UNIVERSITY OF GOUR BANGA

(Established under West Bengal Act XXVI of 2007 &
Recognized by UGC u/s 2f & 12B)
N.H.-34 (Near Rabindra Bhawan), P.O.: Mokdumpur,
Dist..: Malda, West Bengal, Pin-732 103

Four Years Under-Graduate Programme (FYUGP)

SYLLABUS OF BOTANY

(SEMESTER SYSTEM)

as per

[National Education Policy -2020]

SEMESTER: I - VIII

MAJOR / BOT-DC-MJ

BOTANY MINOR

MULTI DISCIPLINARY COURSE (MDC)

SKILL ENHANCEMENT COURSE (SEC)

INTERNSHIP, APPRENTICESHIP, PROJECT, WORKSHOP,

and COMMUNITY OUTREACH (IAPWC)

(Finalized on 31 July 2025)
w.e.f. **Academic session 2023**
REVISED & CODED 2024

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SEMESTER: I - VIII

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BOTANY

Four Years Under-Graduate Programme (FYUGP)
(as per National Education Policy 2020)

THE PREAMBLE

Swami Vivekananda said, ***"The end goal of all education is man-making and character-making."*** The Preamble: Contemporary plant science represents a blend of traditional elements and advanced fields such as Modern Genetics, Biochemistry, Molecular Biology, Bioinformatics, and Biotechnology. Over the years, plant science (Botany) has grown substantially in knowledge and practical applications, driven by significant contributions from research across all its fields. In light of the global emphasis on conservation, field plant biologists have played a crucial role in evaluating and uncovering new aspects of plant diversity. By employing modern tools and techniques in botanical research, new understandings have emerged regarding the functional and structural components of plant development. There are now challenging opportunities in teaching and research across ecology, environmental biology, and reproductive biology. Concern over rising pollution and climate change has reached unprecedented levels. Considering the previously mentioned advancements and the abundant plant resources found in India, the University has introduced a revised undergraduate curriculum in accordance with the National Education Policy-2020. This new curriculum aims to provide undergraduate Botany students with a well-balanced and thoughtfully designed course structure that addresses various aspects of plant science, including plant diversity, taxonomy, reproduction, anatomy, ecology, economic botany, physiology, biochemistry, molecular biology, bioinformatics, and the influence of the environment on plant growth and development. Each of these themes has been appropriately emphasized throughout the eight semesters. It is crucial for undergraduate students to familiarize themselves with various tools and techniques for studying plants at the subcellular level. In light of employment and entrepreneurship, applied courses have been implemented. These courses will give Botany students practical experience and professional insights. Overall, the curriculum is a valuable source of information and is supported by extensive resources. It is anticipated that a student graduating in Botany with this updated curriculum will be equipped to investigate the abundant plant diversity.

These courses shall provide the Botany students with hands-on experience and professional inputs. The curriculum is a source of a lot of information and is supported by rich resource materials. It is hoped that a student graduating in Botany with the new curriculum will be able to explore the rich plant diversity of India. It outlines the pedagogical approach for the NEP-2020 frameworks and sets learning outcomes focused on biodiversity, sustainability, and employability, emphasizing Botany's role in addressing global needs such as climate change, biodiversity conservation, and environmental management. As Dr. A.P.J. Abdul Kalam, the former President of India, said, **"*Education is the most powerful weapon which you can use to change the world*".**

INTRODUCTION

The Four-Year Undergraduate Program (FYUGP) in Botany includes Major (Core) subjects, Minor subjects, Multi Disciplinary Courses (MDC), Ability Enhancement Courses (AEC), Value Added Courses (VAC), Skill Enhancement Courses (SEC), Environmental Education (EE), Community Engagement through initiatives like NCC/NSS, Digital and Technological solutions, Internship experiences, Field Studies, Research Ethics and Research Projects to provide students with a well-rounded understanding of plant resources, the environment, current issues, and entrepreneurship.

The Bachelor of Science in Botany offered by the University of Gour Banga under NEP-2020 is designed with various exit points. Students will receive a UG certificate, UG Diploma, UG Degree, or UG Degree (Honors with Research) in Botany upon completing one, two, three, or four years of study, respectively. It is anticipated that graduates of this FYUGP will possess skills across diverse areas related to the exploration and sustainable use of India's plants and natural resources.

AIMS AND ATTRIBUTES

Four-Year Under-Graduate Programme (FYUGP) in Botany aims

- To introduce the students to the rich biodiversity of India.
- To provide comprehensive knowledge of plant life forms, their structure, function, and evolutionary trends.

- To enable students to explore the potential of plant resources for human welfare and their sustainable use.
- To develop the capabilities of students for the critical evaluation of contemporary issues related to the environment and nature.
- To generate skilled human resources for biological entrepreneurship.
- To mould students to be responsible citizens who understand ethical, environmental, and social responsibilities, capable of communicating scientific ideas effectively for societal, economic, and environmental development.

DISCIPLINARY KNOWLEDGE

Under the New Education Policy-2020, through a multidisciplinary course structure, graduates should be able to demonstrate thorough knowledge and understanding of the theoretical and applied aspects of plant science and related fields of study. Students should be able to make connections across current issues, biological trends, and related fields in a broader spectrum.

COMMUNICATION SKILLS

The students will be able to communicate effectively on any topic related to plants and nature. The course curriculum ensures that Botany graduates can explain and communicate information, thoughts, experiments, and results clearly and succinctly.

MORAL AND ETHICAL AWARENESS

The course curriculum will enhance the ability to recognize ethical issues pertinent to one's work and to pledge not to engage in unethical behavior, such as plagiarism, copyright infringement, or intellectual property infringement. In addition, the curriculum effectively enhances the ability to appreciate recent developments across various fields and to conduct research with honesty and integrity in all aspects.

DIGITAL LITERACY

Botany graduates will be able to utilize Information and Communications Technology (ICT) tools, biological databases, and computer and software to solve biological problems. After completing their

Botany degree, students will be able to understand the value of plant resources, the need to conserve them, bio-prospecting, and the sustainable utilization of plant resources for human welfare.

MULTI-CULTURAL COMPETENCE

The course curriculum strengthens the potential to correlate and compare recent developments across various branches of plant science worldwide; to upgrade the skills of students to collaborate in research across fields of Plant Science with researchers from allied organisations; and to acquire knowledge of traditional practices of different ethnic communities. The graduates of Botany should be competent in the critical analysis of plant- and nature-related problems, the sustainable use of biological resources, and conservation strategies.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- To share the knowledge of plant resources, their importance, and their application in various sectors.
- To design tools for the application of floristic resources for sustainable development.
- To assess environmental challenges and develop solutions, and to create awareness.
- To exhibit a willingness to use interdisciplinary methods to solve problems.

PROGRAMME OUTCOMES (POs)

After completion of the programme, a student will be able

- To develop ideas to assess and inventory existing Plant Resources.
- To formulate innovative strategies for the conservation of biogenetic resources
- To explore and validate ethnobiological knowledge of India with special reference to the Indian Knowledge System.
- To provide solutions for existing societal problems using botanical knowledge.
- To develop research skills to solve complex biological issues.
- To execute good communication skills for disseminating knowledge of Plant sciences.
- To promote the attitude to work as a team, appreciating ethical values.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

- Evaluate the diversity and evolution of plants.
- Analyze the fundamentals of life-sustaining processes.
- Design strategies for public health and human welfare issues.
- Critically analyze the environmental issues and develop strategies to address them.
- Assess the environmental challenges and potential solutions to mitigate the effects of climate change.

Course Structure for 4 Year Bachelor Programme (FYUGP) (2024-2025)

Semester	Major Core (MJ)	Multi-disciplinary (MDC)	Minor Core (MN)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship / Apprenticeship / Project/ Community outreach (IAPWC) (2)	Value addition Course (VAC)	Total Credits
I	DC-MJ-101 (4)	MDC-101 (3)	IDC/DC-MN-101 (4)	MIL-1 (2)	SEC-101 (3)	(IAPWC-101) (2)	(VAC-101) (2) ENVS	**20**
II	DC-MJ-201 (4)	MDC-201 (3)	IDC/DC-MN-201 (4)	MIL -2 (2)	SEC-201 (3)	(IAPWC-201) (2)	(VAC-201) (2) Choose one from a pool of courses	**20**
Students on exit shall be awarded Undergraduate Certificate (in the Field of Study/Discipline) after securing the requisite 40 credits in Semesters I and II								
III	DC-MJ-301 (4) DC-MJ-302 (4)	MDC-301 (3)	IDC/DC-MN-301 (4)	English Language-1 (2)	SEC-301 (3)	(IAPWC-301) (2)		**22**
IV	DC-MJ-401 (4) DC-MJ-402 (4) DC-MJ-403 (4)		IDC/DC-MN-401 (4)	English Language-2 (2)			(VAC-301) (2) Choose one from a pool of courses	**20**
Students on exit shall be awarded an Undergraduate Diploma (in the Field of Study/Discipline) after securing the requisite 82 credits in Semester IV								

V	DC-MJ-501 (4) DC-MJ-502 (4) DC-MJ-503 (4) DC-MJ-504 (4)		IDC/DC-MN-501 (4)					**20**
VI	DC-MJ-601 (4) DC-MJ-602 (4) DC-MJ-603 (4) DC-MJ-604 (4)		IDC/DC-MN-601 (4)					**20**
Students who wish to discontinue after the 3-year UG Programme will be awarded a UG Degree in the Major discipline after successful completion of three years, earning a minimum of 122 credits on completion of Semester VI								
VII	DC-MJ-701 (4) DC-MJ-702 (4) DC-MJ-703 (4) DC-MJ-704 (4)		IDC/DC-MN-701 (4)					**20**
VIII	DC-MJ-801 (4)	IDC/DC-MN-801 (4)		Dissertation on Major (12)/ Academic project/ Entrepreneurship (12)				**20**
Students on exit shall be awarded Bachelor of (in the Field of Study/Discipline) (Honours with Research/Academic Projects/ Entrepreneurship) in Discipline-1 (Major) with Discipline-2 (Minor) after securing the requisite 162 credits on completion of Semester VII								**TOTAL** **162**

N.B. Figures within the bracket indicate the credit points. **# Modalities for holding a Dissertation on a Major /Academic project/ Entrepreneurship are mentioned in the course**

SEMESTER-VIII

(Without Research/ Academic Project/ Entrepreneurship)

Semester	Major Core (MC)/DSE	Minor Core (MnC)	Dissertation on Major / Academic project/ Entrepreneurship #	Total Credits
VIII	DC-MJ-801 (4) DC-MJ-802 (4) DC-MJ-803 (4)	IDC/DC-MN-801 (4)	Dissertation on Major (4) / Academic project (4) / Entrepreneurship (4) DC-MJ-804 (4)	**20**
Students on exit shall be awarded a Bachelor of (in the Field of Study/Discipline - Honours) in Discipline-1 (Major), Discipline-2 (Major), and Discipline-3 (Major) with Discipline-2 (Minor) after securing the requisite 162 credits on completion of Semester VIII.				**Total 162**

N.B. Figures within the bracket indicate the credit points. # Modalities for holding a Dissertation on a Major/Academic project/Entrepreneurship will be notified in due course.

1. Qualification type and Minimum credit requirement (Table 2):

Equivalent National Higher Education Qualification Framework	Qualification title	Minimum credit requirement
Level 5	Undergraduate Certificate	40
Level 6	Undergraduate Diploma	82
Level 7	Bachelor's Degree	122
Level 8	Bachelor's Degree (Honours or Honours with Research)	162

SEMESTER- I

Course Structure for 4-Year Bachelor Programme (FYUGP) (2024-2025)

Semester	Major Core (MJ)	Multidisciplinary (MDC)	Minor Core (MN)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship / Apprenticeship / Project/ Community outreach (IAPWC) (2)	Value Addition Course (VAC)	Total Credits
I	DC-MJ-101 (4)	MDC-101 (3)	IDC/DC-MN-101 (4)	MIL-1 (2)	SEC-101 (3)	(IAPWC-101) (2)	(VAC-101) (2) ENVS	**20**

N.B. Figures within the bracket indicate the credit points.

Major Course / BOT-DC-MJ-101:
Diversity of Cryptogams
[4 credits]

Topic content of THEORY part [03Credits] FM=30 (Teaching hour = 45)

Course Objectives:

- Study the general features of Cryptogams with respect to their cell structures, thallus range, and life cycle patterns.
- Acquire knowledge about the ecological and economic importance of Cryptogams.
- To develop skills in identifying key representative genera of Cryptogams through practical examination.
- To foster observation-based understanding of morphological diversity among different groups of Cryptogams.

Course Outcome: After completing this course, students will be able to:

CO1: Understand the general characteristics of algae, fungi, lichens, bryophytes, and pteridophytes.

CO2: Comprehend the importance of Cryptogams based on their economic and ecological traits.

CO3: Identify and classify selected genera from each group with distinctive vegetative and reproductive structures.

CO4: Analyze the importance of Cryptogams and their relevance to biodiversity and biotechnology.

The detailed course contents

MODULE-1: Algae: General characteristic features, cell structures, range of thallus, life cycle patterns, ecological and economic importance. Comparative study of different classes with special reference to structure, thallus organization, storage materials and pigments; Origin and evolution of sex. Thallus structure and reproduction of *Nostoc, Oedogonium, Chara* and *Polysiphonia*.

MODULE-2: Fungi: General characteristic features, cell structure. Thallus organization; Cell wall composition; fruiting bodies, similarities with plants and animals, ecological and economic importance. Life Cycle Patterns; Homothallism and heterothallism; Parasexuality and sexual compatibility; Characteristic features with special reference to reproductive structure: *Rhizopus, Penicillium, Ascobolus* and *Agaricus*. **Lichen**: General characteristic features, cell structure, fruiting bodies, ecological and economic importance.

MODULE-3: Bryophytes: General characteristic features, adaptation to land habit, difference between liverworts and hornworts, ecological and economic importance. Transition to land habit, Alternation of Generations, Origin of Bryophytes. General characteristics with special reference to reproductive structure: *Riccia, Marchantia* and *Funaria*.

MODULE-4: Pteridophytes: General characteristic features, differences among fern and non-fern plants, ecological and economic importance. Sporophytic characteristics of *Lycopodium, Selaginella* and *Marsilea*.

Topic content of PRACTICAL part [01Credit] (Teaching hour = 15)

[1] **Algae**: Simple workout of - *Nostoc* sp., *Oedogonium* sp., *Chara* sp., *Polysiphonia* sp.

[2] **Fungi**: Simple workout of- *Penicillium* sp., *Rhizopus* sp., *Ascobolus* sp. *Agaricus* sp,

[3] **Lichen**: Identification of types- Crustose, Foliose, and Fruticose.

[4] **Bryophytes**: Identification of- *Riccia* sp., *Marchantia* sp., *Funaria* sp.

