing.
4. N.S. Subrahmanyam – Modern Plant Taxonomy – 2nd Edition, 2016. New Age International Publishers.
5. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F., Donoghue, M.J. – Plant Systematics: A Phylogenetic Approach – 4th Edition, 2016. Sinauer Associates.
6. Gurcharan Singh – Plant Systematics: An Integrated Approach – 4th Edition, 2023. CRC Press (Indian author, international edition).
7. David J. Mabberley – Mabberley's Plant-book: A Portable Dictionary of Plants – 4th Edition, 2017. Cambridge University Press.

8. Peter H. Raven, Ray F. Evert, Susan E. Eichhorn – Biology of Plants – 9th Edition, 2022. W.H. Freeman & Company

PRACTICALS

30 Hrs.

Systematics and Taxonomy

1. Study the position, number and arrangement of floral whorls in flowers of dicot and monocot plants
2. Systematic study of locally available plants belonging to families included in the syllabus.
3. Preparation of herbarium.

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Description and identification of the given floral specimen (6)
2. Identification of the Floral character, Floral Formula, Floral Diagram and Systematic position of floral specimen (6)
3. Spotting (two) $2 \times 2 = (4)$
4. Records/ Herbarium/Chart (5)
5. Viva-Voce (4)



MAJOR COURSE: MJ- 07
PLANT ANATOMY
(Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide knowledge of the internal structure and organization of plant cells, tissues, and organs.
- To introduce students to the development, differentiation, and functions of various tissues and tissue systems.
- To understand the anatomical basis of physiological processes and adaptations in plants.
- To study primary and secondary growth in roots, stems, and leaves of different plant groups.
- To highlight anatomical specializations in relation to ecology (xerophytes, hydrophytes, epiphytes).
- To develop practical skills in microscopic techniques, preparation of slides, and interpretation of anatomical structures.

Course Learning Outcomes:

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

1. Explain the structure and function of plant tissues (meristematic and permanent).
2. Describe the organization of root, stem, and leaf in monocots and dicots.
3. Understand primary and secondary growth and the role of cambium in thickening.
4. Identify anatomical adaptations in plants growing under different ecological conditions (xerophytes, hydrophytes, epiphytes).
5. Demonstrate practical skills in preparation of temporary and permanent slides, use of microscopes, and observation of tissues/organs.
6. Apply anatomical knowledge to interpret plant adaptations, systematic relationships, and economic uses.
7. Integrate plant anatomy with physiology and ecology, appreciating its importance in understanding plant function and survival.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

UNIT 1: Introduction and scope of Plant anatomy (4 lectures)

UNIT 2: Tissues (5 lectures)

Classification of tissues: Meristematic tissue, permanent tissue and secretory tissue, Theories of shoot apex and root apex organization, Epidermal tissue system, cuticle, stomata, trichomes.

UNIT 3: Stem (5 lectures)

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

UNIT 4: Leaf (4 lectures)

Structure of dicot and monocot leaf.

UNIT 5: Root (4 lectures)

Structure of dicot and monocot root.

UNIT 6: Vascular cambium (10 lectures)

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

UNIT 7: Periderm (5 lectures)

Development and composition of periderm, Sapwood, Heartwood.

UNIT 8: Anatomical Adaptations (8 lectures)

Anatomical adaptation of xerophytes & hydrophytes.

Suggested Readings

1. B.P. Pandey – Plant Anatomy – Revised Edition, 2020. S. Chand & Company.
2. A.K. Jain & P.C. Sharma – Plant Anatomy – Revised Edition, 2017. Rastogi Publications.
3. N. S. Subrahmanyam & A.V.S.S. Sambamurty – Plant Anatomy and Embryology – 3rd Edition, 2019. I.K. International Publishing House.
4. Esau, K. – Plant Anatomy – Reprint Edition, 2015 (original classic 3rd Ed. 1977). Wiley-Blackwell.
5. Evert, Ray F. – Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body – 3rd Edition, 2006 (reprinted 2021). Wiley.
6. Mauseth, James D. – Botany: An Introduction to Plant Biology – 6th Edition, 2020. Jones & Bartlett Learning.

PRACTICALS

30 Hrs.

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.

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Preparation and description of temporary slides of given specimen (monocot and dicot root, stem and leaf) (6)
1. Preparation of temporary slides to show anomalous structure of *given specimen* (6)
2. Spotting (two) (Hydrophyte/Xerophytes) 2 x 2 = (4)
3. Records (5)
4. Viva-Voce (4)



Semester V

MAJOR COURSE: MJ-08 CELL BIOLOGY (Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide a foundational understanding of the structure and functions of prokaryotic and eukaryotic cells.
- To study the organization and role of cell organelles in maintaining cellular activities.
- To understand the molecular basis of cellular processes such as transport, signaling, division, and communication.
- To highlight the role of the cytoskeleton, extracellular matrix, and cell junctions in cell structure and function.
- To provide insights into the cell cycle and apoptosis.

Course Learning Outcomes:

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

1. Explain the structure and functions of prokaryotic and eukaryotic cells, and compare their organization.
2. Describe cell membranes and models of membrane structure, transport mechanisms, and membrane specialization.
3. Identify and explain the roles of cell organelles such as nucleus, mitochondria, chloroplasts, ER, lysosomes, ribosomes, and peroxisomes.
4. Explain the cell cycle and its regulation, including mitosis, meiosis, and programmed cell death (apoptosis).
5. Demonstrate laboratory skills in cell preparation, staining, microscopy, and identification of cell structures.

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.

COURSE CONTENT
THEORY
LECTURES - 45

UNIT 1: Microscopy (8 lectures)
General features of light microscope and its type- (simple, compound); dissecting microscope, electron microscope.

UNIT 2: The Cell (05 lectures)
Ultrastructure of prokaryotic and eukaryotic cell and their differences.

UNIT 3: Cell wall and plasma membrane (10 lectures)
Structure and function of plant cell wall, Plasma Membrane, Chemical composition of membranes.

UNIT 4: Cell organelles (10 lectures)
Nucleus, Chloroplast, Mitochondria, Endoplasmic reticulum, Peroxisomes and Ribosomes: Structure & Functions.

UNIT 5: Cell division (12 lectures)
Mitosis and Meiosis, Cell Cycle Control (Check-points).

Suggested Readings

1. P.K. Gupta – Cell and Molecular Biology – Revised Edition, 2021. Rastogi Publications.
2. Veer Bala Rastogi – Cell Biology – Revised Edition, 2020. Rastogi Publications.
3. A.K. Sharma – Cell Biology – 2nd Edition, 2019. Books and Allied Pvt. Ltd.
4. Bruce Alberts et al. – Molecular Biology of the Cell – 7th Edition, 2022. W.W. Norton & Company.
5. Gerald Karp – Cell and Molecular Biology: Concepts and Experiments – 9th Edition, 2021. Wiley.
6. Lodish, Berk et al. – Molecular Cell Biology – 9th Edition, 2021. W.H. Freeman.

PRACTICALS 30 Hrs.

1. Study of generalized plant cell of *Hydrilla*
2. Study the microphotograph of nucleus, chloroplast, mitochondria and endoplasmic reticulum
3. Study of different stages of mitosis and meiosis by preparing temporary slides and also by permanent slides.

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Identification of different stages of mitosis or meiosis by preparing temporary slides (showing at least two stages in mount) (6)
2. Characterization of nucleus/ chloroplast/ mitochondria/ endoplasmic reticulum. (6)
3. Spotting (two) 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)

MAJOR COURSE: MJ-09
BIOCHEMISTRY
(Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To introduce the chemical composition of living systems and the structural organization of biomolecules.
- To provide knowledge about the structure, properties, and functions of carbohydrates, lipids, proteins, nucleic acids, and enzymes.
- To study metabolic pathways of biomolecules and their regulation.
- To explore enzyme kinetics, mechanisms, and factors affecting enzyme activity.
- To highlight the significance of vitamins in biochemical processes.

Course Learning Outcomes:

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

1. Explain the basic principles of biochemistry and its relevance to life processes.
2. Describe the structure and functions of biomolecules – carbohydrates, lipids, proteins, and nucleic acids.
3. Understand enzyme structure, function, and kinetics, and apply concepts of enzyme regulation in metabolism.
4. Analyze the role of vitamins in biochemical regulation and health.
5. Demonstrate laboratory skills in the detection, estimation, and separation of biomolecules, and in studying enzyme activity.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

UNIT 1: Carbohydrates:

Definition, nomenclature, classification, structure and role of carbohydrates, Role of monosaccharides, disaccharides, oligosaccharides and polysaccharides. **(10 lectures)**

UNIT 2: Proteins:

Structures of amino acids; Protein structure—primary, secondary, tertiary and quaternary; biological roles of proteins. **(8 lectures)**

UNIT 3: Lipids:

Structure and its biological significance; Fatty acids- Types, nomenclature and its function. **(06 lectures)**

UNIT 4: 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. **(12 lectures)**

UNIT 5: Enzymes:

Definition, History of its discovery, structure of enzyme: holoenzyme, apoenzyme; prosthetic group, cofactor, lock and key mechanism of enzyme action, factors affecting enzyme activity. **(5 lectures)**

UNIT 6: Vitamins:

General characteristics, classification and roles of vitamin in human health. **(04 lectures)**

Suggested Readings

1. Satyanarayana, U., & Chakrapani, U. Biochemistry – 6th Edition, 2022. Elsevier India.
2. Deb, A.C. Fundamentals of Biochemistry – 9th Edition, 2021. New Central Book Agency.
3. Jain, J.L., Jain, S., & Jain, N. Fundamentals of Biochemistry – 7th Edition, 2020. S. Chand & Company.
4. Lehninger, Nelson, & Cox, Lehninger Principles of Biochemistry – 8th Edition, 2021. W.H. Freeman & Company.
5. Jeremy M. Berg, John L. Tymoczko & Lubert Stryer, Biochemistry – 9th Edition, 2019. W.H. Freeman & Company.