[5] **Pteridophytes**: Identification of- *Lycopodium* sp., *Selaginella* sp., *Marsilea* sp. [Identification with emphasis on reproductive structure]

Practical Marks Distribution
Major Course- BOT-DC-MJ-101
Duration: 3 hours

Sl No	Description	Marks
1.	**Workout of Algae** or **Fungi -** Slide-02, Drawing and Labelling- 02, Comment- 03, Identification (Genus only)- 1	08
2	**Identification (Algae/Fungi, Lichen, Bryophytes and Pteridophytes)** (Comment- 1, Identification-1) X 4 specimen	08
3	**Submission** (lab note book, lab work records, excursion copy etc) (1+1)	02
4	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Bold, H.C. & Wynne, M.J	Introduction to Algae: Structure & Reproduction		Prentice Hall
Ganguly, H.C. &Kar, A.K	College Botany Vol.-II		New Central Book Agency
Hoek, C., Mann, D.G. & Jahns, H.M.	Algae. An Introduction to Phycology		Cambridge Univ. Press
Alexopoulos, C.J., Mims, C.W., Blackwell, M.	Introductory Mycology	1996	John Wiley & Sons (Asia) Singapore.
Webster, J. and Weber, R.	Introduction to Fungi	2007	Cambridge University Press, Cambridge.
Sethi, I.K. and Walia, S.K.	Text book of Fungi and Their Allies	2011	Macmillan Publishers India Ltd
Kershaw, K.A.	Physiological ecology of Lichens,	1985	Cambridge University Press, Cambridge
Smith, G.M	Cryptogamic Botany Vol. 1		McGraw-Hill
Puri, P	Bryophyte		Atmaram& Sons Publishers
Rashid, A	An Introduction to Bryophyta		Vikas Publishing House
Vashistha, P.C., Sinha, A.K., Kumar, A.	Pteridophyta.	2010	S. Chand. Delhi, India

SEMESTER-II

Semester	Major Core (MJ)	Multidisciplinary (MDC)	Minor Core (MN)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship / Apprenticeship / Project/ Community outreach (IAPWC)(2)	Value addition Course (VAC)	Total Credits
II	DC-MJ-201 (4)	MDC-201 (3)	IDC/DC-MN-201 (4)	MIL -2 (2)	SEC-201 (3)	(IAPWC-201) (2)	(VAC-201) (2) Choose one from a pool of courses	**20**

N.B. Figures in brackets indicate the credit points.

Major Course / BOT-DC-MJ-201:
Diversity of Phanerogams
[4 credits]

Topic content of THEORY part [03Credits] FM=30 (Teaching hour = 45)

Course Objective:

- Study and compare different groups of Gymnosperms and Angiosperms and their distribution in India.
- Know about the economic and ecological importance of Gymnosperms and Angiosperms.
- To study the morphological details of Angiosperms, including pollen types
- Study Plant nomenclature and contributions of eminent botanists worldwide.

Course Outcome: After completing this course, students will be able to:

CO1: Recognise and categorise Gymnosperms and Angiosperms

CO2: Understand the ecological and economic roles of Gymnosperms

CO3: Comprehend distinguishing morphological traits of Angiosperms, including pollen types

CO4: Get inspiration from the works of eminent botanists and their contributions to science

The detailed course contents

MODULE-1: Gymnosperms: General characteristic features, difference between cycads and conifers, distribution in India, ecological and economic importance. (wood character with special reference to timber)

MODULE-2: Angiosperms: General characteristic features, difference between dicots and monocots, plant forms- herbs, shrubs, trees & climbers, ecological and economic importance (with special reference to food crops).

MODULE-3: Morphology of Angiosperms: General structures, types and functions of- Leaf: Different parts, types and example; Margin, Apex, Surface, Base and Texture of Lamina: Different types and example; Stipule: Different types with modifications and examples; Stem: Types, functions and characteristics; Different forms of stem; Surface and nature of stem, Root: Types, Function; Flower: Floral Part, adhesion- cohesion (Basic concept with examples), and Fruits: structure, types (Basic concept with examples). Pollen grains with types.

MODULE-4: Plant Nomenclature: Brief idea of binomial nomenclature. Fundamentals of ICBN. **Contribution of Eminent Botanists**: Carl Linneaus, Gregor Johann Mendel, Charles Darwin, James D. Watson & Francis Crick, N.I. Vavilov, Jagadish Chandra Bose, Birbal Sahni, Janaki Ammal, Panchanan Maheswari, M.S. Swaminathan, Arun Kumar Sharma, E.J. Butler.

Topic content of PRACTICAL part [01Credit] (Teaching hour = 15)

1. **Gymnosperms:** Identification of male and female reproductive structures of *Cycas* sp. and *Pinus* sp., Wood characters-manoxylic and pycnoxylic.
2. **Angiosperms:** To study phyllotaxy & variations in leaf venations in dicots and monocots (at least two specimens each), Identification of inflorescence types –cymose and racemose; (basic concept with various examples).
3. **Identification** of fruit types- drupe, pepo, berry, caryopsis, and lomentum.
4. **Dissection of Flower-** *Hibiscus* sp., *Catharanthus* sp., *Sida* sp., *Solanum* sp., *Leucas* sp.,
5. Identification of pollen grains (porate, colpate, colporate)

Practical Marks Distribution
Major Course- BOT-DC-MJ-201
Duration: 3 hours

Sl No	Description	Marks
1	**Workout of floral parts,** Dissection-02, Drawing and Labelling- 03, Comment- 02, Identification (Genus only)-1	08
2	**Identification** (Gymnosperms, Morphology of Angiosperms) (Comment- 1, Identification 1) 2 x 2= 4 specimens	08
3	**Submission** (lab note book, lab work records, excursion copy etc) (1+1)	02
4	**Viva-voce**	02
	Total	**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R.	Biology	2005	Tata McGraw Hill, Delhi.
Vasishta, P.C	Gymnosperms		S. Chand & Co.
Mukherjee, S	College Botany Vol. III		New Central Book Agency
Mitra, D., Guha, J. & Chowdhury, S.K	Studies in Botany, Vol. I		Moulik Library
Heywood, V.H	Flowering Plants of India		Oxford University Press
Bhatnagar, S.P. & Moitra, A.	Gymnosperms	**1996**	New Age International (P) Ltd Publishers, New Delhi, India.

SEMESTER-III

Semester	Major Core (MJ)	Multi disciplinary (MDC)	Minor Core (MN)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship / Apprenticeship / Project/ Community outreach (IAPWC)(2)	Value addition Course (VAC)	Total Credits
III	DC-MJ-301 (4) DC-MJ-302 (4)	MDC-301 (3)	IDC/DC-MN-301 (4)	English Language-1 (2)	SEC-301 (3)	(IAPWC-301) (2)		**22**

N.B. Figures in brackets indicate the credit points.

Major Course / BOT-DC-MJ-301:

ALGAE, BRYOPHYTES, PTERIDOPHYTES AND EVOLUTION OF EARLY LAND PLANTS

[04 Credit]

Topic content of THEORY part [03 Credits] FM= 30 (Teaching hour = 45)

Course Objective:

- A detailed study of biology and life cycle patterns of the different groups of Algae, Bryophytes, Pteridophytes, and their classification.
- To understand the morphology and reproduction of certain representative genera of these cryptogams
- Know about the ecological and economic importance of algae, bryophytes, and pteridophytes.
- Detailed study of the evolution of early land plants with special reference to the habit and habitat of these plant groups

Course Outcome: After completing this course, students will be able to:

CO1: Describe the general characteristics, thallus organization, and reproductive structures of algae, bryophytes, and pteridophytes.

CO2: Differentiate different cryptogamic genera with reference to their morphological structures.

CO3: Acquire knowledge about the economic and ecological importance of cryptogams

CO4: Know about the evolution of early land plants and their impact on the environment.

The detailed course contents

ALGAE

MODULE 1: **Classification**; criteria and basis of Fritsch's classification, evolutionary classification of Lee (2008) up to the phylum, with examples. **Cyanophyta**: cell structure and function with special reference to heterocyst & akinete. Life history of – *Anabaena* sp. **Chlorophyta**: cell structure and function with special reference to chloroplast types. Life history of – *Oedogonium* sp. **Charophyta**: cell structure and function with special reference to corticated cells, globule and nucule of *Chara* sp. Life history of *Chara* sp. **Bacillariophyta (diatoms):** cell structure and function, cell division, auxospore formation in Centrales and Pennales; **Phaeophyta**: cell structure and function. Life history of *Ectocarpus* sp. **Rhodophyta**: cell structure and function with reference to phycocolloids. Life history of – *Polysiphoni*a sp.; Comparative study of different classes with special reference to structure, thallus organization, storage materials and pigments; Origin and evolution of sex.

BRYOPHYTES

MODULE 2: Adaptations to land habit; Classification (Strotler and Crandle-Strotler, 2009) up to class with diagnostic characters and examples; Range of thallus organization. Ecological and economic importance of bryophytes with special reference to *Sphagnum*. **Type Studies-** Bryophytes: Morphology, anatomy, gametophyte structure, reproduction, sporophyte development and alternation of generation of *Marchantia*, *Anthoceros, Sphagnum* and *Funaria.* **Phylogeny:** Unifying features of archaegoniates; transition to land habit, Origin of Alternation of Generations (Homologous and Antithetic theory), Evolution of Sporophytes (Progressive and Regressive concept), Origin of Bryophytes.

PTERIDOPHYTES

MODULE 3: Colonisation and rise of early land plants; Classification of vascular plants by Gifford & Foster (1989) up to division (Rhyniophyta to Filicophyta) with diagnostic characters and examples; Concept of heterospory and origin of seed habit; Apogamy, and apospory; Stelar evolution. **Type Studies-** Pteridophytes: Morphology, anatomy and reproduction of *Psilotum, Lycopodium, Selaginella, Equisetum* and *Pteris* (Developmental details not to be included).

EVOLUTION OF EARLY LAND PLANTS:

MODULE 4: Introduction and Evolutionary emergence of land plants: Evolution from thallophyta to early land plants and gradual progression from aquatic habit to land habit. Evolution and complexity of the sporophyte with special reference to the Telome theory.

Topic content of PRACTICAL part [01Credit] FM=20 (Teaching hour = 15)

A. *Algae:*

1. Preparation of semi-permanent slide using lactophenol as mounting medium and cotton blue as stain of – *Anabaena* sp., *Oedogonium* sp., *Chara* sp., *Ectocarpus* sp. & *Polysiphonia* sp. and camera lucida drawing of selected portion (reproductive structure) of thallus, mentioning proper magnification.

B. *Bryophytes:*

1. *Marchantia* sp.: Work out of Antheridiophore, Archegoniophore.
2. *Anthoceros* sp.: Dissection of sporophyte (to show stomata, spores, pseudoelaters, columella).
3. *Funaria* sp.: Longitudinal section of capsule showing operculum, peristome, annulus and spores.

C. *Pteridophytes:*

1.*Selaginella* sp. and *Lycopodium* sp.: Whole mount of strobilus, longitudinal section of strobilus.

2.*Equisetum* sp.: Longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore.

3.*Pteris* sp.: Transverse section of sporophyll, whole mount of sporangium.

D. Morphological Identification of the above-mentioned specimens of Algae, Bryophytes and Pteridophytes with major emphasis on the reproductive part.

E. Botanical Excursion or field visit to observe the habitat of Algae, Bryophytes and Pteridophytes.

Practical Marks Distribution

Major Course- BOT-DC-MJ-301

Duration: 3 hours

Sl No	Description	Marks
1	**Algae** (compulsory) Slide-01, Camera Lucida Drawing- 03, Magnification- 02, Comment- 02	08
2	**Bryophyte/ Pteridophyte** Slide- 01, Drawing and labelling- 03, Comment- 02	06
3	**Identification (2 specimen)**	02
4	**Submission** (lab note book, field record, excursion copy etc) (1+1)	02
5	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Smith, G.M.	Cryptogamic Botany Vol. 1		McGraw-Hill
Rashid, A.	An Introduction to Bryophyta		Vikas Publishing House
Vashishta, B.R	Bryophyta		S. Chand & Co.
Vashistha, P.C., Sinha, A.K., Kumar, A	Pteridophyta	**2010**	S. Chand. Delhi, India
Gifford, E.M. & Foster, A.S.	Morphology and Evolution of Vascular Plants		Freeman & Co.
Mukherjee, R.N. & Chakraborty, K.	An Introduction to Vascular Cryptogams (Pteridophytes)		Kalyani Publishers
Rashid, A.	An Introduction to Pteridophyta		Vikas Publishing House

Major Course / BOT-DC-MJ-302:
MYCOLOGY AND PLANT PATHOLOGY
[04 Credit]

Topic content of THEORY part [03 Credits] FM= 30 (Teaching hour = 45)

Course Objective:

- To provide foundational knowledge on the biology and classification of fungi and their symbiotic relationships.
- To understand the life cycle patterns of selected fungal genera and their potential in biotechnology, agriculture, and industry.
- To understand the basic concepts of plant pathology, including disease mechanisms and plant defense responses.
- To develop practical skills in identifying fungal structures and diagnosing plant diseases through lab-based observation and analysis.

Course Outcome: After completing this course, students will be able to:

CO1: Describe the structure and reproductive characteristics of fungi and their major life cycle patterns with examples.

CO2: Understand fungal symbiosis and assess their industrial and agricultural potential.

CO3: Identify major plant pathogens and analyze the infection mechanisms and plant defense responses.

CO4: Demonstrate practical skills in identifying fungal species and plant diseases using microscopic and herbarium-based techniques.

The detailed course contents

MYCOLOGY

MODULE-1: Introduction to true fungi: General characteristics; Nutrition; Thallus organization; Cell wall composition; Teleomorphic and Anamorphic; Sexual reproduction and degeneration of sex in fungi; Life Cycle Patterns; Homothallism and heterothallism; Parasexuality and sexual compatibility; Classification (Ainsworth 1973) up to subdivision diagnostic characters with examples. Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Rhizopus* sp., *Ascobolus* sp., *Agaricus* sp. and *Penicillium* sp.

MODULE-2: Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction and

ecological role. Mycorrhiza- Ectomycorrhiza, Endomycorrhiza, Significance and role in Agriculture. Applied Mycology: Role of fungi in biotechnology; Application of fungi in the food industry. Fungi as Biocontrol Agents; Mycotoxins. Industrial production of Cheese, Ethanol, Baker's yeast, Amylase, and Riboflavin.

PLANT PATHOLOGY

MODULE-3: Introduction to plant pathology; Plant pathology in India and Global perspective; Concept of Disease in Plants and Types of Diseases. Terms and definitions: Disease concept, Symptoms, Etiology, Inoculum and Infection, Pathogenesis, Disease triangle and Disease cycle (monocyclic, polycyclic and polyetic), Epidemic and Endemic, Sporadic and Pandemic Disease. Koch's postulate. Mechanism of infection (Pre-penetration, Penetration and Post-Penetration), Plant defense responses with reference to Phytoalexins and PR proteins. Signal transduction leading to SAR and ISR; Pathotoxin (Definition, criteria and example); Resistance- Systemic acquired and Induced systemic

MODULE-4: Concept of plant disease management: Quarantine, Chemical, Biological and Integrated. Concept of crop rotation. Integrated Pest Management (IPM). Symptoms, causal organisms, disease cycles, and control measures of: Bacterial diseases – Citrus canker; Viral diseases – Tobacco Mosaic Disease. Fungal diseases – Late blight of potato, Black stem rust of wheat, Brown spot of rice, and Stem rot of jute.

Topic content of PRACTICAL part [01 credit] FM=20 (Teaching hour = 15)

FUNGI

1. Study of asexual stage from temporary mounts, drawing and microscopic measurement: *Aspergillus* sp., *Rhizopus* sp., *Ascobolus* sp. *Xylaria* sp. and *Agaricus* sp.
2. Study from permanent slides: Sexual stage in *Rhizopus* sp., *Mucor* sp. colony; Conidia of *Penicillium* sp., *Aspergillus* sp.,

PLANT PATHOLOGY

1. Study from temporary mounts (Histopathology): Late Blight of Potato, Stem rot of Jute, Leaf rust of *Justicia*.
2. Study from permanent slides: Uredial, Telial, Pycnidial and Aecial stages of *Puccinia graminis;* Conidial structures of *Alternaria* sp., *Carvularia* sp., *Helminthosporium* sp., *Phytophthora* sp.

3. Herbarium specimens of viral, bacterial, fungal, and nematode diseases (at least 20 herbarium sheets or vials with field reports).
4. Botanical Excursion or field visit to observe the phytopathological specimens.

Practical Marks Distribution
Major Course- BOT-DC-MJ-302
Duration: 3 hours

Sl No	Description	Marks
1.	**Fungi Workout:** Slide-02, standardization and spore measurement - 03, drawing- 01, Comment- 02	**08**
2	**Pathology Workout:** Slide- 02, Drawing and labelling- 02, Comment- 02	**06**
3	**Identification:** 2 specimens	**02**
4	**Submission:** Lab note book, field record, excursion copy etc (1+1)	**02**
5	**Viva-voce**	**02**
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Alexopoulos, C.J., Mims, C.W., Blackwell, M.	Introductory Mycology,	**1996**	John Wiley & Sons (Asia) Singapore. 4th edition
Webster, J. and Weber, R.	Introduction to Fungi	**2007**	Cambridge University Press, Cambridge. 3rd edition.
Sethi, I.K. and Walia, S.K.	Text book of Fungi and Their Allies,	**2011**	Macmillan Publishers India Ltd.
Kershaw, K.A.	Physiological ecology of lichens	**1985**	Cambridge University Press, Cambridge.
Seaward, M.R.D.	Lichen Ecology	**1977**	Academic Press, London.
Sharma, P.D.	Plant Pathology	**2011**	Rastogi Publication, Meerut, India.
Agrios, G.N.	Plant Pathology, 4th edition,	**1997**	Academic Press, U.K.

SEMESTER-IV

Semester	Major Core (MJ)	Multidisciplinary (MDC)	Minor Core (MN)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship / Apprenticeship / Project/ Community outreach (IAPWC) (2)	Value Addition Course (VAC)	Total Credits
IV	DC-MJ-401 (4) DC-MJ-402 (4) DC-MJ-403 (4)		IDC/DC-MN-401 (4)	English Language-2 (2)			(VAC-301) (2) Choose one from a pool of courses	**20**
Students on exit shall be awarded an Undergraduate Diploma (in the Field of Study/Discipline) after securing the requisite 82 credits in Semester IV								

N.B. Figures in brackets indicate the credit points.

Major Course / BOT-DC-MJ-401:
GYMNOSPERMS AND PALEOBOTANY
[04 Credit]

Topic content of THEORY part [03 Credits] FM=30 (Teaching hour = 45)

Course Objective:

- To learn the life cycles of selected individuals of gymnosperms.
- To compare various organisms based on morphology and reproduction
- To recognize the geological time periods and the types of fossils

Course Outcome: After completing this course**,** the students will be able to -

CO1: Understand the plant group gymnosperm and their importance

CO2: Understand the morphology, anatomy, and reproduction of Gymnosperms

CO3: Recognize the geological time periods and learn about the different methods of fossilization.

CO4: Characterize different types of fossils and identify them.

The detailed course contents

GYMNOSPERMS

MODULE-1: General characters and classification by Stewart and Rothwell, 1993 (up to order); Ecological and economic importance of Gymnosperms with reference to Wood, Resins, Essential oils, and Drugs

MODULE-2: Vegetative morphology, anatomy and reproductive structures, development of gametophytes and embryogeny of *Cycas* sp., *Pinus* sp. and *Gnetum* sp.

PALEOBOTANY

MODULE-3: Fossil: types and modes of preservation (Schopf, 1975), conditions of preservations, fossilization process; Geological time scale and major events of plant life through geological ages; Plant Fossil: Types: Body fossil (Micro- and Megafossils), Trace fossil, Chemical fossil, Index fossil; Nomenclature and Reconstruction, Principle of fossil dating (a brief idea).

MODULE-4: Gondwana – an overview of Indian Gondwana flora. Importance of study of fossils; Fossil Pteridophytes:Structural features, Geological distribution and Evolutionary significance of - *Rhynia*, *Lepidodendron* (Reconstructed) and *Calamites* (Reconstructed); Fossil gymnosperms: Structural features and Geological distribution of reconstructed genera: *Lyginopteris*, *Williamsonia* and *Cordaites*.

Topic content of PRACTICAL part FM=20 [01 Credit]

GYMNOSPERMS:

1. Anatomical study of the leaflet of *Cycas* sp. and *Pinus* sp. needle.
2. Morphological studies of the reproductive structure of the genera mentioned in the theoretical syllabus. *Cycas* sp. (Megasporophyll and Microsporophyll), *Pinus* sp.- (male and female cones), *Gnetum* sp. (male and female cones)

PALEOBOTANY:

1. Morphological study: *Glossopteris* sp. leaf fossils, *Ptilophyllum* sp.
2. Study from permanent slides/micrograph: T.S. of stem of *Lepidodendron* sp., *Calamites* sp., *Lyginopteris* sp.
3. **Botanical excursion:** Enlistment of plants observed in the field and submission of field note books with 10-25 photographs.

Practical Marks Distribution

Major Course- BOT-DC-MJ-401

Duration: 3 hours

Sl No	Description	Marks
1.	**Gymnosperm Workout:** Slide-02, Drawing and labelling- 03, Comment- 03	08
2	**Identification (4 specimens) (2 marks each)**	08
3	**Submission:** Lab note book, field record, excursion copy etc (1+1)	02
4	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Bhatnagar, S.P. & Moitra, A.	Gymnosperms.	**1996**	New Age International
Vasishta, P.C	Gymnosperms		S. Chand & Co.
Bhatnagar, S.P. & Moitra, A.	Gymnosperms		New Age International
Arnold, C.R	An Introduction to Paleobotany		Agrobios India
Andrews, Jr. H.N.	Studies in Paleobotany		John Wiley & Sons Inc.
Agashe, S.N.	Palaeobotany		Oxford & IBH
Meyen, S.V.	Fundamentals of Paleobotany		Chapman & Hall

Major Course / BOT-DC-MJ-402:
PLANT MORPHOLOGY AND PLANT ANATOMY
[04 Credit]

Topic content of THEORY part [03 Credits] FM=30 (Teaching hour = 45)

Course Objective:

- Detailed study of morphological characters of Angiosperms and their application in modern taxonomy
- To understand reproduction mechanisms in plants with special reference to flower, floral parts, and fruit types and their dispersal.
- To study the anatomical features and tissue organisation in plants and their classification.
- To study different types of secondary growth in plants and the classification and function of the plant tissue system.

Course Outcome: After completing this course, students will be able to:

CO1: Will be able to characterise Angiosperms based on their morphology

CO2: Understand the reproduction mechanisms in Angiosperms and its different aspects

CO3: Will be able to characterize and recognize different tissue organizations in plants

CO4: Demonstrate practical skills in characterizing different types of tissues and recognise different types of secondary growth and their relevance in plant anatomy

The detailed course contents

PLANT MORPHOLOGY

MODULE-1: Introduction to angiospermic morphology, Palynology, scope and applications in systematics, forensic and pharmacognosy. **Venation:** Different types and example; **Phyllotaxy:** Different types and example; ligule and auricle; modifications of leaves; Modifications of roots; Modifications of stem; Branching: types. **Homology and Analogy:** Concept and its role in plant function with special reference to defense mechanism.

MODULE-2: Inflorescence: Definition and different types with examples; **Flower:** Concept of flower; Types, Parts of a flower and their modifications, appendages and forms (whichever is applicable); Flower as a modified shoot; Insertion of floral leaves on thalamus; **Aestivation:** types with examples; **Androecium:** attachment of anther to the filaments, Dehiscence of anther, relative length of the

filament; **Gynoecium:** types, parts of carpels; **Placenta and Placentation:** types with examples; floral formulae, floral diagram; adhesion and cohesion of floral parts. **Ovule:** Definition, structure types with example. **Fruits and Seeds:** Definition and types with examples. Dispersal of fruits and seeds.

PLANT ANATOMY

MODULE-3: Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy**. Structure and Tissue System:** Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall in growths and transfercells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts, and laticifers. **Apical meristems:** Meristematic and permanent tissues: Organization of shoot apex (Tunica-corpus concept) and organization of root apex (Korper-Kappe concepts); Structure of dicot and monocot leaf, Kranz anatomy. Structure of Xylem and Phloem tissue; Vascular bundle -types and function. Root-Stem transition and its significance.

MODULE-4: Vascular Cambium and Wood: Basic concepts of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Normal and Anomalous secondary growth (citing examples of *Dracaena* sp. stem, *Bignonia* sp.stem, *Tinospora* sp.root, Orchid root), different types of wood. Concept and application of Dendrochronology. **Adaptive and Protective Systems:** Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Anatomical adaptations of xerophytes and hydrophytes.

Topic content of PRACTICAL part FM=20 [01 Credit]

PLANT MORPHOLOGY:

A. **Morphological studies** (No working out):

a) Different types of phyllotaxy in plants;
b) Types of special inflorescence;
c) Aestivations,
d) Anther types
e) Placentation;
f) Different types of fruits- Drupe, Fibrous Drupe, Berry, Pepo, Pome, Hesperidium, Syconus, Sorosis, Caryopsis, Cremocarp, Lomentum.

PLANT ANATOMY:

1. Study of anatomical details through permanent slides/temporary stain mounts/museum specimens/micrographs with the help of suitable examples: Apical meristem of root, shoot and vascular cambium. Xylem: Tracheary elements-tracheids, vessel elements; perforation plates; xylem fibres; Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
2. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
3. Root: monocot, dicot, secondary growth.
4. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
5. Anomalous growth (*Dracaena* sp.stem, *Bignonia* sp.stem, *Tinospora* sp.root, Orchid root).
6. Secretory tissues: cavities, lithocysts and laticifers.
7. Study of morpho-anatomical adaptations of hydrophytes and xerophytes.
    a. **Hydrophyte:** *Eichhornia* sp.*, Nymphaea* sp.*, Hydrilla* sp.
    b. **Xerophyte:** *Nerium* sp.*, Casuarina* sp.*, Opuntia* sp.*, Euphorbia tirucauli*.

Practical Marks Distribution

Major Course- BOT-DC-MJ-402

Duration: 3 hours

Sl No	Description	Marks
1.	**Workout from Plant Anatomy:** Slide-02, Drawing and Labelling- 03, Comment- 03	08
2	**Identification: (**Morphology- 3 specimen, Anatomy 1 specimen) (Reason-1, Identification-1) x 4	08
3	**Submission:** Lab note book, class records, slides etc (1+1)	02
4	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Dickison, W.C.	Integrative Plant Anatomy.	2000	Harcourt Academic Press,
Fahn, A	Plant Anatomy.	1974	Pergamon Press, USA.
Mauseth, J.D.	Plant Anatomy	1988	The Benjamin /Cummings Publisher, USA.
Evert, R.F.	Plant Anatomy:	2006	John Wiley and Sons
Eames, A.J.	Morphology of Angiosperms		McGraw-Hill
Ganguly, H.C. & Kar, A.K.	College Botany Vol. I		New Central Book Agency
Lawrence, G.H.M.	Taxonomy of Vascular Plants		Oxford & IBH
Datta, S.C.	Systematic Botany		Wiley Eastern
Mukherjee, S.	College Botany Vol. III		New Central Book Agency
Mitra, D., Guha, J. & Chowdhury, S.K	Studies in Botany, Vol. I		Moulik Library

Major Course / BOT-DC-MJ-403:
SYSTEMATICS OF ANGIOSPERMS
[04 Credit]

Topic content of THEORY part [03 Credits] FM=30 (Teaching hour = 45)

Course Objective:

- A detailed study of the concept of plant systematics and its significance in plant classification and taxonomy
- To study the principles of ICN and its relevance in plant taxonomy and nomenclature.
- Detailed study of the various concepts of classification of plants with special reference to artificial, natural, and phylogenetic classification.
- To learn the technique of herbarium preparation and documentation, and to study in detail a few angiospermic genera and their identification using taxonomic keys.

Course Outcome: After completing this course, students will be able to:

CO1: Acquire knowledge about plant systematics, plant taxonomy, and nomenclature of Angiosperms.

CO2: Gain knowledge regarding the basic concepts of taxonomic hierarchy and ICN in angiospermic taxonomy.

CO3: Know about the significance of herbarium, documentation and publication for plant nomenclature.

CO4: Characterize and identify some representative genera of Angiosperms based on taxonomic keys.

The detailed course contents

SYSTEMATICS OF ANGIOSPERMS

MODULE-1: Significance of Plant systematics: Introduction to systematics; Plant identification, Classification, Nomenclature. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys.

MODULE-2: Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

MODULE-3: Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Outline of classification systems of Linnaeus (1753), Bentham and Hooker (1862-1883) upto series and brief reference of Angiosperm Phylogeny Group (APG III) classification. Biometrics, numerical taxonomy and cladistics: Characters; Variations; OTUs, character weighting and coding.

MODULE-4: Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). **Diagnostic features of Families: Dicotyledons-** Ranunculaceae, Brassicaceae, Malvaceae, Leguminosae (*sensu-lato*), Apocynaceae,

Solanaceae, Lamiaceae, Cucurbitaceae, Rubiaceae, Euphorbiaceae, Asteraceae. **Monocotyledons**: Alismataceae, Poaceae, Zingiberaceae, and Orchidaceae.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

SYSTEMATICS OF ANGIOSPERMS

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):
    a. Brassicaceae- *Brassica* sp*, Iberis* sp.
    b. Malvaceae- *Sida* sp*, / Urena* sp.
    c. Leguminosae (sensu lato)- *Cassia* sp., *Crotalaria* sp.
    d. Apocynaceae – *Catharanthus* sp.
    e. Solanaceae- *Solanum* sp, *Physalis* sp*., Nicotiana* sp.
    f. Lamiaceae- *Ocimum* sp*., Leucas* sp*., Leonurus* sp.
    g. Rubiaceae: *Dentella* sp., *Oldenlandia* sp., *Spermacoce* sp.
    h. Euphorbiaceae: *Jatropha* sp, *Croton* sp*., Acalypha* sp.
2. Mounting of a properly dried and pressed specimen of at least 25 collected Angiospermic plants with herbarium label and arranged according to Bentham and Hooker's system of classification.
3. **Botanical Excursion:** Enlistment of plants observed in the field and submission of a field notebook with 10-15 photographs with ecological notes on the plants observed.