PRACTICALS

30 Hrs.

1. Biochemical tests for carbohydrates, proteins and lipids.
2. Preparation of ball and stick model for B- DNA molecule (A=T and G=C base pairs).
3. Study of structure of DNA, RNAs through photographs.
4. Operation and working principles of pH meter and Centrifuge.

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Perform Qualitative tests for identification of carbohydrates/ proteins/ lipids. (6)
2. Identification of structure of DNA and/or RNAs through Photographs. (6)
3. Spotting 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)



MAJOR COURSE: MJ-10
CYTOGENETICS
(Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide knowledge of the structure, organization, and function of chromosomes and genes.
- To understand the principles of inheritance as laid down by Mendel and extended through modern genetics.
- To introduce concepts of linkage, crossing over, recombination, and chromosome mapping.
- To study structural and numerical chromosomal variations and their evolutionary and applied significance.
- To develop knowledge of extra-nuclear inheritance, and cytoplasmic factors.
- To impart laboratory skills in cytological preparations, karyotyping, and analysis of meiotic and mitotic stages.

Course Learning Outcomes:

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

1. Explain chromosome structure, organization, and behavior during cell division.
2. Understand Mendelian principles of inheritance and their modifications (incomplete dominance, codominance, epistasis, polygenic inheritance).
3. Describe linkage and crossing over, linkage maps, and analyze recombination frequency.
4. Interpret structural and numerical variations of chromosomes (deletions, duplications, inversions, translocations, aneuploidy, polyploidy) and their significance.
5. Discuss mechanisms of sex-linked inheritance.
6. Recognize extranuclear inheritance (plastid and mitochondrial DNA, maternal inheritance).
7. Demonstrate practical skills in preparing chromosome slides, identifying stages of mitosis and meiosis, and analyzing chromosomal aberrations.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 03 Hrs.

UNIT 1: Mendelian genetics & its extension (12 lectures)

Basic concepts of genetics; Mendel's laws of inheritance, Back cross & Test Cross, Incomplete dominance and co-dominance, Epistasis, Complementary Duplicate genes, Atavism, lethal genes.

UNIT 2: Cytoplasmic or Extra chromosomal inheritance (10 lectures)

-Characteristics, types, modes, significance and challenges,
-Difference between extrachromosomal and chromosomal inheritance,
-Chloroplast inheritance in four O' clock plant,
-maternal inheritance by iojap gene of corn.

UNIT 3: Linkage and crossing over (10 lectures)

Chromosome theory of inheritance, independent assortment versus linkage, Mechanism and significance of Linkage and crossing over (genetic recombination).

UNIT 4: Linkage map- definition, linkage maps of maize chromosomes. (5 lectures)

UNIT 5: Variation in chromosome number & structure (8 lectures)

Deletion, Duplication, Inversion, Translocation, Euploidy, Aneuploidy, Origin of *Raphnobrassica* & *Triticale*

Suggested Readings

1. P.K. Gupta – Cytogenetics – Revised Edition, 2021. Rastogi Publications.
2. V.B. Rastogi – Fundamentals of Cytogenetics – 2020. Rastogi Publications.
3. A.K. Sharma & A. Sharma – Chromosome Techniques: Theory and Practice – Reprint 2019. Butterworth-Heinemann India.
4. Gardner, Simmons & Snustad – Principles of Genetics – 9th Edition, 2021. Wiley.
5. Klug, Cummings, Spencer & Palladino – Concepts of Genetics – 12th Edition, 2020. Pearson.
6. Hartl & Jones – Genetics: Analysis of Genes and Genomes – 9th Edition, 2021. Jones & Bartlett Learning.

PRACTICALS

30 Hrs.

1. Mendel's laws through seed ratios: Law of segregation and independent assortment.
2. Testing goodness of fit by chi-square method (problems based on Mendelian ratios).
3. Two point and Three-point cross gene mapping (numerical based) or by photographs
4. Structure of various types of chromosomes
5. Diagrammatic Study of representation of chromosomal aberrations, *Raphnobrassica*, *Triticale*

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Testing of goodness of fit by chi-square method
or Numerical based on two point and three-point cross (6)
2. Identification of two point and three-point cross through photographs (6)
3. Spotting (two) 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)



MAJOR COURSE: MJ-11
PLANT BREEDING
(Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To introduce students to the principles, history, and significance of plant breeding in crop improvement.
- To provide knowledge about different breeding methods for self-pollinated, cross-pollinated, and vegetatively propagated crops.
- To explain the role of genetics, cytogenetics, and biotechnology in plant breeding.
- To develop understanding of hybridization techniques, selection methods, and heterosis.
- To highlight the importance of molecular markers, tissue culture, and genetic engineering in modern plant breeding.
- To develop practical skills in emasculation, controlled pollination, pedigree selection, and field evaluation of breeding material.
- To know about Institute of Plant Breeding and famous Plant Breeders

Course Learning Outcomes:

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

1. Explain the objectives and significance of plant breeding in agriculture and food security.
2. Describe breeding methods for self-pollinated (pure line, mass selection, pedigree), cross-pollinated (recurrent selection, synthetic and composite varieties), and clonally propagated crops.
3. Understand hybridization techniques, emasculation methods, and artificial pollination strategies.
4. Analyze the role of heterosis and inbreeding depression in crop improvement.
5. Understand mutation breeding, polyploidy breeding, and distant hybridization and their applications.
6. Evaluate modern breeding approaches including marker-assisted selection, tissue culture, and transgenic breeding.
7. Demonstrate practical skills in field techniques: crossing, tagging, progeny testing, and selection.
8. Assess the contribution of plant breeding to sustainability, biodiversity, and global food production.

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.

COURSE CONTENT
THEORY
LECTURES - 45

- UNIT 1:** Introduction to Classical and Conventional Plant Breeding and Objectives. (5 lectures)
- UNIT2:** Methods of Crop Improvement, Introduction, Selection and Hybridization, Polyploid breeding. (7 lectures)
- UNIT 3:** Inbreeding, Inbreeding depression and Heterosis. (4 lectures)
- UNIT 4:** Gene Mutation: Types of mutations, Molecular basis of mutations, Mutagens–Physical and chemical, Role of mutation in crop improvement. (10 lectures)
- UNIT 5:** Institute and famous Scientist: NBPGR, ICRISAT; Norman E. Borlaug, M.S. Swaminathan, Dilbagh Singh Athwal. (5 lectures)
- UNIT 6:** Green Revolution: Development of semi dwarf rice and wheat varieties; hybrid millets. (5 lectures)
- UNIT 7:** Role of Biotechnology in crop improvement for disease and pest resistance, biofortification (SCP). (5 lectures)
- UNIT 8:** Intellectual Property Rights for Plant Breeders. (4 lectures)

Suggested Readings:

1. Satya, P. – Plant Breeding (Genetic Principles and Methodologies) – 2nd Edition, 2024. Books & Allied Pvt. Ltd., Kolkata.
2. Yadava, D. K., Dikshit, H. K., Mishra, G. P., & Tripathi, S. – Fundamentals of Field Crop Breeding – 1st Edition, 2022. Springer Nature Singapore Pte Ltd.
3. Dhulgande, G. S. & Dhale, D. A. – Basics of Plant Breeding and Seed Technology – 1st Edition, 2023. Book Saga Publications, Maharashtra.
4. Singh, B. D. – Plant Breeding: Principles and Methods – 12th Edition, 2022. Medtech / Kalyani Publishers, New Delhi.
5. Chopra, V. L. – Plant Breeding: Theory and Practice – 3rd Edition, 2020. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Priyadarshan, P. M. – Plant Breeding: Classical to Modern – 1st Edition, 2019. Springer Nature Singapore Pte Ltd.
7. Acquaah, G. – Principles of Plant Genetics and Breeding – 3rd Edition, 2021. Wiley-Blackwell, USA.
8. Fehr, W. R. – Principles of Cultivar Development: Theory and Technique – 1st Edition, 2020 (Reprint). Macmillan Publishing, USA.

PRACTICALS

30 Hrs.

1. Field visit and report making for the Hybridization techniques-emasculatation
2. Field visit and report making of back cross and test cross method of plant breeding.
3. Calculation based on Back Cross and Test Cross, Heterosis
4. Microbial species as resource for SCP- Algae, Bacteria, Fungi and Yeast.
5. Diagrammatic Representation of Development of semi dwarf rice and wheat varieties, hybrid millets

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. To perform artificial hybridization in bisexual flowers **or** Calculation based on back cross/ test cross and heterosis. (6)
2. Identification of the photographs of Microbial species/ Plant Breeders/ Semi Dwarf rice, wheat varieties, hybrid millets. (6)
3. Spotting (two) 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)



Semester VI

MAJOR COURSE: MJ-12 ECOLOGY AND ENVIRONMENTAL SCIENCE (Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide a basic understanding of ecological principles and the interrelationships among organisms and their environment.
- To study the structure and functioning of ecosystems, energy flow, and nutrient cycling.
- To introduce concepts of population, community ecology, and ecological succession.
- To develop awareness of biodiversity, conservation strategies, and sustainable management of natural resources.
- To impart knowledge about environmental issues such as climate change, pollution, deforestation, and waste management.
- To understand environmental policies, laws, and global initiatives for environmental protection.
- To cultivate practical skills in ecological fieldwork, environmental monitoring, and data analysis.

Course Learning Outcomes:

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

1. Explain fundamental ecological concepts and the interdependence between organisms and their environment.
2. Describe ecosystem structure and function, including food chains, food webs, productivity, and nutrient cycling.
3. Analyze population and community dynamics, including growth patterns, interactions, and succession.
4. Understand the importance of biodiversity, threats to biodiversity, and strategies for conservation (in-situ and ex-situ).
5. Evaluate environmental issues such as air, water and noise pollution, and propose mitigation measures.
6. Discuss climate change, global warming, and their implications on ecosystems and human society.
7. Interpret environmental policies, acts, and conventions related to conservation and sustainable development.
8. Demonstrate field and laboratory skills in ecological sampling, biodiversity assessment, and environmental monitoring.
9. Apply ecological knowledge to solve real-world environmental problems and promote sustainable lifestyles.