Practical Marks Distribution
Major Course- BOT-DC-MJ-403
Duration: 3 hours

Sl No	Description	Marks
1.	**Workout of Angiospermic flower:** Floral part dissection-02, Drawing- 03, Description- 03, Study of bengal plant- 02	10
2	**Identification (2 specimens)** (1 Monocot and 1 dicot)	04
3	**Herbarium submission**	02
4	**Submission** (lab note book, field record, excursion copy etc) (1+1)	02
5	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Mitra, D., Guha, J. & Chowdhury, S.K	Studies in Botany, Vol. I		Moulik Library
Naik, V.N.	Taxonomy of Angiosperms		Tata McGraw Hill
Heywood, V.H.	Flowering Plants of India		Oxford University Press
Stace, C.A.	Plant Taxonomy and Biosystematics		Arnold Publishers
Prain, D.	Bengal Plants Vol. I & II		Bishen Singh, Mahendra Pal Singh
Sivarajan, V.V.	Introduction to Principles of Plant Taxonomy		Oxford & IBH

SEMESTER-V

Semester	Major Core (MC)/DSE	Minor Core (MnC)	Total Credits
V	DC-MJ-501 (4) DC-MJ-502 (4) DC-MJ-503 (4) DC-MJ-504 (4)	IDC/DC-MN-501 (4)	**20**
Students who wish to discontinue after the 3-year UG Programme will be awarded a UG Degree in the Major discipline after successful completion of three years, earning a minimum of 122 credits on completion of Semester VI			

N.B. Figures within the bracket indicate the credit points.

Major Course / BOT-DC-MJ-501 or MC 8:
CELL BIOLOGY AND GENETICS
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- Detailed study of prokaryotic and eukaryotic cells with special reference to the cell wall characteristics, cell organelles, cytoskeleton, and their function.
- Detailed study of the mitotic and meiotic cell division and its importance.
- To study the important aspects of genetics with special reference to the concepts of inheritance, ploidy level, mutation, and linkage.
- To understand the concepts of extrachromosomal inheritance, evolutionary genetics, genetic variation, and speciation.

Course Outcome: After completing this course, students will be able to:

CO1: Acquire knowledge about the characteristics of eukaryotic and prokaryotic cell structure and characterize various cell organelles.

CO2: Gain detailed knowledge of meiotic and mitotic cell division and its importance in plant growth and reproduction.

CO3: Know about the various factors of cell division with special reference to gene, mutation, dominance, ploidy, linkage etc.

CO4: Learn the concepts of extrachromosomal inheritance and evolutionary genetics and factors leading to genetic variation and speciation

The detailed course contents

CELL BIOLOGY

MODULE-1: The cell: Cell as a unit of structure and function, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). **Cell wall and membrane:** Plant cell wall; Plasma membrane, Chemical composition of membranes, Models of membrane structure (fluid mosaic model), Membrane transport: – Passive, active and facilitated transport, endocytosis and exocytosis.

MODULE-2: Cell organelles (structure and function): Nucleus: Structure of nuclear envelope, nuclear pore complex, nuclear lamina, molecular organisation of chromatin, nucleolus;Chloroplast, mitochondria, and peroxisome: Structural organization, functions, semiautonomous nature of chloroplast and mitochondria; Endomembrane system: Endoplasmic Reticulum– Structure**,** targeting, and insertion of proteins in the ER, Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus - organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes; **Cytoskeleton:** microtubules, microfilaments and intermediary filament. **Cell division:** Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle check points, role of protein kinases.

GENETICS

MODULE-3: Mendelian genetics and its extension: Mendelism: Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits. Linkage, crossing over, and chromosome mapping: Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two-factor and three-factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

MODULE-4: Extrachromosomal Inheritance: Basic concepts with examples in chloroplasts and mitochondria. Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy; Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical; Detection of mutations: ClB method. Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

CELL BIOLOGY

1. Study of plant cell structure with the help of epidermal peel mount of *Allium/Rhoeo/Crinum*
2. Chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, and Preparation of permanent slides. Study of Mitotic Chromosomes: Metaphase chromosome preparation, freehand drawing, determination of 2n number, and comment on the chromosome morphology of *Allium cepa.*
3. Determination of mitotic index in pre-fixed root tips of *Allium cepa.*
4. Identification of cell organelles with the help of electron micrographs (Chloroplast, ER, Golgi Apparatus); Stages of cell division from permanent slide or electron micrographs.

GENETICS

- Preparation of permanent slides. Study of meiotic chromosomes: Smear preparation of meiotic cells, identification of different stages and freehand drawing from flower buds: *Allium cepa*.
- Identification from permanent slides: Meiosis – (i) normal stages (ii) abnormal stages- laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*)

Major Course- BOT-DC-MJ-501

Duration: 3 hours

Sl No	Description	Marks
1	**Cytology Workout (Metaphase Chromosome / Mitotic index)** Slide-02, Drawing- 01, Observation- 02, Calculation- 03, Comment- 02	10
2	**Genetics Workout** Slide- 01, Drawing and labelling- 02, Comment- 01	04
3	**Identification (1 specimen)**	02
4	**Submission** (lab note book, slides etc) (1+1)	02
5	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Cooper, G.M.	The Cell - A Molecular Approach		ASM Press
Karp, G	Cell and Molecular Biology: Concepts and Experiments		John Wiley & Sons. Inc
Powar, C.B.	Cell Biology		Himalaya Publishing House
Verma, P.S. & Agarwal, V.K.	Concept of Cell Biology		S. Chand & Co.
Hardin, J., Becker, G., Sklien Smith, L.J.	Becker's World of the Cell	2012	Pearson Education Inc. U.S.A. 8th edition
Allard, R.W.	Principles of Plant Breeding		John Wiley
Chawdhuri, H.K.	Elementary Principles of Plant Breeding		Oxford & IBH
Poehlman, J.M. & Barthakur, D.	Plant Breeding		Oxford & IBH
Singh, B.D.	Plant Breeding: Principles and Methods		Kalyani Publishers
Gardner, E.J., Simmons, M.J. & Snustad, D.P	Principles of Genetics		John Wiley
Gupta, P.K.	Genetics		Rastogi Publications
Klug, W.S. & Cummings, M.R.	Concept of Genetics		Prentice Hall
Lewin, B.	Genes (any one: - VI or VII or VIII or IX)		Oxford University Press
Russell, P.J.	Genetics		Benjamin / Cumming Publ. Co.
Stent, G.S. & Calendar, R.	Molecular Genetics-An Introductory Narrative		CBS
Stickberger, M.W.	Genetics		Mc.Millan

Major Course / BOT-DC-MJ-502 or MC 9:
PLANT BREEDING AND BIOSTATISTICS
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- To understand the selection criteria and methods for breeding new crop varieties
- To demonstrate proficiency in classical and modern plant breeding techniques
- To understand the basic concepts and principles of biostatistics
- To learn about probability, statistical distributions, and hypothesis testing

Course Outcome: After completing this course, students will be able to:

CO1: Understand the concept of using different methods in plant breeding for crop improvement.

CO2: Understand the advantages and limitations of different breeding techniques

CO3: Understand the basic concepts of biostatistics and sampling methods

CO4: Compare the significant differences in 2 or more samples using statistical analysis and analyze various Mendel's laws of inheritance.

The detailed course contents

PLANT BREEDING

MODULE-1: Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding. Basic concept of plant breeding, significance, and role in crop improvement. Green Revolution (History, Basic concepts, and significance). Seed bank, Gene Bank, Germplasm, Importance, and role in Plant Breeding.

MODULE-2: Selection methods in plant breeding for self-pollinated, cross-pollinated and vegetatively propagated plants; Mass Selection, Pure-line Selection, Pedigree Selection, Bulk Selection, and hybridization. Outline idea about Male sterility, Inbreeding depression and heterosis: History, genetic basis of inbreeding depression and heterosis; Hybrid Vigor. Quantitative inheritance: Concept, mechanism Monogenic vs polygenic Inheritance.Crop improvement and breeding: Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

BIOSTATISTICS

MODULE-3: Introduction to Biostatistics: Characteristics, Usefulness and Limitations, Types of Data. Sampling methods: concept of sampling of population, measures of central tendency and dispersal: determination of mean, mode, median, variance, standard deviation, and standard error.

MODULE-4: Rules of probability (Addition and Multiplication theorems), Null-hypothesis, Tests of significance: chi-square test, t-test (student and paired t-test). Correlation and Regression.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

PLANT BREEDING

1. Study of germplasm.
2. Study of the floral structure of self-pollinated and cross-pollinated crops.
3. Demonstration of Emasculation and hybridization techniques in self- and cross-pollinated crops.
4. Artificial pollination in self-pollinated crops (any one crop).

BIOSTATISTICS

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
2. Chi-square analysis through Complete and Incomplete dominance and gene interaction through seed ratios (9:7, 1:1, 3:1, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4, 9:3:3:1).
3. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation, and standard error (using seedling population/leaflet size) with special emphasis on grouped data in classes.

Practical Marks Distribution
Major Course- BOT-DC-MJ-502
Duration: 3 hours

Sl No	Description	Marks
1.	**Biostatistics (Chi-square OR Mean, Standard Deviation Standard Error)** **Chi-square-** Observation-02, Calculation- 05, Comment- 03 **Mean, SD, SE-** Observation- 04, Calculation- 04, Comment- 02	10
2	**Demonstration of Emasculation** up to Tagging	06
3	**Submission**	02
4	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Allard, R.W.	Principles of Plant Breeding		John Wiley
Chawdhuri, H.K.	Elementary Principles of Plant Breeding		Oxford & IBH
Poehlman, J.M. & Barthakur, D.	Plant Breeding		Oxford & IBH
Singh, B.D.	Plant Breeding: Principles and Methods		Kalyani Publishers
Sokal, R.R. & Rohlf, F.J.	Introduction to Biostatistics		W H Freeman
P K Banerjee	Introduction to Biostatistics		S. Chand

Major Course / BOT-DC-MJ-503 or MC 10:
PHARMACOGNOSY
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- To understand Pharmacognosy and its importance in modern medicine with reference to Ayurveda, Siddha and Unani medicine systems
- To study the different aspects of Drug Classification, evaluation and bioassay
- A detailed study of the different types of secondary metabolites and active constituents in few important medicinal plants of India
- To understand the importance of conservation of medicinal plants with respect to *in-situ* and *ex-situ* modes of conservation

Course Outcome: After completing this course, students will be able to:

CO1: Understand the importance of Ayurveda, Siddha and Unani medicine and their relevance in modern medicine

CO2: Classify crude drugs and evaluate them using various bioassay techniques.

CO3: Recognise different types of active constituents in few important medicinal plants of India

CO4: Will be able to learn isolation and estimation techniques to characterise crude drugs from common plants.

The detailed course contents

PHARMACOGNOSY

MODULE-1: General account: Pharmacognosy and its importance in modern medicine. History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences: Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu, and tridosha concepts, Rasayana, plants used in Ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e-tabiya, tumors treatments or therapy, polyherbal formulations.

MODULE-2: Plants use:s a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. Concept of Drug, Crude drugs; Pharmacological and chemical classification of drugs; Drug evaluations - (Definitions with examples of the following) - organoleptic, microscopic, chemical and physical evaluation. Bioassay of a drug: definition and examples.

MODULE-3: Secondary metabolites of plants: Definitions of, and differences between, Primary and Secondary Metabolites; secondary metabolites and plant protection; Utilization of major types of metabolites as drug - phenolics & quinones, terpenoids, flavonoids, and alkaloids. Plant hormones and their applications. **Active constituents:** Source plants, parts used, chemical nature & uses of the following- Glycosidic anthraquinone (Barbaloin); Tannic acid derivative (Catechin); Resins (Curcuminoids); Steroids (Diosgenin, Digitoxin); Alkaloids (Caffeine, Quinine, Reserpine).

MODULE-4: Major pharmacological groups of plant drugs and their uses. Factors influencing the cultivation of medicinal plants. Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; *In situ* conservation: Biosphere reserves, sacred groves, National Parks; *Ex situ* conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

PHARMACOGNOSY

1. Microscopic evaluation of powder drugs (*Adhatoda vasica* leaf powder; *Hollarhena* bark).
2. Histochemical tests for starch in non-lignified vessels (*Zingiber* sp.) and alkaloids (stem of *Catharanthus* sp.).

3. Qualitative estimation of Tannin (*Camellia sinensis / Terminalia chebula*), Alkaloid (*Catharanthus roseus / Hollarhena* bark)
4. **Botanical excursion:** Field visit to plantation sites/fields to familiarize students with cultivation practices and submission of collected specimens (minimum of 10 specimens with proper documents and identification of plants with pharmacological importance).

Practical Marks Distribution

Major Course- BOT-DC-MJ-503

Duration: 3 hours

Sl No	Description	Marks
1	**Qualitative Estimation** Principle-02, Requirement- 02, Procedure & Observation- 02, Comment- 02	08
2	**Histopathological/ Organoleptic study** Slide- 02, Drawing and labelling- 03, Observation & Comment- 02	07
3	**Submission** (lab note book, field record etc) (2+1)	03
4	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Beckett, A.H.	Practical Pharmaceutical Chemistry		CBS Publishers
Evans, W.C	Pharmacognosy		Saunders
Melentyeva, G. & Antonova, L.	Pharmaceutical Chemistry		MIR Publishers
Wallis, T.E.	Text Book of Pharmacognosy		CBS Publishers

Major Course / BOT-DC-MJ-504 or MC 11:
PLANT BIOCHEMISTRY
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- To understand the chemistry and function of different biomolecules.
- To understand the chemical nature, class, and function of Carbohydrates, Lipids, Proteins, and Nucleic acids.
- To acquire knowledge about the concepts of bioenergetics and its relevance in chemical reactions of biomolecules.
- Detailed study of Enzyme structure and classification, and theories related to enzyme actions.

Course Outcome: After completing this course, students will be able to:

CO1: Know about the various chemical bonds of biomolecules and their interactions.

CO2: Acquire knowledge about the various biomolecules like carbohydrates, fats, and proteins with special emphasis on the chemical structure, classification, and function.

CO3: Will be able to know the structure and classification of DNA and RNA.

CO4: Gain knowledge about the bioenergetics and classification and importance of enzymes

The detailed course contents

PLANT BIOCHEMISTRY

MODULE-1: Biomolecules: Types and significance of chemical bonds (Covalent, non-covalent & hydrogen bonds, van der Waals interactions); Structure and properties of water; pH and buffers. **Carbohydrates:** Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

MODULE-2: Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; saturated and unsaturated fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides. **Proteins:** Structure of amino acids and classification; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.

MODULE-3: Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA. **Bioenergenetics:** Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule.

MODULE-4: Enzymes: Definition, Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), Michaelis-Menten equation, enzyme inhibition and factors affecting enzyme activity.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

PLANT BIOCHEMISTRY

1. Detection of the nature of carbohydrate- glucose, fructose, and starch from laboratory samples.
2. Estimation of amino-nitrogen in an amino acid (glycine) by formol titration method.
3. Estimation of glucose by Benedict's quantitative reagent.
4. Estimation of titrable acidity from lemon.
5. Estimation of catalase activity in plant samples.
6. Estimation of urease activity in plant samples.
7. Colorimetric estimation of protein using Folin-Ciocalteau phenol reagent.

Practical Marks Distribution

Major Course- BOT-DC-MJ-504

Duration: 3 hours

Sl No	Description	Marks
1	**Workout (Quantitative):** Principle- 02, Requisition- 02, Observation & Calculation- 04, Comment- 02	10
2	**Workout (Qualitative):** General Test- 02, Confirmatory Test- 02, Comment- 02	06
3	**Submission:** Lab note book	02
4	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Berg, J.M., Tymoczko, J.L. & Stryer, L	Biochemistry		Freeman Publ.
Conn, E.E., Stumpf, P.K., Bruening, G. & Doi, R.H	Outlines of Biochemistry		John Wiley
Elliot, W.H. & Elliot, D.C.	Biochemistry and Molecular Biology		Oxford University Press
Goodwin, T.W. & Mercer, E.I.	Introduction to Plant Biochemistry		Oxford: Pergamon
Lea, P.J. & Leegwood, R.C.	Plant Biochemistry and Molecular Biology		John Wiley
Lehninger, A.L., Nelson, D.L. & Cox, M.M.	Principles of Biochemistry		CBS
Verma, S.K	A Text book of Plant Physiology & Biochemistry		S. Chand & Co.
Voet, D. & Voet, J.G.	Biochemistry		John Wiley

SEMESTER-VI

Semester	Major Core (MC)/DSE	Minor Core (MnC)	Total Credits
VI	DC-MJ-601 (4) DC-MJ-602 (4) DC-MJ-603 (4) DC-MJ-604 (4)	IDC/DC-MN-601 (4)	**20**
Students who wish to discontinue after the 3-year UG Programme will be awarded a UG Degree in the Major discipline after successful completion of three years, earning a minimum of 122 credits on completion of Semester VI			

Major Course / BOT-DC-MJ-601 or MC 12:
MICROBIOLOGY AND VIROLOGY
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- To introduce the microbial world, including bacterial types, structure, and growth characteristics.
- To understand bacterial reproduction and mechanisms of genetic recombination.
- To explore virus classification, structure, replication, and their applications in medicine and agriculture.
- To develop laboratory skills in microbial staining, culturing, microscopy, and industrial microbiology techniques

Course Outcome: After completing this course, students will be able to:

CO1: Describe the structural organization, classification, and growth patterns of bacteria and viruses.

CO2: Understand bacterial reproduction and genetic recombination processes.

CO3: Analyze the structural features and replication strategies of viruses, and understand their economic importance.

CO4: Demonstrate proficiency in essential microbiological techniques, with an understanding of laboratory safety and instrumentation.

The detailed course contents

MICROBIOLOGY

MODULE-1: Introduction to microbial world: Discovery, general characteristics; Types- archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure: Flagella (ultrastructure) and Pilli; Cell wall – chemical structure and differences between Gram +ve & Gram –ve bacteria; Bacterial genome and plasmid; Endospore formation, structure and function.

MODULE-2: Bacterial reproduction: Vegetative and asexual; Genetic Recombination (a) **Transformation**- with special emphasis on Natural and Induced competence and DNA uptake, (b) **Conjugation**- F- factor, $F^{+}X\ F^{-}$, Hfr x F^{-}, concept of F', chromosome mobilization, (c) **Transduction**- Generalised and specialized.

VIROLOGY

MODULE-3: **Viruses:** Discovery, physicochemical and biological characteristics; classification (Baltimore), general, structure with special reference to viroids and prions; replication (general account), DNA virus, (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases

MODULE-4: Economic importance of bacteria; Industrial Application: Components of a typical bioreactor, Types of bioreactors-laboratory; Fermentation: Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Industrial Production of Vinegar and Streptomycin (brief outline); Enzyme (Amylase, Protease); Plant Growth Promoting Rhizobacteria (PGPR): Biological nitrogen fixation and nodulation process in legumes.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

MICROBIOLOGY

1. Types of Bacteria to be observed from permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation.
2. Gram Staining (Gram +Ve and Gram -Ve)

3. Observation of Bacteroides in root Nodule (Simple staining: Methylene blue);
4. Endospore staining with malachite green. (*Bacillus* spp.)
5. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
6. Principles and functioning of instruments in the microbiology laboratory
7. Hands-on sterilization techniques and preparation of culture media.
8. A visit to any educational institute/ industry to see an industrial fermenter and other downstream processing operations.

NOTE: Students will perform the Gram staining procedure (differential staining) up to the Safranine step and comment on their observations based only on the supplied bacterial samples. The reference strain concept may be demonstrated but not mandatory for examination purposes.

Practical Marks Distribution

Major Course- BOT-DC-MJ-601

Duration: 3 hours

Sl No	Description	Marks
1.	**Gram Staining:** Principle- 02, Procedure- 04, Comment- 02	**08**
2	**Root Nodule:** Principle- 02, Observation- 02, Comment- 02	**06**
3	**Identification (1 specimen)**	**02**
4	**Submission:** Lab note book	**02**
5	**Viva-voce**	**02**
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
B.A. Forbes	Diagnostic Microbiology	2002	Mosby publisher
R.C. Dubey and D.K. Maheshwari	Practical Microbiology	**2002**	
P. Gunasekaran	Laboratory Manual in Microbiology	**2000**	

B.W.J. Mahy and H.O. Kangro.	Virology Methods Manual	**1996**	Academic Press
Davison and R.M. Elliot.	Molecular Virology: A Practical Approach.	**1993**	Oxford University Press.
D.R. Harper	Virology Lab Fax.	**1993**	Bioscientific Publication Academic Press.
Burleson	Virology - A Laboratory Manual	**1992**	Academic Press

Major Course / BOT-DC-MJ-602 or MC 13:
PLANT ECOLOGY AND ENVIRONMENTAL BIOLOGY
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- To understand ecological concepts like ecosystem, population, and biodiversity
- To learn how living organisms interact with each other and with their abiotic factors
- To identify and understand major environmental problems
- To explore potential solutions for environmental challenges

Course Outcome: **After completing this course, students will be able to:**

CO1: To understand the ecological concepts of plants and its various aspects.

CO2: Interpret the dynamics of ecosystems and their functionality.

CO3: Learn about the influence of human activities on ecosystems.

CO4: Address environmental challenges, such as pollution control, conservation, and sustainable development.

The detailed course contents

PLANT ECOLOGY

MODULE-1: Introduction: Basic concepts; Levels of organization. Inter-relationships between the living world and the environment. Soil and Water: Importance; Origin, Formation; Composition; Physical; Chemical and Biological components; Precipitation types (rain, fog, snow, hail, dew); Variations; adaptations of plants to their variation.Biotic interactions: Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; biomass, standing crop.

MODULE-2: Population ecology: Characteristics and Dynamics, Ecological Speciation Plant communities: Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts. Ecosystems: Structure; Processes; Food chains and Food webs; Ecological pyramids. Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Hydrological Cycle; Water in soil (concept only); Water table. Biogeochemical cycles Carbon, Nitrogen and Phosphorus.

ENVIRONMENTAL BIOLOGY

MODULE-3: Microbes and quality of environment: Distribution of microbes in air; Isolation of microorganisms from soil, air, and water. Microbial flora of water: Water pollution, role of microbes in sewage and domestic wastewater treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples. Microbes in agriculture and remediation of contaminated soils; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

MODULE-4: Regions of Biodiversity: Mega-diversity regions of India, Hotspots of biodiversity, Threats to biodiversity: Human interventions and biodiversity loss, Global environmental changes and biodiversity, Introduction of exotic species and biodiversity, Natural calamities and biodiversity, Extinction of species, Threatened plants of India. Conservation of biodiversity: Importance of biodiversity conservation, methods of biodiversity conservation; *in-situ* and *ex-situ* modes of biodiversity conservation, *In-vitro* conservation; germplasm and gene bank, pollen and spore bank, DNA bank.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

PLANT ECOLOGY

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
2. Study of morpho-anatomical adaptations of hydrophytes and xerophytes.
    a. Hydrophyte: *Eichhornia* sp., *Nymphaea* sp., *Hydrilla* sp.
    b. Xerophyte: *Nerium* sp., *Casuarina* sp., *Opuntia* sp., *Euphorbia tirucauli*.
3. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
4. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
5. **Botanical Excursion:** Field visit to familiarize students with the ecology of different sites.

ENVIRONMENTAL BIOLOGY

1. Determination of dissolved oxygen and dissolved carbon dioxide of water samples from polluted and unpolluted sources.
2. Qualitative Analysis of Water samples collected from different sources.

Practical Marks Distribution

Major Course- BOT-DC-MJ-602

Duration: 3 hours

Sl No	Description	Marks
1.	**Ecology (Quadrate):** Principle- 02, Observation and Calculation- 04, Comment- 02	08
2	**Environmental Biology:** Principle- 02, Observation-01, Calculation- 02, Comment- 01	06
3	**Identification (1 specimen)**	02
4	**Submission**	02
5	**Viva-voce**	02
Total		20

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Odum, E.P.	Fundamentals of Ecology		Saunders Publication
Ambasht, R.S and Ambasht, N.K	A Text book of plant Ecology		CBS Publication
Sukla, R.S. & Chandal, P.S.	Plant Ecology		S. Chand & Co.
Verma, P.S. & Agarwal, V.K.	Concept of Ecology		S. Chand & Co.
Kumar, H.D	Modern Concept of Ecology		Vikas Pub House
Dhaliwal, G.S., Sangha, G.S. and Ralhan, P.K.	Fundamentals of Environmental Sciences		Kalyani Publication
Asthana, D.K. and Asthana M.	Environmental Problems and Solutions		S. Chand & Co.
Cox, C.B.& Moore, P.D.	Biogeography –An Ecological and Evolutionary Approach		Blackwell Scientific Publication
Mani, M.S.	Biogeography of India		Springer-Verlag
Mitra, D., Guha, J. & Chowdhury, S.K	Studies in Botany Vol. II		Moulik Library
Sharma, P.D.	Elements of Ecology		Rastogi Publication

Major Course / BOT-DC-MJ-603 or MC 14:
PLANT PHYSIOLOGY AND PLANT METABOLISM
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- To know the water potential of plants with major emphasis on nutrient uptake, mineral nutrition and transpiration.
- To study the physiology of photosynthesis and respiration and differentiation of C3, C4 and CAM plants

- ❖ Detailed study of the physiological role of plant growth regulators with special reference to growth hormones and seed dormancy.
- ❖ To study about the various metabolic activities of plants with reference to ATP synthesis and nitrogen metabolism.

Course Outcome: After completing this course, students will be able to:

CO1: To understand various aspects of water potential and its relevance in nutrient uptake.

CO2: Acquire knowledge about the physiological pathways of photosynthesis and respiration.

CO3: Know about the various plant growth regulators and their importance in plant growth and development.

CO4: Understand the significance of various metabolic activities in plants and signal transduction pathways.

The detailed course contents

PLANT PHYSIOLOGY

MODULE-1: Plant-water relations: Water Potential and its components, water absorption by roots, aquaporins, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory. Transpiration; Cavitation and embolism. Mineral nutrition: Essential and beneficial elements, macro and micronutrients. Nutrient Uptake: Transport of ions across the cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, and active absorption. Proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

MODULE-2: Carbon assimilation: photosynthetic pigments and their role (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PS-I, PS-II, CO_2 reduction, photorespiration, C4 pathways; CAM and its ecological significance. Factors affecting CO_2 reduction. Carbon Oxidation: Glycolysis and its significance, fate of pyruvate, oxidative pentose phosphate pathway, TCA cycle, mitochondrial electron transport, oxidative phosphorylation, and factors affecting respiration. Translocation in the phloem: Phloem loading and unloading.

MODULE-3: Transpiration: factors affecting transpiration, anti-transpirants, mechanism of stomatal movement. Role and significance of CO_2, K^+-ion, blue light and abscisic acid in stomatal movement; Anti-transpirants. Plant growth regulators: Types of plant growth regulators; Physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid. Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization. Phytochrome, cryptochromes and phytotropins: Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR). Seed Dormancy: Types, causes and methods of breaking seed dormancy.

PLANT METABOLISM

MODULE-4: ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyer's conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers. Lipid metabolism: Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation. Nitrogen metabolism: Nitrate assimilation, biological nitrogen fixation (examples of legumes and nonlegumes);Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination. Mechanisms of signal transduction: Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

1. Determination of stomatal frequency and rate of transpiration per stomata per hour.
2. Comparison of water imbibition in starchy, proteinaceous, and fatty seeds.
3. Rate of photosynthesis under varying HCO^{-3} concentration (using bicarbonate) in aquatic plants.
4. Measurement of oxygen uptake by respiring tissue (per gram / hr.) by germinating seeds.
5. To compare the rate of respiration in different parts of a plant (Flower, leaf, buds etc)
6. Determination of R.Q. of germinating seeds by Ganong's respirometer or respiroscope.
7. Determination of water potential/Osmotic pressure of a given tissue (potato tuber) by the weight method.

Practical Marks Distribution

Major Course- BOT-DC-MJ-603

Duration: 3 hours

Sl No	Description	Marks
1	**Workout:** Principle- 04, Requisition- 02, Experimental Set up- 02, Result and Calculation- 06, Comment- 02	16
2	**Submission** (Laboratory note book)	02
3	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Jain, V.K.	Fundamentals of Plant Physiology		S. Chand & Co.
Lehninger, A.L., Nelson, D.L. & Cox, M.M.	Principles of Biochemistry		CBS
Mukherji, S. & Ghosh, A.	Plant physiology		New central Book Agency
Pandey, S.N & Sinha, B.K.	Plant Physiology		Vikas Publ. House
Salisbury, F.B. & Ross, C.W.	Plant Physiology		Wordsworth Publ. Co.
Sinha, R.K.	Modern Plant Physiology		Narosa Publishing House
Taiz, L & Zeiger, E.	Plant Physiology		Sinauser Associates Inc. Publishers
Verma, S.K	A Textbook of Plant Physiology & Biochemistry		S. Chand & Co.