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.

COURSE CONTENT THEORY LECTURES - 45

Full marks: 75

Time: 03 Hrs.

UNIT 1: Introduction, Objectives of Ecology and Environmental Science, Levels of organization, Atmosphere, Hydrosphere and Lithosphere. **(8 lectures)**

UNIT 2: Plant Communities **(6 lectures)**
Analytic and synthetic characters, Mechanism of succession–Hydrosere & Xerosere, Concept of Climax.

UNIT 3: Ecosystem **(10 lectures)**
Basic concept, Structural and functional components of ecosystem, types of ecosystem, Grassland and Pond ecosystem, Food web and Food chain, Ecological pyramids.

Unit 4: Alteration of Ecosystem: **(5 lectures)**
Alteration of Ecosystem due to changing pattern of land use, Migration, Transportation, Urbanization, Industrialization and Environmental Impact Assessment.

UNIT 5: Phytogeography **(4 lectures)**
Phytogeographical regions of India; Local Vegetation and Endemism; Basic concept of Biodiversity and hotspots.

UNIT 6: Environmental issues **(12 lectures)**
A. Air pollution, Water pollution, noise pollution–Cause, effect & control, greenhouse effect and consequences of climate change.
B. International and National laws for environmental protection, Role of NGT, Environmental summits– Kyoto protocol, Montreal protocol, Earth summit, Ramsar convention.

Suggested Readings

1. Vir Singh – Textbook of Environment and Ecology – 1st Edition, 2024. Springer Nature Singapore Pte Ltd.
2. Deeksha Dave, S. S. Katewa, Chandana Mohanty & Sarbari Acharya – Textbook of Environmental Studies – 3rd Edition, 2024. Cengage India.
3. Erach Bharucha – Textbook of Environmental Studies for Undergraduate Courses – 4th Edition, 2025. Universities Press.
4. Namita Joshi & P. C. Joshi – A Textbook of Ecology and Environment – 1st Edition, 2023. Himalaya Publishing House.

5. M. C. Dash – Fundamentals of Ecology – 2nd Revised Edition, 2001 (and later reprints). Tata-McGraw Hill, New Delhi.
6. Michael Begon, Colin R. Townsend & John L. Harper – Ecology: From Individuals to Ecosystems – 4th Edition, 2006. Blackwell Publishing (Wiley-Blackwell).
7. Sharma, P.D - Ecology and Environment, 13th Edition, 2017, Rastogi Publications, Meerut
8. Verma, P.S. and Agarwal, V.K., (2000): Environmental Biology: Principles of Ecology, S. Chand Limited
9. Bhatia, A.L., (2010): Textbook of Environmental Biology, I.K International Publishing House Pvt. Ltd.

PRACTICALS

30 Hrs.

1. Study of microbial flora of water samples.
2. Study of Plant Community/Vegetation of College Campus by Quadrata 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.

PRACTICALS EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

- | | |
|--|-------------|
| 1. Analysis of Plant Community/ Vegetation of College Campus by Quadrata method and measurement of frequency and density | (6) |
| 2. Identification of microbial flora of water samples | (6) |
| 3. Spotting (two) | 2 x 2 = (4) |
| 4. Record | (5) |
| 5. Viva-Voce | (4) |

MAJOR COURSE: MJ-13
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS
(Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide knowledge about the structure and development of male and female gametophytes in angiosperms.
- To understand pollination mechanisms, fertilization, and post-fertilization changes.
- To study the formation, types, and development of embryos, endosperm, and seed.
- To introduce the role of apomixis, polyembryony, and their applications in plant breeding.
- To impart knowledge of experimental embryology and its relevance in crop improvement and biotechnology.
- To develop skills in microscopic preparation, observation, and identification of reproductive structures in plants.

Course Learning Outcomes:

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

1. Describe the structure and development of anther, pollen grains, ovule, and embryo sac.
2. Explain pollination types and mechanisms, fertilization, and double fertilization in angiosperms.
3. Understand post-fertilization changes leading to embryo, endosperm, seed, and fruit development.
4. Differentiate types of embryos and endosperm and their significance in seed biology.
5. Explain apomixis and polyembryony and their applications in horticulture and crop breeding.
6. Demonstrate practical skills in preparing slides, observing gametophytes, pollen viability, and seed development stages.
7. Relate embryological studies to applied fields such as taxonomy, plant breeding, seed technology, and biotechnology.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 03 Hrs.

UNIT 1: Anther

(6 lectures)

Anther wall: structure and function, microsporogenesis.

UNIT 2: Ovule

(11 lectures)

Structure and Types of ovule, Megasporogenesis, Male and Female gametophyte- (monosporic, bisporic and tetrasporic)

UNIT 3: Pollination and fertilization

(12 lectures)

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

UNIT 4: Endosperm

(4 lectures)

Types, development, structure and functions of endosperm.

UNIT 5: Embryo

(4 lectures)

Development of dicot embryo and monocot embryo.

UNIT 6: Seed

(4 lectures)

Structure, importance and dispersal mechanisms

UNIT 7: Polyembryony & Apomixis

(4 lectures)

Introduction, classification, causes & application.

Suggested Readings

1. Mangla, Y.; Khanduri, P.; Gupta, C. K. – Reproductive Biology of Angiosperms: Concepts and Laboratory Methods – 1st Edition, 2023. Cambridge University Press.
2. Rashid, A. – Reproductive Biology of Angiosperms – 1st Edition, 2022. TechSar Pvt. Ltd.
3. Pandey, A. K. – Reproductive Biology of Angiosperms – 1st Edition, 2023. CRC Press.
4. Saxena, P. – Reproductive Biology of Angiosperms – 1st Edition, 2019. Wisdom Press.
5. Johri, B. M., Ambegaokar, K. B. & Srivastava, P. S. – Comparative Embryology of Angiosperms – 1st Edition, 1992. Springer-Verlag Berlin Heidelberg.
6. Johri, B. M. (Ed.) – Embryology of Angiosperms – 1st Edition, 1984 (reprint 2011). Springer Berlin, Heidelberg.
7. Bhojwani, S. S., Dantu, P. K. & Bhatnagar, S. P. – The Embryology of Angiosperms – 7th Edition, 2025. Vikas Publishing (Vikas Publishing House).
8. Bhojwani, S. S., Dantu, P. K. & Bhatnagar, S. P. – The Embryology of Angiosperms – earlier edition, 2014. Vikas Publishing.
9. Maheshwari, P. – An Introduction to the Embryology of Angiosperms – 1st Edition, 1950. McGraw-Hill.

PRACTICALS

30 Hrs.

1. Study the structure and prepare temporary slides of anther (pollen grains) of five 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.

PRACTICALS EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Prepare temporary slides of anther of two common flowering plants **or** Demonstrate the germination of pollen grains in the provided plant material. (6)
2. Identify the structure of embryo sac/ anatropous ovule through temporary slides/ photographs (6)
3. Spotting (two) $2 \times 2 = (4)$
4. Record (5)
5. Viva-Voce (4)



MAJOR COURSE: MJ-14
ECONOMIC BOTANY
(Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide knowledge of plants and plant products of economic importance in human life.
- To understand the role of plants in food, fodder, fiber, fuel, timber, medicine, and industry.
- To study the origin, distribution, cultivation, and uses of major crop plants.
- To appreciate the contribution of plants to agriculture, economy, and traditional knowledge.
- To promote awareness of sustainable utilization and conservation of economically important plants.
- To develop skills in identification and documentation of important economic plant species.

Course Learning Outcomes:

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

1. Explain the significance of plants in food security, health, industry, and economy.
2. Identify and discuss important food crops (cereals, pulses, oilseeds, fruits, vegetables, spices) with their uses and nutritional importance.
3. Understand plants used in fibers, timber, gums, resins, dyes, beverages, and medicines.
4. Recognize the industrial importance of plants in paper, rubber, sugar, oil, and pharmaceutical industries.
5. Relate traditional knowledge and ethnobotany to the use of plants in tribal and rural societies.
6. Demonstrate practical skills in identifying economic plants, plant parts used, and preparation of herbarium/economic charts.
7. Evaluate the need for sustainable utilization and conservation of plant genetic resources.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 03 Hrs.

UNIT 1 Introduction to Economic Botany	(4 lectures)
Morphology, Botanical name, Family, part used & uses of followings:	
UNIT 2: Cereals-Wheat and Rice (its cultivation also)	(4 lectures)
UNIT 3: Millets and Pulses- Finger Millet and Gram	(2 lectures)
UNIT 4: Oil yielding plants-Mustard and Sunflower	(2 lectures)
UNIT 5: Fibre yielding plant- Cotton and Jute	(2 lectures)
UNIT 6: Beverages-Tea and Coffee	(4 lectures)
UNIT 7: Timber yielding plants- Shisham, Sal	(2 lectures)
UNIT 8: Fruit yielding plants- Mango, Guava, Apple	(4 lectures)
UNIT 9: Vegetables-Potato, Cabbage, Bitter Gourd	(4 lectures)
UNIT 10: Essential oils- Lemongrass oil, Rose oil, Champaca oil	(5 lectures)
UNIT 11: Medicinal plants- Neem, Arjun, Vasaka, Amaltas, Bada gokru and Sahjan	(8 lectures)
UNIT 12: Rubber and Gum Yielding Plants – Rubber tree, <i>Acacia</i>	(2 lectures)
UNIT 13: Fumigators and Masticators – Betel and Tobacco	(2 lectures)

Suggested Readings

1. Kochhar, S. L. – Economic Botany in the Tropics – 4th Edition, 2020. Macmillan Publishers India.
2. Pandey, B. P. – Economic Botany – 4th Revised Edition, 2018. S. Chand Publishing, New Delhi.
3. Jain, S. K. & Rao, R. R. – A Handbook of Field and Herbarium Methods (includes Economic Botany Applications) – 1st Edition, 2017. Today & Tomorrow's Printers & Publishers.
4. Sharma, O. P. – Textbook of Economic Botany – 1st Edition, 2015. McGraw Hill Education India.
5. Vashishta, P. C., Sinha, A. K. & Kumar, A. – Botany for Degree Students: Economic Botany – Revised Edition, 2021. S. Chand Publishing.
6. Simpson, B. B. & Ogorzaly, M. C. – Economic Botany: Plants in Our World – 4th Edition, 2019. McGraw-Hill Education.