Major Course / BOT-DC-MJ-604 or MC 15:
PLANT BIOTECHNOLOGY AND MOLECULAR BIOLOGY
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- To understand the different aspects of Plant Biotechnology -Plant Tissue Culture and its application
- Understand the methods of developing GMOs and their Biosafety concerns.
- Understand the concept of different types of Recombinant DNA Technology and its various aspects
- To study the molecular concepts of genes and Genetic technologies and their diverse applications

Course Outcome: After completing this course, students will be able to:

CO1: Will be able to develop the concept of modern BIotechnological tools like tissue culture and its multifaceted applications

CO2: Will be able to learn in detail the methods for developing GMOs such as Golden Rice, BT-Cotton, and Super Bugs.

CO3: Will be able to acquire knowledge about the practical application of Recombinant DNA Technology like- PCR and DNA sequencing

CO4: Will be able to understand in detail the concept of DNA Library, Gene Transfer and Transgenics.

The detailed course contents

PLANT BIOTECHNOLOGY

MODULE-1: Plant Tissue Culture Historical perspective; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Composition of tissue culture media; Nutrient and hormone requirements (role of vitamins and hormones). Micropropagation: methods and stages, advantages, disadvantages and application, organogenesis and embryogenesis (zygotic and somatic, induction of somatic embryogenesis, role of plant growth regulators, application – synthetic seeds); callus culture; application of plant tissue culture in agriculture and forestry. Protoplast isolation, culture and fusion; Application of Tissue culture applications.

MODULE-2: Applications of Biotechnology: Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase,); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

MOLECULAR BIOLOGY

MODULE-3: Recombinant DNA technology: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC18 and pUC19, pBR322, Ti-plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC). Gene Cloning: Recombinant DNA, Bacterial Transformation, and selection of recombinant clones, PCR-mediated gene cloning. Role of Transposons in mutation. DNA repair mechanisms.

MODULE-4: Gene Construct; Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus. Operon concept: Lac-Operon and Trp-Operon construction of genomic and cDNA libraries, screening DNA libraries to obtain genes of interest by genetic selection; complementation, colony hybridization; PCR; Methods of gene transfer: Brief idea about different methods of gene transfer, Agrobacterium mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

1. Demonstrations
    a. Preparation of MS medium. (Demonstration)
    b. *In vitro* sterilization and inoculation methods using leaf and nodal explants
2. Demonstration through photographs
    a. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis and artificial seeds
    b. Study of methods of gene: *Agrobacterium*- mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
    c. Study of steps of genetic engineering for production of Bt cotton and Golden rice.

3. Isolation of protoplasts (Demonstration) / visuals
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Isolation of Plant DNA
6. Gel Electrophoresis of plant Genomic DNA
7. Estimate the concentration of RNA by orcinol reaction

Practical Marks Distribution

Major Course- BOT-DC-MJ-604 or MC 15

Duration: 3 hours

Sl No	Description	Marks
1	**Workout (2 nos):** (Principle- 01, Calculation- 03, Comment- 02)	12
2	**Demonstration of Tissue Culture**	04
3	**Submission**	02
4	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Bhojwani, S.S. and Razdan, M.K.,	Plant Tissue Culture: Theory and Practice.	1996	Elsevier Science Amsterdam. The Netherlands.
Glick, B.R., Pasternak, J.J.	Molecular Biotechnology- Principles and Applications of Recombinant DNA	2003	ASM Press, Washington
Snustad, D.P. and Simmons, M.J.	Principles of Genetics. 5th edition.	2010	John Wiley and Sons, U.K.
Stewart, C.N.	Plant Biotechnology & Genetics: Principles, Techniques and Applications	2008	John Wiley & Sons Inc. U.S.A.

Channarayappa	Molecular Biotechnology: Principles and Practices		Universities Press
Dubey, R.C. .	Biotechnology		S. Chand & Co.
Gamborg, O.L. & Philips, G.C.	Plant Cell, Tissue and Organ Culture -Fundamental Method		Narosa Publications
Razdan, M.K.	An Introduction to Plant Tissue Culture		Oxford & IBH

SEMESTER VII

Semester	Major Core (MC)/DSE	Minor Core (MnC)	Dissertation on Major / Academic project/ Entrepreneurship #	Total Credits
VII	DC-MJ-701 (4) DC-MJ-702 (4) DC-MJ-703 (4) DC-MJ-704 (4)	IDC/DC-MN-701 (4)		**20**
Students on exit shall be awarded Bachelor of (in the Field of Study/Discipline - Honours) in Discipline-1 (Major) with Discipline-2 (Minor) after securing the requisite 162 credits on completion of Semester VIII				

N.B. Figures within the bracket indicate the credit points.

Major Course / BOT-DC-MJ-701 or MC 16:
PALYNOLOGY AND REPRODUCTIVE BIOLOGY OF ANGIOSPERMS
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- To understand the principles, branches, and applications of palynology in taxonomy, forensics, and ecology.
- To study pollen morphology, viability, storage, and their significance in plant biology.
- To understand the development of reproductive structures and processes in angiosperms.
- To develop practical skills in identifying pollen and reproductive tissues and assessing pollen fertility.

Course Outcome: After completing this course, students will be able to:

CO1: Explain the scope and applications of palynology in both academic and applied fields.

CO2: Analyze pollen structure, aperture types, and viability in relation to plant reproduction and evolution.

CO3: Describe the development and structure of anthers, ovules, embryo sacs, and embryos in angiosperms.

CO4: Perform laboratory techniques to observe reproductive stages, study pollen morphology, and analyse pollen germination.

The detailed course contents

PALYNOLOGY

MODULE-1: Palynology and scope: a brief account, Branches of Palynology: palynology in taxonomic & phylogenetic deductions; applied aspects of Palynology: melissopalynology, medical Palynology and forensic Palynology.

MODULE-2: Pollen morphology: Units, polarity, symmetry, shape, size, aperture; NPC system for numerical expression of apertural details. Pollen Viability and Storage: Estimation; variations; responsible factors; short- and long-term storage; significance.

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

MODULE-3: **Reproductive Development:** Induction of flowering; flower as a modified determinate shoot. Flower development: ABC Model of flower development. **Anther and pollen biology:** Anther wall: Structure and functions, microsporogenesis, callose deposition, and its significance. microgametogenesis, male germ unit. **Ovule:** Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic, tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

MODULE-4: **Pollination and fertilization:** Pollination types, agents and adaptations; pollen germination; path of pollen tube in pistil; double fertilization. **Embryo, Endosperm and Seed:** Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

PALYNOLOGY

1. Slides/Micrographs of Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture pseudomonads,

polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph).

3. Pollen fertility and Pollen germination: Fertility, Germination: Calculation of percentage germination in different media using the hanging drop method.

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

1. Ovule: Types-anatropous, orthotropous, amphitropous / campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate (Permanent slides/ specimens/ photographs, Micrographs).
2. Female gametophyte through permanent slides / photographs: Types, ultrastructure of mature egg apparatus.
3. Intra-ovarian pollination; Test tube pollination through photographs.
4. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
5. Embryogenesis: Study of the development of the dicot embryo through permanent slides/ micrographs; Study of the suspensor through electron micrographs.

Major Course- BOT-DC-MJ-701

Duration: 3 hours

Sl No	Description	Marks
1.	**Workout Palynology :**Principle- 02, Experimental set up- 01, Observation and Calculation- 03, Comment- 01	**07**
2	**Workout Reproductive Biology :** (Slide preparation- 02, Drawing and Labelling- 02, Comment- 01)	**05**
3	**Identification (2 specimen)**	**04**
4	**Submission**	**02**
5	**Viva-voce**	**02**
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Bhojwani, S.S. and Bhatnagar, S.P.	The Embryology of Angiosperms, 5th edition.		Vikas Publishing House. Delhi.

Shivanna, K.R.	Pollen Biology and Biotechnology		Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
Raghavan, V.	Developmental Biology of Flowering plants,		Springer, Netherlands
Johri, B.M.	Embryology of Angiosperms,		Springer-Verlag, Netherlands.
Nair, P.K.K.	Pollen Morphology of Angiosperms		Scholar Publication
Erdtman, G.	Pollen Morphology and Plant Taxonomy		Ielden: E.G. Brill
Faegri, K. & Iverson, J.	Text Book of Pollen Analysis		Oxford: Blackwell Scientific Publication

Major Course / BOT-DC-MJ-702 or MC 17:
ECONOMIC BOTANY AND ETHNOBOTANY
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- ❖ To give a preliminary knowledge about economic botany and crop domestication.
- ❖ To inform students about plants yielding drugs, timber, fibre, rubber, beverages etc.
- ❖ To give a general idea about ethno-medicine with respect to some of the important drug yielding plants
- ❖ To understand the application of the indigenous knowledge of plant application in our daily life.

Course Outcome: After completing this course, students will be able to:

CO1: Describe the diversity of plant species used by humans across different geographical regions.

CO2: Identify and classify plant species that are economically relevant and useful

CO3: Able to understand the role of ethnomedicine in modern medicine.

CO4: Use the traditional knowledge system for sustainable development and plant conservation.

The detailed course contents

ECONOMIC BOTANY

MODULE-1: Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions in India; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

MODULE-2: Economic importance plants to man and environment (origin, morphology, processing & uses): **Cereals:** Wheat and Rice; Brief account of millets. **Legumes:** Chick pea and Pigeon pea. **Sources of sugars and starches:** Morphology and processing of sugarcane, products and by-products of the sugarcane industry. **Spices:** special reference to fennel, saffron, clove and black pepper. **Beverages:** Tea, Coffee (morphology, processing & uses) **Sources of oils and fats:** groundnut, coconut, linseed, soybean and mustard; **Natural Rubber:** Para-rubber: tapping, processing and uses. **Drug-yielding plants:** Therapeutic and habit-forming drugs with special reference to *Cinchona, Digitalis* and *Cannabis*; **Timber plants:** General account with special reference to teak and pine. **Fibers:** Classification based on the origin of fibers; Cotton and Jute (morphology, extraction and uses)

ETHNOBOTANY

MODULE-3: Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context: major and minor ethnic groups or Tribes of India and their lifestyles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. Ethnobotany as a tool to protect the interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

MODULE-4: Role of ethnobotany in modern Medicine: Medico-ethnobotanical sources in India; Significance of the following plants in ethno-botanical practices (along with their habitat and morphology) (a) *Azadiractha indica*; (b) *Ocimum sanctum*; (c) *Vitex negundo*; (d) *Gloriosa superb*; (e) *Tribulus terrestris*; (f) *Pongamia pinnata*; (g) *Cassia auriculata*; (h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special examples *Rauvolfia serpentina*, *Trichopus zeylanicus, Artemisia vulgaris, Withania somnifera*. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

1. **Cereals:** Wheat (habit sketch, L. S/T.S. grain and starch grains; Paddy (habit sketch, study of paddy and grain, starch grains).
2. **Legumes:** Soybean, Groundnut, (habit, fruit, seed structure. Comparison of Total Soluble Protein in Soybean and Groundnut following Lowry's method.
3. **Sugars and starches**: Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains).
4. **Spices:** Black pepper, Fennel, *Coriandrum* and Clove (Common and Scientific names, habit, morphology of the parts used).
5. **Drug-yielding plants:** Specimens of *Digitalis, Papaver, Adhatoda, Azadirachta, and Aloe vera* (Habit sketch, Morphological study of the parts used).
6. **Fiber-yielding plants:** Cotton (whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).
7. **Botanical excursion:** Field visit to plantation sites/fields to familiarize students with cultivation practices and submission of collected specimens (minimum of 10 specimens with proper documents and identification covering cereals, Legumes, spices, Beverages, fiber-yielding or wood)

Practical Marks Distribution
Major Course- BOT-DC-MJ-702 or MC 17
Duration: 3 hours

Sl No	Description	Marks
1	**Workout of Cereals, Legumes and Sugar yielding plants and related tests** Drawing and labelling of seed/tuber structure- 02, Location of starch grains / Comparison of protein content- 04, Comment- 02	08
2	**Test for cellulose/liginin in Fibers** (Slide- 01, Observation- 02, Comment- 01)	04
3	**Identification (2 specimen) –Spices and Drug yielding plants** (Comment-1, Identification 1) x 2	04
4	**Submission (**lab note book, field record, herbarium etc**)**	02
5	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Kochhar, S.L.	Economic Botany in Tropics,	**2012**	MacMillan & Co. New Delhi
Wickens, G.E.	Economic Botany: Principles & Practices.	**2011**	Kluwer Academic Publishers, Netherlands
Chrispeels, M.J. and Sadava, D.E.	Plants, Genes and Agriculture.	**1994**	Jones & Bartlett Publishers
S.K. Jain	Manual of Ethnobotany	**1995**	Scientific Publishers, Jodhpur
S.K. Jain	Contributions of Indian ethnobotany	**1990**	Scientific publishers, Jodhpur
Colton C.M.	Ethnobotany – Principles and applications.	**1997**	John Wiley and sons
Rama Ro, N and A.N. Henry	The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.	**1996**	Botanical Survey of India

Major Course / BOT-DC-MJ-703 or MC 18:
STRESS PHYSIOLOGY
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objective:

- Understand different aspects of Plant Stress and the concept of molecular signalling during these stresses.
- Understand the various aspects of Biotic Stress- Systemic Acquired Resistance and Signalling mechanisms.
- To study Plant Nutrition, Heavy Metals, and related stress with reference to signalling and ROS Scavenging
- To study different aspects of Adaptations in Plants to overcome Environmental Stress

Course Outcome: After completing this course, students will be able to:

CO1: Will be able to distinguish between different types of plant stress and the associated signalling pathways

CO2: Will be able to acquire knowledge regarding Phyto Resistance towards stress with reference to SAR

CO3: Will be able to recognise different types of Plant Nutrition and Heavy Metals with reference to their effect on plants

CO4: Will be able to understand the mechanisms of Plant Adaptations and Survival against different types of Environmental Stress.

The detailed course contents

STRESS PHYSIOLOGY

MODULE-1: Defining plant stress: Acclimation and adaptation. Environmental factors. **Abiotic Stress:** Water stress; Salinity stress; High-light stress; Temperature stress; Heat Shock Protein; Anaerobic and oxidative stress; Responses of plants to environmental stress; Oxidative burst.

MODULE-2: **Biotic stresses:** Pathogenicity, Host-Pathogen interaction, Infection; Hypersensitive reaction; Pathogenesis–related (PR) proteins; Systemic acquired resistance; Induced Systemic Resistance; Mediation of insect and pathogen resistance by Jasmonates.

MODULE-3: Essential nutrients, deficiencies and plant disorders; Chelates; Treating nutritional deficiencies; Heavy-metal stress and homeostasis; Molecular mechanism of mineral nutrition in plants. Stress sensing mechanisms in plants: Calcium modulation, Phospholipid signaling; Reactive oxygen species–Production and scavenging mechanisms.

MODULE-4: Developmental and physiological mechanisms that protect plants against environmental stress: Adaptation in plants; Changes in root: shoot ratio; Aerenchyma development; Osmotic adjustment; Compatible solute production.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of stresses. (Principle, Procedure, Result and calculation)
2. Quantitative estimation and analysis of Catalase in the absence and presence of stresses (Principle, Procedure, Result and calculation)
3. Quantitative estimation of Total Soluble protein in the seedlings in the absence and presence of stress. (Principle, Procedure, Result and calculation)

Practical Marks Distribution
Major Course- BOT-DC-MJ-703 or MC 18
Duration: 3 hours

Sl No	Description	Marks
1	**Quantitative estimation of peroxidase/Catalase/total soluble protein:** Principle- 04, Requisition- 02, Result and Calculation- 08, Comment- 02	16
2	**Submissions of Laboratory records**	02
3	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Hopkins, W.G. and Huner, A.	Introduction to Plant Physiology. 4th edition	**2008**	John Wiley andSons. U.S.A.
Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A	Plant Physiology and Development	**2015**	Sinauer Associates Inc., USA

Major Course / BOT-DC-MJ-704 or MC 19:
RESEARCH METHODOLOGY IN PLANT SCIENCE
[04 Credit]

Topic content of THEORY part [03 Credits] (Teaching hour = 45)

Course Objectives:

- To understand the basic concepts of research in plant science, including planning, research models, experimental design, and implementation.
- To know the importance of intellectual property rights in research.
- To understand the importance of publication and the methods of manuscript writing.
- To study the various advanced tools and techniques in modern-day research.

Course Outcome: After completing this course, students will be able to:

CO1: Prepare themselves for research in plant science.

CO2: Will be able to implement the concept of IPR in their research publications.

CO3: Prepare original manuscripts of their research, following ethical and biosafety rules and avoiding plagiarism.

CO4: Know the working principles and operation of a few advanced research tools and instruments for effective research outcomes.

The detailed course contents

MODULE-1: Basic Concepts of Research: Objectives, Research Methods vs Methodology, Types of Research-Quantitative vs Qualitative, Basic vs Applied, Search engines, Literature Review and its consolidation. Research Design, Data Collection and Analysis, Experimental design, and implementation, Data presentation (Tables and Figures), and their Interpretation. Scientific paper writing- Manuscript preparation and presentation; Research Journals, Impact Factor, and paper citation index.

MODULE-2: Intellectual Property Rights (IPR): Types of IP: Patents, Trademarks, Copyrights. Geographical Indications, Protection of New GMOs; Concept of Indian Intellectual Property Rights; Concept of World Intellectual Property Organization (WIPO); Roles of Institutional, Ethical, and Biosafety Committees; Plagiarism.

MODULE-3: Analytical Techniques in Research: Working principles of Soxhlet extraction, Column chromatography, High-pressure liquid Chromatography (HPLC), Electrophoresis, and ELISA. Principles of Fluorescence, UV, Visible, NMR, and Atomic Absorption Spectroscopy and Autoradiography.

MODULE-4: Microscopic techniques in Research: Working Principles of Microscopy- light microscopes, fluorescent, phase contrast, and confocal. Resolutions, magnifications, and Scale bars. Principles and applications of Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM); Fixation and staining: Methods and fundamental concepts for preserving and staining specimens for both light and electron microscopy.

Topic content of PRACTICAL part [01 Credit] FM=20 (Teaching hours = 15)

The Practical Paper for this course will be project-based.

1. Students will be trained to prepare a research project of his/her own
2. The topic will be chosen within the framework of the syllabus.
3. Students will prepare a hard copy of the Project and a presentation at the time of evaluation.
4. **Basic format of the project to be followed**
   a. Topic relevance
   b. Working principle
   c. Expected outcome and future perspectives
   d. References

Practical Marks Distribution

Major Course- BOT-DC-MJ-704 or MC 19

Duration: 3 hours

Practical Paper to be conducted in the same mode as other Major Courses		
Sl No	**Description**	**Marks**
1	**Submission of the hard copy of the project with a limit of 3000 words.**	10
2	**Presentation with 15-20 slides: (Time 10 min)**	5
3	**Viva-voce/ discussion followed by presentation**	5
Total		**20**

- **Evaluation Process:** Evaluation of this paper will be conducted at the respective exam centre in the presence of the board of examiners from the colleges.
- **The candidate must submit 03 (three) hard-bound copies at the time of the examination, duly signed by the candidate.** The board of examiners will examine and endorse the copies during the evaluation process.

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Dawson, C.	Practical research methods	**2002**	UBS Publishers, New Delhi
Anthony, M, Graziano, A.M. and Raulin, M.L.	Research Methods: A Process of Inquiry,	**2009**	Allyn and Bacon
Kothari, C.R.	Research Methodology: Methods and Techniques, 2nd edition,	**2014**	NewAge International (P) Ltd.,
Walliman, N.	Research Methods- The Basics.	**2011**	Taylor and Francis, London,
Cresswell, J.W.	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th edition).	**2014**	SAGE Publications Inc.
Rost, F. W. D.	Fluorescence microscopy.	**1992**	C. U. Publication
SK. Kamaraj, A Thirumurugan, SS. Dhanabalan, & S.A. Hevia	Microscopic Techniques for the Non-expert.	**2022**	Springer.
John Kuo	Electron Microscopy -Methods and Protocols.	**2014**	Springer

SEMESTER-VIII
(Without Research/ Academic Project/ Entrepreneurship)

Semester	Major Core (MC)/DSE	Minor Core (MnC)	Dissertation on Major / Academic project/ Entrepreneurship #	Total Credits
VIII	DC-MJ-801 (4) DC-MJ-802 (4) DC-MJ-803 (4)	IDC/DC-MN-801 (4)	Dissertation on Major (4) / Academic project (4) / Entrepreneurship (4) DC-MJ-804 (4) *It could be either:* 1. Seminar presentation on minor project (4) 2. Term paper presentation on current issues and problems of Major Papers (4) 3. Dissertation through practicum or hands-on activities (4)	**20**
Students on exit shall be awarded a Bachelor of (in the Field of Study/Discipline - Honours) in Discipline-1 (Major), Discipline-2 (Major), and Discipline-3 (Major) with Discipline-2 (Minor) after securing the requisite 162 credits on completion of Semester VIII.				**Total 162**

N.B. Figures within the bracket indicate the credit points. # Modalities for holding a Dissertation on a Major/Academic project/Entrepreneurship will be notified in due course.

Major Course / BOT-DC-MJ-801 or MC 20:
ANALYTICAL TECHNIQUES IN PLANT SCIENCE
[04 Credit]

Topic content of THEORY part [03 Credits] FM= 30 (Teaching hour = 45)

MODULE 1: Lab safety and good lab practices: General laboratory safety, good laboratory practices, biosafety measures, classes of laboratory chemicals (Labels, Quality - LR/ AR/ Molecular biology grade/ HPLC grade); laboratory waste management. Working Principle, use, and precautions of basic Laboratory equipment: Weighing balance, pH meter, autoclave, BOD incubator, spectrophotometer, gel electrophoresis unit, centrifuge, and distillation unit.

MODULE 2: Measurements and calculations-Units of measurements and conversion from one unit to another, measurement of volumes of liquids, Weighing, calculations: scientific notations, powers, logarithms, and fractions. **Buffers and Solutions:** - Molarity, Molality, Normality, percent solution, stock solution, standard solution, pH, buffers - phosphate, Tris- acetate, Tris- Cl, and Citrate buffer.

MODULE 3: Microbial Techniques: - Basic culture media: (PDA, PDB, MEA, LB, YEB, MS)-liquid and solid; **Culture techniques:** plating (streak, spread & pour), replica plating, serial dilution. **Chromatographic Principles:** Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

MODULE 4: Bioinformatics: Introduction to Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System. National Center for Biotechnology Information (NCBI): Basic local alignment search tool (BLAST). Molecular Phylogeny using MEGA. Applications of Bioinformatics in various fields.

Topic content of PRACTICAL part [01 Credit] (Teaching hour = 15)

1. Demonstration of laboratory equipment (Weighing balance, pH meter, autoclave, laminar airflow, BOD incubator, spectrophotometer, gel electrophoresis unit, centrifuge, distillation unit)
2. Demonstration of the working principle of Microscopy (Simple, Compound, Light). Photo Demonstration of the working principle of SEM and TEM.
3. Demonstration of Different media preparation, culturing techniques used in microbiology and tissue culture.
4. Separation (chloroplast pigments/ amino acids) by the paper chromatography method and calculation of the RF Value.
5. Demonstration of Sequence retrieval from databases in fasta format (NCBI) and BLAST. Sequence alignment and Construction of a phylogenetic tree. Using the MEGA bioinformatics tool.

Practical Marks Distribution
Major Course- BOT-DC-MJ-801 or MC 20
Duration: 3 hours

Sl No	Description	Marks
1	**Separation through Paper Chromatography** Experimental Set up- 03, Result- 02, Calculation- 02, Comment- 01	08
2	**Demonstration of Instruments (Working Principle & Precautions)**	05
3	**Demonstration of Culture techniques in microbiology**	03
4	**Submission of Laboratory Records**	02
5	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Plummer, D.T.	An Introduction to Practical Biochemistry	1996	Tata McGraw-Hill Publishing Co. Ltd. New Delhi
Ruzin, S.E.	Plant Microtechnique and Microscopy	1999	Oxford University Press, New York.
Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K.	Short Protocols in Molecular Biology; 3rd edition.	1995	John Wiley & Sons.
Zar, J.H.	Biostatistical Analysis. 4 th edition	2012	Pearson Publication.

Major Course / BOT-DC-MJ-802 or MC 21
MICROBIAL RESOURCE MANAGEMENT
[04 Credit]

Topic content of THEORY part [03 Credits] FM= 30 (Teaching hour = 45)

MODULE 1: Microbial resources: Definition and types. Sustainable utilization: Concept, approaches (economic and ecological). Microbes and quality of environment: Distribution of

microbes in air; Isolation of microorganisms from soil, air and water. Microbial flora of water: Water pollution, role of microbes in sewage and domestic wastewater treatment systems. Determination of BOD, COD, TDS and TOC of water samples.

MODULE 2: Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples. Microbes in agriculture and remediation of contaminated soils. Biological Nitrogen fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

MODULE 3: Bioreactors / Fermenters and fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilot scale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

MODULE 4: Industrial Production: Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Brief idea of microbial fermentations for the production: Amylase, Citric acid and Penicillin; Industrial production technique of Ethanol, Paneer, Cheese, Yoghurt, Vinegar. Application of Microbial resources in agriculture (PGPR, PGPF, BCA). Mycorrhiza- Ectomycorrhiza, Endomycorrhiza, Phosphate mobilization by AMF. Significance and role in Agriculture.

Topic content of PRACTICAL part [01Credit] (Teaching hour = 15)

1. Principles and functioning and Precautions of basic instruments in microbiology laboratory (Autoclave, Laminar Air Flow, Bacteriological Incubators (Still and Shaking).
2. Demonstration of hands-on sterilization techniques and preparation of culture media.
3. Demonstration of isolation of microorganisms in culture media through serial dilution techniques from soil and water.
4. Determination of Viability of Yeast Cells in commercially available Bakers Yeast (Dry active yeast powder) using the methylene blue staining technique and a haemocytometer.

5. Morphological study and Observation of yeast cells. (Drawing of Different stages of unbudded cells and budded cells), NB: Based on the ratio of unbudded cells: Budded cells, the variability of the product can be determined.
6. Comparison of Microbes in Fermented milk products: Curd, Yoghurt, and cheese through simple staining techniques.
7. A visit to any educational institute/industry to observe industrial production using microbial resources. [GPS-mapped pictures and photographs, duration of visit should be a minimum of one working day].

Practical Marks Distribution
Major Course- BOT-DC-MJ-802 or MC 21
Duration: 3 hours

Sl No	Description	Marks
1	**Determination of Viability of Yeast Cells in Commercially Available Bakers' Yeast:** (Slide preparation-2, Observation and Calculation-4, Comment -2)	08
2	**Morphological study of Bacteria in** Fermented milk products (Slide Preparation and Drawing- 2; Observation and Comment- 2)	04
3	**Submission** of Field Records: Field visit to educational institute/industry	04
4	**Submission** of Laboratory Records	02
5	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Crueger W and Crueger A.	Biotechnology: A textbook of Industrial Microbiology. 2nd Edition.	**2000**	Panima Publishing Company, New Delhi
Patel AH.	Industrial Microbiology 1st Edition.	**1996**	MacMillan India Limited Publishing Company Ltd. New Delhi

Tortora GJ, Funke BR, and Case CL.	Microbiology: An introduction. 9th Edition.	**2008**	Pearson Education
Prescott, Harley and Klein's	Microbiology. 9th Edition	**2013**	McGraw Hill Higher education
Casida LE.	Industrial Microbiology. 1st edition.	**1991**	Wiley Eastern Limited
Stanbury PF, Whitaker A and Hall SJ.	Principles of Fermentation Technology. 2nd edition	**2006**	Elsevier Science Ltd.
Adams MR and Moss MO	Food Microbiology. 4th edition	**1995**	New Age International (P) Limited Publishers,
Banwart JM	Basic Food Microbiology. 1st edition	**1987**	CBS Publishers and Distributors, Delhi
Frazier WC and Westhoff DC	Food Microbiology. 3rd edition	**1992**	Tata McGraw-Hill Publishing Company Ltd,
Jay JM, Loessner MJ and Golden DA	Modern Food Microbiology. 7th edition	**2005**	CBS Publishers and Distributors, Delhi

Major Course / BOT-DC-MJ-803 or MC 22:
APPLIED PLANT SCIENCES FOR HUMAN WELFARE
[04 Credit]

Topic content of THEORY part [03 Credits] FM= 30 (Teaching hour = 45)

MODULE 1: Basic concept of Natural Resources; Forests of World / India; water resources; Mineral resources; Food resources; Energy sources; Land resources Environmental pollution- definition, causes, effects and control, measures (special emphasis on thermal pollution, Nuclear pollution); Solid waste management- urban and industrial wastes; Bioremediation, Bioflocculation Society and Environment- sustainable development –concept.

MODULE 2: Concept of Practical applications of Ethnobotanical data: External benefits - National interests in ethnobotany: Plant-derived drugs used in orthodox medical practice; Traditional Plant management and Environmental conservation; Traditional germplasm management: *in situ* and *ex situ* conservation; Ethnomedicine; Renewable plant products: Sustainable source of income; Protection strategies of local resources.

MODULE 3: Commercial Nursery development: objectives and scope. Planning and seasonal activities - Planting - direct seeding and transplants. Vegetative propagation: air-layering, cutting, treatment of cutting, rooting medium and planting of cuttings. Hydroponics; Floriculture: Importance and scope of floriculture and landscape gardening. Ornamental Plants: Flowering annuals; Herbaceous perennials. Bonsai. Commercial Floriculture: Commercial application of floriculture and nursery management. Costing of tissue-culture-raised plants, quality control, packaging, transport, and shipment.