PRACTICALS

30 Hrs.

Economic Botany

1. Field visit and preparation of herbarium of economically important plants included in the syllabus
2. Description of economically valuable plants of your locality (as per syllabus)

PRACTICALS EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Identification of any four specimen of economic importance from syllabus. (6)
2. To study the morphological characteristics of economic valuable plants included in the syllabus (any two) (6)
3. Spotting (two) 2 x 2 = (4)
4. Practical Record (5)
5. Viva-Voce (4)

MAJOR COURSE: MJ- 15
MOLECULAR BIOLOGY
(Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide a detailed understanding of the molecular basis of genetic material (DNA & RNA).
- To study the mechanisms of DNA replication, repair, recombination, transcription, and translation.
- To introduce the regulation of gene expression in prokaryotes.
- To understand the role of regulatory RNAs and operons.
- To explore molecular tools and techniques used in genetic engineering and biotechnology.
- To relate molecular biology concepts with human health, agriculture, and industry.

Course Learning Outcomes:

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

1. Explain the structure and properties of nucleic acids and their role as genetic material.
2. Describe DNA replication (enzymes, mechanism, fidelity, and repair systems).
3. Understand mechanisms of recombination (homologous, site-specific, transposition).
4. Explain transcription and post-transcriptional modifications in prokaryotes.
5. Describe translation, genetic code, and regulation of protein synthesis.
6. Analyze regulation of gene expression through operons and transcription factors.
7. Demonstrate practical skills in basic molecular techniques and interpretation of experimental results.

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 sub division in the question of Group B.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 03 Hrs.

UNIT 1: Nucleic Acids (6 lectures)

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

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

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

UNIT 3: Replication of DNA (5 lectures)

Mechanism of DNA replication, Enzymes involved in DNA replication

UNIT 4: Central Dogma and Genetic Code (4 lectures)

General account of Central dogma and Genetic code.

UNIT 5: Mechanism of Transcription (6 lectures)

Transcription in prokaryotes

UNIT 6: Translation (6 lectures)

Process of translation in Prokaryotes.

UNIT 7: Regulation of Gene expression (8 lectures)

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

Suggested Readings

1. Gupta, P. K. – A Textbook of Molecular Biology – 5th Edition, 2021. Rastogi Publications, Meerut.
2. Malacinski, G. M. & Freifelder, D. (Adapted by P. S. Verma) – Essentials of Molecular Biology – 4th Edition (Indian Adaptation), 2020. Jones & Bartlett Learning / Ane Books India.
3. Satyanarayana, U. & Chakrapani, U. – Molecular Biology – 1st Edition, 2019. Elsevier India.
4. Rastogi, S. C. – Molecular Biology – 3rd Edition, 2017. New Age International Publishers, New Delhi.
5. Lodish, H., Berk, A., Kaiser, C., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. & Martin, K. – Molecular Cell Biology – 9th Edition, 2021. W.H. Freeman & Company.
6. Weaver, R. F. – Molecular Biology – 6th Edition, 2018. McGraw-Hill Education.
7. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M. & Losick, R. – Molecular Biology of the Gene – 7th Edition, 2018. Pearson Education.
8. Brown, T. A. – Gene Cloning and DNA Analysis: An Introduction – 8th Edition, 2020. Wiley-Blackwell.
9. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. – Molecular Biology of the Cell – 7th Edition, 2022. Garland Science.

PRACTICALS

30 Hrs.

1. Demonstration of DNA replication mechanism.
2. Experiment using establishing nucleic acid as a genetic material.
3. Project report on regulation of gene expression in prokaryotes

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Description of working model of Nucleosome/ Watson & Crick Model of DNA (6)
2. Description of the DNA replication mechanisms/ nucleic acid as genetic materials through model/ photographs (6)
3. Spotting (two) 2x 2 = (4)
4. Record (5)
5. Viva-Voce (4)



Semester VII

MAJOR COURSE: MJ-16 RESEARCH METHODOLOGY (Credit course: Theory- 04)

Marks: 25 (5 Attendance & others + 20 SIE: 1hr) + 50 (ESE: 3 Hrs) = 100

Pass Marks: Th (MSE + ESE) = 40

Course Objective

- To introduce the fundamentals of research, its significance, and the scientific method.
- To familiarize students with different types of research (qualitative, quantitative, experimental, descriptive, historical, etc.).
- To develop understanding of research design, sampling techniques, and data collection methods.
- To provide knowledge of tools and techniques for data analysis and interpretation.
- To impart skills in writing research dissertations.
- To train students in ethical issues in research, plagiarism, and intellectual property rights.
- To enhance skills in referencing, citation styles, and use of digital resources for literature review.

Course Learning Outcomes

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

1. Explain the meaning, objectives, and types of research and their applications in science and society.
2. Design appropriate research projects using correct methodology, sampling, and tools.
3. Collect, analyze, and interpret data using statistical and computational methods.
4. Prepare a structured research proposal with clear objectives, methodology, and expected outcomes.
5. Write scientific reports, dissertations, and research papers in a systematic and professional manner.
6. Use proper referencing and citation styles (APA, MLA, Chicago, etc.)
7. Recognize and follow research ethics, avoiding plagiarism and ensuring academic integrity.
8. Present research findings effectively using power point method.

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**.

Term Examination (25 marks):

The term examination will consist of Oral and power point presentation of 15-20 minutes on the assigned topic.

End Semester Examination (ESE 50 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** seven questions of fifteen marks each, out of which **any four** are to be answered.

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

**COURSE CONTENT
THEORY
LECTURES - 60**

Full marks: 100

Time: 03 Hrs

- UNIT 1: Basic concepts of research (12 lectures)**
A. Objective, Hypothesis, Review of Literature, Collection of data, References, Citation style; APA, AMA, Chicago, MLA.
B. Use of Academic Database for Biological Science, encyclopedia, Research Guides, Handbook, Role of Journals, impact factor and citation index.
- UNIT 2: General laboratory practices (12 lectures)**
1. Microbial Culture media and its preparation – Definition; Types, Composition and Use of MS Media and PDA Media.
2. Sterilization techniques employed in General laboratory.
- UNIT3: Preparation of Solution (4 lectures)**
Dilutions, Percentage solutions. Molar, molal and normal solutions.
- UNIT 4: Study of Instruments and their Uses (4 lectures)**
Centrifuge, pH meter, Conductivity meter, LAF, Autoclave, etc.
- UNIT 4: Methods to study plant cell/ tissue structure (8 lectures)**
A. **Section Cutting & Mount:** Transverse section (TS), longitudinal section (LS), Radial section, Tangential section; Whole mounts, peel mounts, squash preparations of onion root tip cells.
B. **Staining agents** used for staining bacteria, algae, fungus, archegoniates and angiospermic specimens.
- UNIT 5: Ethical Issues and writing research dissertations (5 lectures)**
Ethical issue related to Publishing, Plagiarism and Self- Plagiarism, Introduction to copy right-academic misconduct/ plagiarism, commercialization and Royalty.
- UNIT 6: Oral and Poster Presentation (15 lectures)**
Importance of Oral Presentation, Understanding the audience and purpose. Planning and outlining. PPT basics: Fundamental of slide design (Clarity, visual appeal, fonts, layout, etc.), Practice Presentation – 5-10 minutes.

Visit to Local Research institutes

Suggested Readings

1. Kothari, C. R. & Garg, G. – Research Methodology: Methods and Techniques – 4th Edition, 2019. New Age International Publishers, New Delhi.
2. Panneerselvam, R. – Research Methodology – 3rd Edition, 2021. PHI Learning Pvt. Ltd., New Delhi.
3. Sinha, R. K. – Research Methodology in Social Science – 2nd Edition, 2020. Concept Publishing Company, New Delhi.
4. Gupta, S. L. & Gupta, H. – Research Methodology: Text and Cases – 2nd Edition, 2022. PHI Learning Pvt. Ltd., New Delhi.
5. Creswell, J. W. & Creswell, J. D. – Research Design: Qualitative, Quantitative, and Mixed Methods Approaches – 6th Edition, 2022. SAGE Publications.
6. Kumar, R. – Research Methodology: A Step-by-Step Guide for Beginners – 6th Edition, 2023. SAGE Publications.
7. Flick, U. – An Introduction to Qualitative Research – 7th Edition, 2023. SAGE Publications.
8. Bryman, A. – Social Research Methods – 6th Edition, 2021. Oxford University Press.

MAJOR COURSE: MJ-17
PLANT PHYSIOLOGY AND METABOLISM
(Credit course: Theory- 03, Practical-01)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To provide knowledge of physiological processes in plants including water relations, mineral nutrition, and translocation of solutes.
- To understand the biochemical pathways of photosynthesis, respiration, and nitrogen metabolism.
- To study the role of plant hormones and growth regulators in growth and development.
- To understand the underlying physiological process of flowering.
- To impart experimental skills in physiological and biochemical analysis of plants.

Course Learning Outcomes:

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

1. Explain plant–water relations, transpiration, and mechanisms of water transport.
2. Describe mineral nutrition in plants and their physiological roles.
3. Understand mechanisms of translocation of organic and inorganic solutes through phloem and xylem.
4. Explain photosynthesis (light reactions, Calvin cycle, C₄ and CAM pathways) and factors affecting it.
5. Analyze respiration (glycolysis, Krebs cycle, electron transport, oxidative phosphorylation, fermentations).
6. Illustrate bioenergetics including ATP production, energy coupling, and redox reactions.
7. Describe nitrogen metabolism (nitrogen fixation, nitrate reduction, assimilation of ammonia).
8. Evaluate the role of phytohormones and growth regulators in seed germination, dormancy, flowering, senescence, and abscission.
9. Demonstrate practical skills in experiments related to transpiration, photosynthesis, respiration, enzyme activity, and seed viability.

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.

COURSE CONTENT
THEORY
LECTURES - 45

UNIT 1: Plant water relationship (4 lectures)

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 (3 lectures)

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

UNIT 3: Phloem Translocation (2 lectures)

Mechanism of translocation of food.

UNIT 4: Nitrogen metabolism (3 lectures)

Biological nitrogen fixation, reductive amination and transamination

UNIT 5: Carbon assimilation (9 lectures)

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

UNIT 6: Carbon oxidation (6 lectures)

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

UNIT 7: Lipid metabolism (4 lectures)

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

UNIT 8: ATP-synthesis (5 lectures)

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

UNIT 9: Plant growth regulators (4 lectures)

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

UNIT 10: Physiology of flowering (5 lectures)

Photoperiodism, florigen concept and vernalization.

Suggested Readings

1. Taiz, L., Zeiger, E., Møller, I. M. & Murphy, A. – Plant Physiology and Development – 7th Edition, 2023. Sinauer Associates / Oxford University Press (Indian Edition available).
2. Salisbury, F. B. & Ross, C. W. – Plant Physiology – 5th Edition, 2019 (Indian Reprint). Cengage Learning India.
3. Panda, B. B. – Plant Physiology and Metabolism – 2nd Edition, 2022. New Central Book Agency, Kolkata.
4. Srivastava, H. S. – Plant Physiology, Growth and Development – 3rd Edition, 2021. Rastogi Publications, Meerut.

5. Singh, S. P. – Plant Physiology and Metabolism – 1st Edition, 2020. Rastogi Publications, Meerut.
6. Hopkins, W. G. & Hüner, N. P. A. – Introduction to Plant Physiology – 6th Edition, 2022. Wiley-Blackwell.
7. Salisbury, F. B. & Ross, C. W. – Plant Physiology – 5th Edition, 2019. Cengage Learning.
8. Taiz, L., Zeiger, E., Møller, I. M. & Murphy, A. – Plant Physiology and Development – 7th Edition, 2023. Sinauer Associates / Oxford University Press.

PRACTICALS

30 Hrs.

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, Nitrogenous bases 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.

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Perform experiment to show that CO₂ is essential for photosynthesis **or** Determination of water potential of given tissue (potato tuber) by weight method. **or** Experiment showing O₂ is evolved during photosynthesis **or** To determine the rate of transpiration by Farmer's/ Ganong's potometer. (6)
2. To study the effect of different concentration of IAA on *Avena* coleoptile elongation, **or** Separation of pigments by Chromatography method. (6)
3. Spotting (two) 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)

Semester VII

MAJOR COURSE: MJ-18 PLANT BIOTECHNOLOGY (Credit course: Theory- 03, Practical- 1)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- To introduce the fundamental principles and applications of plant biotechnology.
- To familiarize students with various techniques such as tissue culture, genetic engineering, and molecular markers used in crop improvement.
- To develop understanding of biotechnological processes such as PCR and recombinant DNA technology and hybridization techniques.
- To highlight the role of plant biotechnology in sustainable agriculture, food security, medicine, and environmental management.
- To cultivate practical skills in plant tissue culture, micropropagation, and molecular approaches for plant improvement.

Course Learning Outcomes:

On course completion the learner will be able to:

1. Explain the concepts, scope, and importance of plant biotechnology in modern agriculture and industry.
2. Demonstrate knowledge of plant tissue culture techniques, including micropropagation, haploid culture, and somatic hybridization.
3. Demonstrate practical skills in plant tissue culture and DNA-based molecular methods.
4. Analyze the role of molecular markers in plant breeding and crop improvement programs.
5. Evaluate the applications of transgenic plants in food security, pharmaceuticals, and environmental sustainability.
6. Perform basic laboratory techniques related to plant tissue culture and molecular tools.

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.

COURSE CONTENT
THEORY
LECTURES - 45

Full marks: 75

Time: 03 Hrs.

UNIT 1: Plant Tissue Culture (10 lectures)

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 (15 lectures)

Tools, Restriction endonucleases, Plasmid, Cloning Vectors: Prokaryotic (pBR322, Ti plasmid); Lambda phage, Cosmid, Eukaryotic Vectors (YAC). Properties, Ti- Plasmid; r-DNA technology- discovery, process and application; agarose gel electrophoresis as an important tool, genomic and c-DNA library, PCR technology: DNA – fingerprinting, Blotting techniques – Northern and southern blotting.

UNIT 3: Methods of gene transfer (10 lectures)

Biological method (Indirect): Agrobacterium-mediated; Physical methods (Direct): Electroporation, Microinjection, Microprojectile bombardment.

UNIT 4: Application of Bio-technology (10 lectures)

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; biosafety concerns, application and role of nanobiotechnology in agriculture and health care.

Suggested Readings

1. Chawla, H. S. – Introduction to Plant Biotechnology – 4th Edition, 2020. CRC Press / Science Publishers.
2. Singh, B. D. & Shekhawat, N. S. – Plant Biotechnology: Techniques and Applications – 4th Edition, 2021. Kalyani Publishers, Ludhiana.
3. Gupta, P. K. – Elements of Biotechnology – 3rd Edition, 2022. Rastogi Publications, Meerut.
4. Razdan, M. K. – Introduction to Plant Tissue Culture – 3rd Edition, 2019. Oxford & IBH Publishing Co., New Delhi.
5. Slater, A., Scott, N. & Fowler, M. – Plant Biotechnology: The Genetic Manipulation of Plants – 2nd Edition, 2021. Oxford University Press.
6. Brown, T. A. – Gene Cloning and DNA Analysis: An Introduction – 8th Edition, 2020. Wiley-Blackwell.
7. Bhojwani, S. S. & Dantu, P. K. – Plant Tissue Culture: An Introductory Text – 2nd Edition, 2021. Springer.
8. Gamborg, O. L. & Phillips, G. C. – Plant Cell, Tissue and Organ Culture: Fundamental Methods – 2nd Edition, 2020. Springer.

PRACTICALS

30 Hrs.

1. Preparation of culture media and inoculation of explants—seeds and leaf meristem.
2. Study of anther, embryo, endosperm culture, micropropagation and somatic hybridization through photographs.
3. Perform the gel electrophoresis (Agarose gel for DNA)

4. 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.
5. Study of cloning vectors through photographs

Visit to research institutes

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. Preparation of culture media and inoculation of explants- seeds and leaf meristem
or anther, embryo, endosperm culture /micropropagation, somatic hybridization through
photographs. (two) (6)
2. Photographs of instrument used in biotechnology laboratory/cloning vectors (6)
3. Spotting 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)



ADVANCED MAJOR COURSE: AMJ - 1
CYTOGENETICS AND CROP IMPROVEMENT
(Credit course: Theory- 04)

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

Pass Marks: Th (MSE + ESE) = 40

Course Objectives

The course aims to:

- Introduce the principles of cytogenetics, including chromosome structure, special types of chromosomes, behavior, and inheritance patterns.
- To study the mechanisms of DNA replication, repair, recombination, transcription, and translation.
- To introduce the regulation of gene expression in prokaryotes and eukaryotes.
- To understand the role of regulatory RNAs and operons in gene regulation.
- Provide knowledge of chromosomal aberrations, ploidy, and their role in crop evolution and improvement.
- Familiarize students with the cytogenetic basis of plant breeding and hybrid development.
- Develop an understanding of modern tools such as molecular cytogenetics, mutational breeding, and molecular markers.
- Expose students to applications of cytogenetics in crop yield enhancement.
- Familiarize with Allelopathy in growth and development of crops.

Course Learning Outcomes

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

1. Explain the structure, organization, and behavior of chromosomes during cell division and reproduction.
2. Describe DNA replication (enzymes, mechanism, fidelity, and repair systems).
3. Understand mechanisms of recombination (homologous, site-specific, transposition).
4. Explain transcription and post-transcriptional modifications in prokaryotes.
5. Analyze regulation of gene expression through operons and transcription factors.
6. Differentiate between structural and numerical chromosomal aberrations and their biological significance.
7. Analyze the role of polyploidy and aneuploidy in plant evolution and crop improvement.
8. Describe the principles of plant breeding and genetic basis of hybrid vigor.
9. Apply cytogenetic knowledge to hybridization, wide crosses, and development of new crop varieties.
10. Evaluate the role of induced mutations and molecular markers in crop improvement.
11. Assess strategies for improving yield, nutritional quality, and resistance to biotic and abiotic stresses.
12. Appreciate the concept of Allelopathy in plant growth and interaction.

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 seven questions** of fifteen marks each, out of which **any four** are to be answered.

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

COURSE CONTENT

**THEORY
LECTURES - 60**

CYTOGENETICS

(30 lectures)

- 1) Cell cycle: Interphase and mitosis, cytokinesis, stages of meiosis, significance of meiosis, synaptonemal complex and its significance in meiosis; recombination nodules and their role in meiotic recombination.
- 2) DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanisms.
- 3) RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA.
- 4) Physical basis of heredity: the nucleus (including new basket model of nuclear pore complex), structure of chromatin fiber, special types of chromosomes (Lampbrush, Salivary gland and B chromosomes).
- 5) Regulation of gene expression: Operon circuits in bacteria and other prokaryotes; circuits for lytic cycle and lysogeny in bacteriophages; regulation of gene expression in eukaryotes.

PLANT BREEDING

(30 lectures)

- 6) Inbreeding and heterosis: Effects of inbreeding; degrees of inbreeding depression; concept of heterosis and hybrid vigour; manifestation of heterosis; genetic basis of heterosis;

exploitation of heterosis in self, cross and vegetatively propagated crops; fixation of heterosis.

- 7) Breeding for disease resistance: Concept of plant diseases; procedures for breeding disease resistant crops; achievements.
- 8) Ploidy breeding: Haploid breeding, use of auto polyploidy and allopolyploidy in crop improvement.
- 9) Mutation breeding: Use of the physical and chemical mutagens in induction of mutation; LD50; procedure of mutation breeding; advantages, disadvantages and limitations of mutation breeding; achievements made through mutation breeding.
- 10) Allelopathy: Brief history; definition; Evidence of allelopathy, Allelochemicals occurrence, mode of allelochemicals release, mode of action of allelochemicals. Interactions between plant communities - crop-crop interaction, crop-weed interaction. Exploitation of allelopathy in crop production and protection, future prospects.

Suggested Readings:

1. Singh, B. D. – Plant Breeding: Principles and Methods – 12th Edition, 2021. Kalyani Publishers, Ludhiana.
2. Sharma, J. R. – Principles and Practice of Plant Breeding – 2nd Edition, 2020. Tata McGraw-Hill Education.
3. Gupta, P. K. – Cytogenetics – 3rd Edition, 2021. Rastogi Publications, Meerut.
4. Swaminathan, M. S. & Chopra, V. L. – Cytogenetics and Crop Improvement – 2nd Edition, 2020. Macmillan India.
5. Agrawal, R. L. – Fundamentals of Plant Breeding and Hybrid Seed Production – 2nd Edition, 2021. Oxford & IBH Publishing.
6. Snustad, D. P. & Simmons, M. J. – Principles of Genetics – 8th Edition, 2021. Wiley.
7. Hartl, D. L. & Jones, E. W. – Genetics: Analysis of Genes and Genomes – 9th Edition, 2021. Jones & Bartlett Learning.
8. Klug, W. S., Cummings, M. R., Spencer, C. A. & Palladino, M. A. – Concepts of Genetics – 12th Edition, 2021. Pearson.

Semester VIII

MAJOR COURSE: MJ-19 BIOSTATISTICS AND BIOINFORMATICS (Credit course: Theory- 03, Practical- 1)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- Introduce fundamental concepts of biostatistics and their applications in biological sciences.
- Develop skills in data collection, organization, analysis, and interpretation using statistical tools.
- Familiarize students with probability distributions, hypothesis testing, correlation, and regression relevant to biological research.
- Provide an understanding of bioinformatics principles, including databases, sequence alignment, and molecular modeling.
- Equip students with practical skills in using statistical software and bioinformatics tools for solving biological problems.
- Encourage critical thinking in applying biostatistics and bioinformatics for biological research, biotechnology, and medicine.

Course Learning Outcomes:

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

1. Explain the role and importance of statistics in biological research.
2. Organize and summarize biological data using measures of central tendency, dispersion, and graphical methods.
3. Apply probability concepts and statistical tests (t-test, chi-square, etc) to biological problems.
4. Interpret relationships between variables using correlation and regression analysis.
5. Use statistical software for analysis of experimental data
6. Describe the scope and applications of bioinformatics in modern biology.
7. Access and retrieve biological information from databases (GenBank, PDB, EMBL, etc.).
8. Perform sequence alignment, phylogenetic analysis, and gene/protein annotation using bioinformatics tools.
9. Analyze molecular structures and evolutionary relationships using computational approaches.

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.

COURSE CONTENT

THEORY LECTURES - 45

Full marks: 75

Time: 03 Hrs.

UNIT 1: BIOSTATISTICS

(20 Lectures)

1. **Data and its type:** Primary and Secondary; Frequency Distribution, Classification and Tabulation.
2. **Representation of data:** Diagrammatic representation- Histogram and Pie Diagram, Ogive Curve and Polygon Curve.
3. **Measure of Central tendency:** Mean, Mode and Median.
4. **Measurement of Variation:** Standard deviation, Standard Error of Mean, Coefficient of Variation.
5. **Chi square Test and Student's t-test.** Measure of Dispersion.
6. **Correlation:** Types and methods of calculation, Karl Pearsons Coefficient correlation, Rank Correlation.
7. **Regression analysis:** Concept and its types.

UNIT 2: BIOINFORMATICS

(25 Lectures)

1. **Bioinformatics:** Definition, Introduction, Scope and its applications; Bioinformatics as an interdisciplinary field of study
2. **Usage of Internet in Bioinformatics:** online bioinformatics resources-NCBI (National Centre for Biotechnology Information), Gene Bank, Protein Data Bank (PDB), Bioinformatics with Basic Alignment Search Tools (BLAST) and fast alignment (FASTA).
3. **Biological Databases and Retrieval:** Introduction, Classification of Biological Databases

Suggested Readings

1. Khan, I. A. & Khanum, A. – Fundamentals of Biostatistics – 3rd Edition, 2021. Ukaaz Publications, Hyderabad.
2. Mahajan, B. K. – Methods in Biostatistics – 8th Edition, 2020. Jaypee Brothers Medical Publishers, New Delhi.
3. Rastogi, V. B. – Introductory Bioinformatics – 1st Edition, 2020. New Age International Publishers, New Delhi.
4. Arora, P. N. & Malhan, P. K. – Biostatistics – 2nd Edition, 2021. Himalaya Publishing House, Mumbai.
5. Baldi, P. & Brunak, S. – Bioinformatics: The Machine Learning Approach – 3rd Edition, 2021. MIT Press.
6. Mount, D. W. – Bioinformatics: Sequence and Genome Analysis – 3rd Edition, 2020. Cold Spring Harbor Laboratory Press.
7. Campbell, M. A. & Heyer, L. J. – Discovering Genomics, Proteomics and Bioinformatics – 3rd Edition, 2021. Pearson Education.
8. Lesk, A. M. – Introduction to Bioinformatics – 5th Edition, 2023. Oxford University Press.

PRACTICALS

30 Hrs.

Biostatistics

1. Sampling, Data collection, tabulation and graphical representation.
2. Measurement of central tendencies
3. Measures of deviation

4. Test of significance- chi square test

Bioinformatics

1. To perform experiments with BLAST, FASTA
2. To retrieve DNA, Amino Acids and protein data from different sources- NCBI, PDB, SCOP, PUBMED, GENE BANK, UNIPROT
3. Retrieval of gene sequence from NCBI (<https://www.ncbi.nlm.nih.gov/>)

ONLINE TOOLS AND WEB SOURCES

1. Retrieval of gene sequence from NCBI (<https://www.ncbi.nlm.nih.gov/>)
2. Accessing Protein structure from PDB (<https://www.rcsb.org/>)
3. Online bioinformatics: UniProt (<https://www.uniprot.org/>)
4. Online bioinformatics: EMBL-EBI : (<https://www.ebi.ac.uk/>)
5. Online bioinformatics: (<https://www.ncbi.nlm.nih.gov/pubmed/>)
6. Online bioinformatics: (<https://www.ncbi.nlm.nih.gov/pubmed/genbank>)

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. To Show graphical representation of statistical data **Or** create file format of given gene/ protein **or** Testing goodness of fit or not by chi-square method (6)
2. Calculation of standard error to test ratio between two given seed samples (as per Mendel's ratio) **or** Perform 't- test' to find significance of the given sample. **or** Identify the online data base (through photographs) (6)
3. Spotting (two) 2x 2 = (4)
4. Records (5)
5. Viva-Voce (4)

Semester VIII

MAJOR COURSE: MJ-20

APPLIED BOTANY

(Credit course: Theory- 03, Practical- 1)

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

Pass Marks: Th (SIE + ESE) = 30

Course Objectives:

- Provide knowledge of how plants are utilized in agriculture, industry, medicine, and environment.
- Introduce students to the role of plants in food security, sustainable development, and economic growth.
- Familiarize learners with ethnobotany and medicinal plants.
- Develop an understanding of crop improvement techniques, horticulture practices, and conservation strategies.
- Highlight the practical applications of botanical knowledge in day-to-day life and community welfare.

Course Learning Outcomes:

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

1. Explain the significance of applied botany in agriculture, health, and industry.
2. Identify economically important plants and their uses in food, medicine, and industry.
3. Demonstrate knowledge of crop improvement, horticulture, and sustainable farming practices.
4. Apply ethnobotanical knowledge to understand traditional and modern uses of plants.
5. Analyze the role of medicinal and aromatic plants in pharmaceuticals and nutraceuticals.
6. Evaluate strategies for conservation of biodiversity and sustainable utilization of plant resources.
7. Appreciate the contribution of plants to environmental management, renewable energy, and biotechnology.

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.

COURSE CONTENT
THEORY
LECTURES - 45

Full marks: 75

Time: 03 Hrs.

- UNIT1: Plant Genomics** (4 lectures)
Basic concept of plant genomics; Brief idea about Papaya genome
- UNIT 2: Biodiversity and its conservation.** (5 lectures)
Impact of Urban Heat Islands on Biodiversity, Role and application of remote sensing and GIS in biodiversity conservation.
- UNIT 3: Pharmacognosy and Phytochemistry of medicinal plants.** (10 lectures)
A. Definition, history, scope of pharmacognosy and phytochemistry.
B. Brief account on pharmacognosy and phytochemistry aspect and uses of following medicinal plants:-
i. *Atropa belladonna* ii. *Rauwolfia serpentine* iii. *Ocimum sanctum*
iv. *Tinospora cordifolia* v. *Azadirachta indica* vi. *Withania somnifera*
- UNIT 4: Natural Resource Management** (4 lectures)
Definition, Importance, Objectives, Methods and its different approaches; Phytoremediation and Algal flora as natural resource management.
- UNIT 5: Soilless farming** (5 lectures)
Techniques and prospect of soilless farming- Hydroponics, Aquaponics and Aeroponics.
- UNIT 6: An overview of biofuels** (8 lectures)
Definition, types, biomass to biofuel processes, biofuel production, advantages and disadvantages.
- UNIT 7: Mushroom Cultivation** (8 lectures)
Basic requirement of mushroom cultivation, Techniques and current prospect of mushroom cultivation.
- UNIT 8: Nursery techniques and vermiculture for floriculture** (8 lectures)
Methods, preparations, benefits and field application of vermiculture in flower farming.

Suggested Readings

1. Arjariya, Amita – Anuprayukt Vanaspati Vigyan: Applied Botany – 1st Edition, 2022. Big Book (Hindi Edition).
2. Thakur Publication – Applied Botany (Anuprayukt Vanaspati Vigyan) – 1st Edition, 2022. Thakur Publication.
3. Nirali Prakashan – Applied Aspects of Plant Sciences (FY B.Sc. Botany BOT 101 T) – 1st Edition, 2024. Nirali Prakashan.
4. Guernine, Omar – Soil-Less Agriculture: Hydroponics-Aquaponics-Bioaponics-Aeroponics-Biodynamics-NFT – 1st Edition, 2021. Independently Published.
5. Zachariah, Annie Bobby (Ed.) – Soilless Farming: The New Trend of Farming – 1st Edition, 2019. Delve Publishing.
6. Ayandele, Micheal – Soilless Agriculture Cultivation: A Beginner's Guide to Hydroponics, Aquaponics and Aeroponics Farming – 1st Edition, 2024. Independently Published.
7. Jana, B. L. – Hydroponics (Soilless Gardening) – 1st Edition, 2015. Aavishkar Publishers, Distributors.
8. Chowdhuri, T. K. et al. – Textbook on Floriculture: Volume 1 – 1st Edition, 2022. National Publishers (India).
9. Mishra, K. K. – Floriculture: Principles and Practices – 1st Edition, 2019. Brillion Publishing.
10. Jagetiya, B. L. & Somani, L. L. – Textbook of Commercial Floriculture – 1st Edition, 2020. Agrotech Books.

PRACTICALS

30 Hrs.

1. e-Herbarium preparation
2. Report writing on pharmacognosy and phytochemistry of medicinal plants.
3. Study of algal flora as natural resource for sustainable agriculture.
4. Techniques on Soilless farming: effect of different nutrients solutions on plant growth
5. Mushroom cultivation
6. Vermiculture techniques
7. Preparation of enriched farmyard manure (FYM)
8. Compost making- aerobic and anaerobic methods

PRACTICAL EXAMINATION

Full marks: 25

Pass Marks: 10

Time: 03 Hrs.

1. e-Herbarium Preparation (6)
2. Vermicompost preparation
or Compost making- aerobic and anaerobic methods under nursery techniques
or Description of various types of algal flora as natural resource for sustainable agriculture (6)
3. Spotting 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)



ADVANCED MAJOR COURSE: AMJ- 2
APPLIED ECOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY
(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

The course aims to:

- Introduce the fundamental principles of applied ecology and their relevance to sustainable development.
- Familiarize students with ecological interactions, ecosystem dynamics, and conservation strategies.
- Provide knowledge of environmental biotechnology tools for pollution control, waste management, and resource recovery.
- Develop understanding of bioremediation, bioenergy, and biosensors as solutions to environmental challenges.
- Promote awareness of the role of ecology and biotechnology in biodiversity conservation, climate change mitigation, and environmental sustainability.

Course Learning Outcomes

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

1. Explain ecological principles and their applications in natural resource management.
2. Analyze the structure and function of ecosystems, nutrient cycles, and energy flow.
3. Evaluate human impacts on ecosystems and propose strategies for biodiversity conservation.
4. Apply ecological knowledge to sustainable agriculture, forestry, and urban planning.
5. Describe the concepts and applications of environmental biotechnology.
6. Demonstrate understanding of microbial processes in waste treatment, composting, and biogas production.
7. Apply biotechnological approaches for pollution control, including bioremediation and phytoremediation.
8. Assess the role of biofertilizers, biopesticides, and bioenergy in sustainable development.
9. Appreciate the integration of ecology and biotechnology in addressing global issues such as climate change, food security, and environmental health.

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 seven questions** of fifteen marks each, out of which **any four** are to be answered. **Note:** There may be subdivision in the question of Group B.

COURSE CONTENT THEORY LECTURES – 60

General Ecology

- 1) Ecosystem: **(8 lectures)**
 - a) Modern concept, structural components, trophic structure, food chain, food web and ecological pyramids.
 - b) Ecological energetics: concept and mode of energy flow in aquatic ecosystem.
 - c) Productivity: types and methods of primary productivity and its measurement.
- 2) Community: **(6 lectures)**
 - a) Structure: Analytic and synthetic characters with emphasis on I.V.I, and species diversity index (H).
 - b) Ecological niche, edges and ecotones.
 - c) Ecological succession: Types and process of succession, hydrosere and xerosere, concept of climax.
- 3) Phytogeography: **(8 lectures)**
 - a) Biomes of the world.
 - b) Major vegetation types of India with special reference to Jharkhand.

Resource Ecology

- 4) Natural resources: **(6 lectures)**
 - a) Biodiversity-concept, importance and quantum of biodiversity.
 - b) Forest, wetland, mangroves, agriculture, fisheries and wild life resources of India.
- 5) Modern fuel and their environmental effect: **(5 lectures)**
 - a. Methanogenic bacteria and biogas.
 - b. Solar energy converters.
 - c. Petroplants.
- 6) Wetlands: Definition, characteristic and productivity, major wetlands of India and their biotic resources. **(4 lectures)**

Limnology

- 7) Introduction and History of Limnology. **(2 lectures)**
- 8) Lentic and Lotic ecosystem, quality of drinking water, strategies for conservation of fresh water. **(5 lectures)**
- 9) Physico-chemical Characteristic of lentic and lotic ecosystem – Temperature, pH, conductivity, dissolved oxygen and free CO₂. B.O.D and C.O.D, TDS (Total Dissolved Solid). **(5 lectures)**

Applied Ecology

- 10) Remote sensing: Basic concept and application in pollution management and natural resource management. **(3 lectures)**
- 11) Biomonitoring: **(3 lectures)**
- a) Concept of biomonitoring.
 - b) Biomonitoring of water and air pollution.
 - c) Advantages of biomonitoring over conventional techniques.
- 12) A brief account of: **(5 lectures)**
- a) Biopiracy
 - b) Bioprospecting
 - c) Environmental economics
 - d) Village biodiversity register
 - e) Bioethics

Suggested Readings:

1. Sharma, P.D. Ecology and Environment – 13th Edition, 2023. Rastogi Publications.
2. Misra, R. Ecology Workbook – 2nd Edition, 2010. Oxford & IBH Publishing.
3. Odum, Eugene P. & Barrett, Gary W. Fundamentals of Ecology – 5th Edition, 2005. Thomson Brooks/Cole.
4. Singh, Vir – Textbook of Environment and Ecology – 1st Edition, 2024. Springer Nature Singapore Pte Ltd.
5. Sakhare, V. B. – Applied Ecology – 1st Edition, Year unspecified. NPH India / National Publishers.
6. Rittmann, Bruce E. & McCarty, Perry L. – Environmental Biotechnology: Principles and Applications – 2nd Edition, 2020. McGraw-Hill Education.
7. Kaushik, Garima (Ed.) – Applied Environmental Biotechnology: Present Scenario and Future Trends – 1st Edition, 2015. Springer New Delhi.
8. Singh, Ram Lakhan (Ed.) – Principles and Applications of Environmental Biotechnology for a Sustainable Future – 1st Edition, 2017. Springer Singapore.
9. Mohapatra, Pradipta K. – Textbook of Environmental Biotechnology – 1st Edition, 2007. I.K. International Publishing House.

ADVANCED MAJOR COURSE: AMJ – 3
PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY
(Credit course: Theory- 04)

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

Pass Marks: Th (MSE + ESE) = 40

Course Objectives

- The course aims to:
- Introduce the molecular basis of plant life processes, including DNA, RNA, and protein structure and function.
- Familiarize students with the regulation of gene expression.
- Provide knowledge of modern molecular techniques such as PCR, sequencing, cloning, and genome editing.
- Develop understanding of biotechnological tools for crop improvement, including tissue culture, transgenics, and molecular markers.
- Encourage critical thinking about ethical and biosafety issues related to biotechnology.

Course Learning Outcomes

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

1. Explain the molecular organization of genomes, genes, and regulatory elements in plants.
2. Describe the processes of DNA replication, transcription, translation, and gene regulation.
3. Analyze the role of signaling pathways and molecular responses in plant development and stress adaptation.
4. Utilize molecular markers for crop improvement, diversity analysis, and marker-assisted selection.
5. Critically examine biosafety regulations and ethical aspects in biotechnology.
6. Appreciate the integration of molecular biology and biotechnology in achieving food security, environmental sustainability, and human welfare.

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 seven questions** of fifteen marks each, out of which **any four** are to be answered.

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

COURSE CONTENT
THEORY
LECTURES – 60

Molecules and their Interactions

(15 lectures)

- 1) Structure of atoms, molecules and chemical bonds.
- 2) Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.).
- 3) Conformation of nucleic acids (A-, B-, Z-, DNA), t-RNA, micro-RNA).
- 4) Stability of protein and nucleic acid structures.

Fundamental Processes of Plant Genome

(20 lectures)

- 5) DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms.
- 6) Control of gene expression at transcription and translation level: Regulation of prokaryotic and eukaryotic gene expression.

Molecular methods

(25 lectures)

- 7) Isolation and purification of RNA, DNA (genomic and plasmid), different separation methods; analysis of RNA and DNA by gel electrophoresis.
- 8) DNA sequencing methods, strategies for genome sequencing, CRISPER-CAS technique of gene editing.
- 9) Polymerase Chain Reaction (PCR): Basic concept; applications of PCR in DNA polymorphism, molecular mapping. DNA fingerprinting (RFLP, RAPD and AFLP techniques).
- 10) The gene banks: Objective, procedure of making cDNA library and its advantages; construction of the genomic library; ligation; packaging and implications; method of screening cDNA and genomic libraries; significance of the gene banks.

Suggested Readings:

1. Lodish, H., Berk, A., Kaiser, C., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. & Martin, K. – Molecular Cell Biology – 9th Edition, 2021. W.H. Freeman & Company.
2. Weaver, R. F. – Molecular Biology – 6th Edition, 2018. McGraw-Hill Education.
3. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M. & Losick, R. – Molecular Biology of the Gene – 7th Edition, 2018. Pearson Education.
4. Brown, T. A. – Gene Cloning and DNA Analysis: An Introduction – 8th Edition, 2020. Wiley-Blackwell.
5. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. – Molecular Biology of the Cell – 7th Edition, 2022. Garland Science.
6. Razdan, M. K. – Introduction to Plant Tissue Culture – 3rd Edition, 2019. Oxford & IBH Publishing Co., New Delhi.
7. Slater, A., Scott, N. & Fowler, M. – Plant Biotechnology: The Genetic Manipulation of Plants – 2nd Edition, 2021. Oxford University Press.
8. Brown, T. A. – Gene Cloning and DNA Analysis: An Introduction – 8th Edition, 2020. Wiley-Blackwell.
9. Bhojwani, S. S. & Dantu, P. K. – Plant Tissue Culture: An Introductory Text – 2nd Edition, 2021. Springer.
10. Gamborg, O. L. & Phillips, G. C. – Plant Cell, Tissue and Organ Culture: Fundamental Methods – 2nd Edition, 2020. Springer.

**SYLLABUS OF ASSOCIATED CORE & ELECTIVE (MINOR) COURSE:
BOTANY - NEP, VINOBA BHAVE
UNIVERSITY**

<u>SEMESTER I/II</u>	69-70
ASSOCIATED CORE COURSE–ACC: MICROBES, ALGAE, FUNGI AND ARCHEGONIATES	
<u>SEMESTER III/IV</u>	71-72
ELECTIVE (MINOR) COURSE–EC-I: PLANT ECOLOGY AND TAXONOMY	
<u>SEMESTER V/VI</u>	73-74
ELECTIVE (MINOR) COURSE–EC-II: PLANT ANATOMY, EMBRYOLOGY AND ECONOMIC BOTANY	
<u>SEMESTER VII/VIII</u>	75-76
ELECTIVE (MINOR) COURSE–EC-III: PLANT PHYSIOLOGY, CELL BIOLOGY & GENETICS AND BIOTECHNOLOGY	



SEMESTER I or II

ASSOCIATED CORE COURSE– ACC MICROBES, ALGAE, FUNGI AND ARCHEGONIATES (Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (MSE + ESE) = 30

Course Objectives:

The course aims to:

- Familiarize students with the morphology and importance of microorganisms.
- Provide an overview of algal diversity and evolutionary significance.
- Develop understanding of morphology, reproduction, and life cycles of major algal groups.
- Introduce the diversity, structure, reproduction of fungi.
- Develop understanding of the structure, thallus organization, and symbiotic relationship between fungal and algal partners.
- To provide students with an understanding of the morphology, anatomy, and reproduction of selected Bryophytes, Pteridophytes and Gymnosperms.

Course Learning Outcomes:

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

1. Explain the historical development and scope of microbiology, including contributions of pioneers.
2. Describe the structure, physiology, and reproduction of major groups of microorganisms (bacteria and viruses).
3. Differentiate between beneficial and harmful roles of microbes in environment, industry, agriculture, and health.
4. recall and classify algae based on morphology, reproduction, and phylogenetic relationships.
5. Explain the general characteristics, structure, life cycles, classification of few fungi.
6. Describe the structure, thallus organization, and symbiotic relationship between fungal and algal partners.
7. Explain the general characters, morphology, anatomy, and life cycles of Bryophytes, Pteridophytes and Gymnosperms.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 03 Hrs.

UNIT 1: MICROBES

(20 lectures)

1. Virus :- Discovery, general characteristics, nature of virus; Structure of TMV and bacteriophage.
2. Bacteria:- Discovery, general characteristics, types and economic importance with special reference to agriculture, medicine and industry.

UNIT 2: ALGAE, FUNGI AND ARHEGONIATES

(25 lectures)

1. General characteristics, Morphology, Anatomy and Reproduction of following genus:
 - i. *Volvox*
 - ii. *Albugo*
 - iii. *Marchantia*
 - iv. *Selaginella*
 - v. *Pinus* &
 - vi. General account of Lichens

Suggested Readings

1. Pelczar, M.J., (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
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 (Algae) 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

30 Hrs.

1. Structure of Bacteriophage and TMV by photographs.
2. Study of different 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 Hrs.

1. Prepare a temporary slide and comment on it with a well labelled diagram of any one of the following genera: *Volvox*, *Albugo*, *Marchantia*, *Selaginella*, *Pinus* (6)
2. Identification of microbes through photographs or by permanent slides. (6)
3. Spotting 2 X 2 = (4)
4. Record (5)
5. Viva-Voce (4)

SEMESTER III or IV

ELECTIVE (MINOR) COURSE–EC-I PLANT ECOLOGY AND TAXONOMY (Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (MSE + ESE) = 30

Course Objectives:

- To provide a basic understanding of ecological principles and the interrelationships among organisms and their environment.
- To understand the anatomical basis of physiological processes and adaptations in plants.
- To impart knowledge about environmental issues such as climate change and pollution.
- To provide a comprehensive understanding of the principles, history, and importance of plant systematics and taxonomy.
- To introduce concepts of classification, nomenclature, and identification of plants.
- To familiarize students with natural systems of classification.

Course Learning Outcomes:

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

1. Explain fundamental ecological concepts and the interdependence between organisms and their environment.
2. Evaluate environmental issues such as air, water, soil, and noise pollution, and propose mitigation measures.
3. Explain basic principles of systematics and taxonomy, and the importance of classification (Bentham and Hooker's system) in understanding plant diversity.
4. Apply rules of nomenclature as per the International Code of Nomenclature (ICN).

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 03 Hrs.

UNIT 1: PLANT ECOLOGY

(20 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

(25 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

30 Hrs.

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 (6)
2. Write the Floral character, Floral Formula, Floral Diagram and Systematic position of the plant material provided to you. (6)
3. Spotting 2 x 2 = (4)
4. Record (5)
5. Viva-Voce (4)

SEMESTER V or VI

ELECTIVE (MINOR) COURSE–EC-II PLANT ANATOMY, EMBRYOLOGY AND ECONOMIC BOTANY (Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (MSE + ESE) = 30

Course Objectives:

- To provide knowledge of the internal structure and organization of plant cells, tissues, and organs.
- To introduce students to the development, differentiation, and functions of various tissues and tissue systems.
- To provide knowledge about the structure and development of male and female gametophytes in angiosperms.
- To understand pollination mechanisms, fertilization, and post-fertilization changes.
- To study the formation, types, and development of embryos and seed.
- To provide knowledge of plants and plant products of economic importance in human life.
- To understand the role of plants in food, fodder, fibre, fuel, timber, medicine, and industry

Course Learning Outcomes:

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

1. Explain the structure and function of plant tissues (meristematic and permanent).
2. Understand primary and secondary growth and the role of cambium in thickening.
3. Describe the structure and development of anther, pollen grains, ovule, and embryo sac.
4. Explain pollination types and mechanisms, fertilization, and double fertilization in angiosperms.
5. Understand post-fertilization changes leading to embryo, endosperm, seed, and fruit development.
6. Come to know development of embryo sac development in *Polygonum*.
8. Identify and discuss important food crops (cereals, pulses, oilseeds, fruits, vegetables, spices) with their uses and nutritional importance.
7. Understand plants used in cereals, pulses, oil, fibres, timber, beverages, fruit, vegetables, and medicines.
8. Demonstrate practical skills in identifying economic plants, plant parts used, and preparation of herbarium/economic charts.

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 03 Hrs.

UNIT 1: PLANT ANATOMY

(12 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

(18 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

(15 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. Sambamurthy, 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

30 Hrs.

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 (6)
2. Identify the photograph or permanent slide for Ovule structure or Embryo sac structure (6)
3. Spotting 2 X 2 = (4)
4. Record (5)
5. Viva-Voce (4)

SEMESTER VII or VIII

ELECTIVE (MINOR) COURSE–EC-III PLANT PHYSIOLOGY, CELL BIOLOGY & GENETICS AND BIOTECHNOLOGY (Credit course: Theory- 03, Practical- 01)

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

Pass Marks: Th (MSE + ESE) = 30

Course Objectives:

- To provide knowledge of physiological processes in plants including water relations, mineral nutrition, and transpiration.
- To understand the biochemical pathways of photosynthesis.
- To provide a foundational understanding of the of Plant Cell.
- To provide insights into and the cell cycle
- To impart laboratory skills in cytological preparations and analysis of meiotic and mitotic stages
- To introduce the fundamental principles and applications of plant biotechnology.
- To familiarize students with various techniques such as plant tissue culture; basic concept of recombinant DNA technology.

Course Learning Outcomes:

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

1. Explain plant–water relations, osmosis, diffusion, transpiration, and mechanisms of water transport.
2. Describe mineral nutrition in plants and their physiological roles.
3. Explain photosynthesis: light reactions, Calvin cycle and factors affecting it.
4. Explain the principles of inheritance.
5. Demonstrate practical skills in identifying stages of mitosis and meiosis, and analyzing chromosomal aberrations.
6. Demonstrate knowledge of plant tissue culture techniques and RDT

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.

**COURSE CONTENT
THEORY
LECTURES - 45**

Full marks: 75

Time: 03 Hrs.

UNIT 1: PLANT PHYSIOLOGY

(20 lectures)

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

UNIT 2: CELL BIOLOGY & GENETICS

(15 lectures)

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

UNIT 3: BIOTECHNOLOGY

(10 lectures)

1. Plant Tissue Culture –History, Requirement, Techniques & Application.
2. Basic concept of recombinant DNA technology (cloning vectors and restriction endonucleases).
3. Concept and uses of biotechnology in everyday life.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley 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. Bhattacharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual, 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 Wiley & Sons. India 8th edition.
6. Bhojwani, S. S. and Razdan, M. K. (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.

PRACTICALS

30 Hrs.

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. Cytological slide preparation to study of different stages of mitosis and meiosis
5. 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. (6)
2. Study the principles and functioning of instruments used in microbiology laboratory or Cytological slide preparation. (6)
3. Spotting 2 x 2 = (4)
4. Records (5)
5. Viva-Voce (4)