MODULE 4: Urban vegetation and green spaces: significance for human population, mental and physical health, urban microclimate regulation, and ecosystem services. Concept of urban green spaces, green belts, parks, green roofs and green buildings. Principles of biomonitoring and bioremediation; plants, lichens and other bioindicators for assessing urban air, water and soil quality.

Topic content of PRACTICAL part [01Credit] (Teaching hour = 15)

1. Categorization of solid waste generated by a domestic system (biodegradable and non-biodegradable).
2. Determination of dissolved oxygen of water samples from urban and rural sources.
3. Qualitative estimation of alkaloids in ethnomedicinally important plant extract/ powder.
4. Qualitative estimation of flavonoids in ethnomedicinally important plant extract / powder through Aluminium Chloride Assay.
5. Comparative estimation of foliar dust deposition from diverse habitats.
6. Impact of particulate pollutants on leaf anatomy.

Practical Marks Distribution
Major Course- BOT-DC-MJ-803 or MC 22
Duration: 3 hours

Sl No	Description	Marks
1	**Determination of Oxygen from Urban and Rural Sources:** Principle-02, Result- 02, Calculation- 03, Comment-01	08
2	**Qualitative estimation of Flavonoids / Alkaloids:** Principle-02, Experiment and Observation-04, Comment- 01	07
3	**Submission:** Lab note book-01, field record-02	03
4	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Chakraborty, U. and Chakraborty, B.	Stress Biology	**2005**	Narosa Publishing House.
Prasad, M.N.V.	Plant Ecophysiology.	**1997**	John Wiley & Sons, Inc.
Prasad, M.N.V. and Strzalka, K.	Physiology and Biochemistry of Heavy Metal Detoxification and Tolerance in Plants.	**2004**	Kluwer Academic Publishers.
Lecrec, J.C.	Plant Ecophysiology.	**2003**	Science Publishers Inc.
Prasad, M.N.V.	Heavy Metal Stress in Plants: From Biomolecules to Ecosystems. 2nd Ed.	**2004**	Springer-Verlag.
Kvesitadze, G., Khatisashvili, G., Sadunishvili, T. and Ramsden, J.J.	Biochemical Mechanisms of Detoxification in Higher Plants: Basis of Phytoremediation	**2006**	Springer Verlag.

Major Course / BOT-DC-MJ-804 or MC 23:
TERM PAPER/ FIELD REPORT/ LITERATURE REVIEW/ BOOK REVIEW
[04 Credit]

Topic content of THEORY part [03 Credits] FM=75

Paper Presentation= 03 Credit and Viva Voce= 01 Credit

For this Paper,
Students of Botany Major (without Research) will opt for
Literature Review/ Book Review/ Field Report/ Term paper

Common guidelines for the paper for their preparation and examination are as follows

1. Students will choose a broad area of plant sciences (preferably based on the syllabus) for individual students.
2. Students must submit two Spiral Bind hard copies of the Review Paper to the for evaluation. The concerned teacher should endorse the hard copy before the examination.

3. Power Point presentation of the Review work should be evaluated in the presence of external examiner(s).
4. Marks should be average marks provided by both internal and external examiner(s).
5. Relevant topics based on current issues of environment, sustainable development, climate change, biodiversity, biotechnology interventions etc. should be preferred.
6. Mark's distribution is as follows:

Literature Review-Based Project Work/ Book Review/ Term Paper/ Field Report

Sl No	Subject or points for Marks	Marks Allotted
1	Title page and topic relevance	02
2	**Abstract** (covering background of research, brief methodology, results, and conclusion, within a word limit of 300)	05
3	**Introduction and Review** of the literature (Headings/Subheadings), mentioning the information resources(search engines, etc.), time span of literature search, survey questionnaire, if required	15
4	**Objectives** of the study	05
5	**Results** covering key findings and outcome	15
6	**Conclusion** and **Future Perspectives**	03
7	**References**	05
Total Marks on Copy/Report		**50**
8	**PowerPoint Presentation** (within 30 slides, covering the title slides, detailed contents, conclusion, acknowledgements, and references) (slide preparation: 05, and presentation: 10)	15
9	**Viva-voce**	10
Total Marks onPresentation & Viva-voce		**25**
Full Marks of the Paper		**75**

- **Evaluation Process:** Evaluation of this paper will be conducted at the University with both the internal members from the University and External Members from the colleges.
- **The candidate has to submit 03 (three) hard-bound copies at the time of examinations, duly signed by the mentor and the Head of the Department.** The board of examiners will examine and endorse the copies during the evaluation process.
- **For survey-oriented work, relevant documents, such as questionnaires duly signed by the mentor and the candidate, are to be attached as Annexure at the end of the dissertation copies.**

SEMESTER-VIII

(With Research/ Academic Project/ Entrepreneurship)

Semester	Major Core (MC)/DSE	Minor Core (MnC)	Dissertation on Major / Academic project/ Entrepreneurship #	Total Credits
VIII	DC-MJ-801 (4)	IDC/DC-MN-801 (4)	Dissertation on Major and Academic project / Entrepreneurship (12) DC-DRP 1(12)	**20**
Students on exit shall be awarded a Bachelor of (in the Field of Study/Discipline - Honours) in Discipline-1 (Major) with Discipline-2 (Minor) after securing the requisite 162 credits on completion of Semester VIII.				**Total= 162**

N.B. Figures in brackets indicate the credit points.

Modalities for holding a Dissertation on a Major/Academic project/Entrepreneurship will be notified in due course.

Major Course / BOT-DC-MJ-801 or MC 20:
ANALYTICAL TECHNIQUES IN PLANT SCIENCE
[04 Credit]

Topic content of THEORY part [03 Credits] FM = 30 (Teaching hour = 45)

MODULE 1: Lab safety and good lab practices: General laboratory safety, good laboratory practices, biosafety measures, classes of laboratory chemicals (Labels, Quality - LR/AR/Molecular biology grade/ HPLC grade); laboratory waste management. Working Principle, use, and precautions of basic Laboratory equipment: Weighing balance, pH meter, autoclave, BOD incubator, spectrophotometer, gel electrophoresis unit, centrifuge, and distillation unit.

MODULE 2: Measurements and calculations-Units of measurements and conversion from one unit to another, measurement of volumes of liquids, Weighing, calculations: scientific notations, powers, logarithms, and fractions. **Buffers and Solutions:** - Molarity, Molality, Normality, percent solution, stock solution, standard solution, pH, buffers - phosphate, Tris- acetate, Tris- Cl, and Citrate buffer.

MODULE 3: Microbial Techniques: - Basic culture media: (PDA, PDB, MEA, LB, YEB, MS)-liquid and solid; **Culture techniques:** plating (streak, spread & pour), replica plating, serial dilution. **Chromatographic Principles:** Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

MODULE 4: Bioinformatics: Introduction to Bioinformatics, Aim, Scope, and Research Areas of Bioinformatics. Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System. National Center for Biotechnology Information (NCBI): Basic local alignment search tool (BLAST). Molecular Phylogeny using MEGA. Applications of Bioinformatics in various fields.

Topic content of PRACTICAL part [01 Credit] (Teaching hour = 15)

1. Demonstration of laboratory equipment (Weighing balance, pH meter, autoclave, laminar airflow, BOD incubator, spectrophotometer, gel electrophoresis unit, centrifuge, distillation unit)
2. Demonstration of the working principle of Microscopy (Simple, Compound, Light). Photo Demonstration of the working principle of SEM, TEM.
3. Demonstration of Different media preparation, culturing technique used in microbiology and tissue culture.
4. Separation (chloroplast pigments/ amino acids) by the paper chromatography method and calculation of the RF Value.
5. Demonstration of Sequence retrieval from databases in FASTA format (NCBI) and BLAST. Sequence alignment and Construction of phylogenetic trees. Using the MEGA bioinformatics tool.

Practical Marks Distribution
Major Course-BOT-DC-MJ-801 or MC 20
Duration: 3 hours

Sl No	Description	Marks
1	**Separation through Paper Chromatography** Experimental Set up-03, Result- 02, Calculation- 02, Comment- 01	08
2	**Demonstration of Instruments (Working Principle & Precautions)**	05
3	**Demonstration of Culture techniques in microbiology**	03
4	**Submission of Laboratory Records**	02
5	**Viva-voce**	02
Total		**20**

Suggested Readings

Author's name(s)	Title of the book	Edition	Publisher
Plummer, D.T.	An Introduction to Practical Biochemistry	**1996**	Tata McGraw-Hill Publishing Co. Ltd. New Delhi
Ruzin, S.E.	Plant Microtechnique and Microscopy	**1999**	Oxford University Press, New York.
Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K.	Short Protocols in Molecular Biology; 3rd edition.	**1995**	John Wiley & Sons.
Zar, J.H.	Biostatistical Analysis. 4th edition	**2012**	Pearson Publication.

Major Course / BOT-DC-DRP-1
DISSERTATION / RESEARCH / PROJECT
[12 Credit]

Dissertation Preparation 8 Credit and Presentation 4 Credit

The dissertation should be presented in a number of chapters, starting with the introduction and ending with the Summary and Conclusions. Each of the other chapters will have a precise title that reflects its contents. A chapter can be subdivided into sections and sub-sections so as to present the content discretely and with due emphasis.

Chapter 1: Introduction: The title of Chapter 1 shall be Introduction. It shall justify and highlight the problem posed, define the topic, and explain the aim and scope of the work presented in the dissertation. It may also highlight the significant contributions from the investigation.

Chapter 2: Review of Literature: This shall normally form Chapter 2 and shall present a critical appraisal of the previous work published in the literature pertaining to the topic of the investigation.

Chapter 3: Materials and Methods: This chapter deals with a detailed methodology by which is being used to collect/ synthesize the data collected and synthesized.

Chapter 4: Results and Discussions: This shall form the penultimate chapter of the dissertation and shall include a thorough evaluation of the investigation carried out and bring out the contributions from the study. The discussion shall logically lead to inferences and conclusions, as well as scope for possible future work.

Chapter 5: Summary and Conclusions: This will be the final chapter of the dissertation. A brief report of the work carried out shall form the first part of the Chapter. Conclusions derived from the logical analysis presented in the results and discussions chapter shall be presented and clearly enumerated, each point stated separately. Scope for future work should be stated lucidly in the last part of the chapter.

Chapter 6: References / Bibliography: The candidates shall follow the style of citation and style of listing in one of the standard journals in the subject area consistently throughout his/her dissertation (mentioned below). However, the names of all the authors along with their initials and the full title of the article /monograph/ book, etc., have to be given in addition to the journals /publishers, volume, number,

pages(s), and year of publication. Citation from websites should include the names(s) of author(s) (including the initials), full title of the article, website reference and when last accessed. Reference to personal communications, similarly, shall include the author, title of the communication (if any) and date of receipt. The example is given below:

For journal:

Example 1: Ojha SN, Tiwari D, Anand A, Sundriyal RC (2020) Ethnomedicinal Knowledge of a Marginal Hill Community of Central Himalaya: Diversity, Usage Pattern, and Conservation Concerns. Journal of Ethnobiology and Ethnomedicine. 16: 29-33.

Example 2: Ojha, S.N., Tiwari, D., Anand, A., and Sundriyal, R.C. (2020). Ethnomedicinal Knowledge of a Marginal Hill Community of Central Himalaya: Diversity, Usage Pattern, and Conservation Concerns. *Journal of Ethnobiology and Ethnomedicine.* **16:** 29-33.

Example 3: **Ojha, S.N., Tiwari, D., Anand, A., and Sundriyal, R.C.** Ethnomedicinal Knowledge of a Marginal Hill Community of Central Himalaya: Diversity, Usage Pattern, and Conservation Concerns. ***Journal of Ethnobiology and Ethnomedicine.*** **16:** 29-33 (2020).

For books:

Chauhan NS (1999) Medicinal and Aromatic Plants of Himachal Pradesh. Indus Publishing Company, New Delhi.

For Chapter in books:

Tewari, L.M., Tewari, G., Chopra, N., Tewari, A., Pandey, N.C., and Kumar, M. (2020). Phytochemical Screening and Antioxidant Potential of Some Selected Wild Edible Plants of Nainital District, Uttarakhand. In: *Natural Products and their Utilization Pattern* (Eds. Tewari G, Tewari A, Tewari LM). New York, NY: Nova Science Publishers, Inc. **pp** 71–97.

Chapter 7: Appendix: Detailed information, lengthy derivations, raw experimental observations, etc., are to be presented in the separate appendices, which shall be numbered in Roman Capitals (e.g., “Appendix IV”). Submit the Plagiarism report (using any available plagiarism software) of the dissertation. Please bind a copy of the synopsis after the plagiarism report.

Type -Setting, Text Processing and Printing: The text shall be printed using a standard text processor. The standard font shall be Times New Roman, 12 pt, with 1.5 line spacing.

Auxiliary

1. **Binding:** Hard Binding
2. **Front Covers:** The front covers shall contain the following details: the full title of the thesis, properly centered and positioned at the top. Full name of the candidate with Roll No., Registration No., Session, Year of Submission, Name of the Guide, Department, and Name of the College properly centered at the middle of the page.
3. **Title Sheet:** This shall be the first printed page of the thesis and shall contain the submission statement: the dissertation submitted in partial fulfillment of the requirements of the Degree e.g. Graduate Degree Honours with Research, the name and enrollment no. of the candidate, name(s) of the Guide and Co-guide (s) (if any), Department, institute and year of submission.
4. **Declaration of Academic Honesty and Integrity by Candidate:** A declaration of Academic honesty and integrity is required to be included along with every dissertation after the Guide's certificate.
5. **Certificate from the Guide and the Head of the Department separately.**
6. **Abstract:** The 500-word (maximum) abstract shall highlight the important features of the dissertation. The abstract in the dissertation, however, shall include two additional parts: the dissertation layout, providing a brief chapter-wise description of the work, and the keywords.
7. **Contents:** The contents shall follow the abstract and list the titles of the chapters, sections, and subsections using decimal notation, as in the text, with corresponding page numbers against them, flush to the right. Two separate lists of figure captions and table titles, along with their numbers and corresponding page numbers, shall follow the contents.
8. **Abbreviation Notation and Nomenclature:** A complete and comprehensive list of all abbreviations, notations, and nomenclature, including Greek alphabets with subscripts and superscripts, shall be provided after the list of tables and figures.

Marks Distribution for Dissertation Research Project

Sl No	Subject or points for Marks	Marks Allotted
1	Title page, topic, and relevance of topic/justification	10
2	Abstract (covering background of research, brief methodology, results, and conclusion, within a word limit of 300)	10
3	Introduction & Review of the literature (Headings / Subheadings)	30
4	Objectives of the study	10
5	Materials and Methods	30
6	Result and Discussion	25+25
7	Conclusion	20
8	References	15
Total Marks on Copy/Report		**175**
8	PowerPoint Presentation (within 50 slides, covering the title slides, detailed contents, conclusion, acknowledgements, and references) (slide preparation: 10, and presentation: 20)	30
9	Viva-voce	20
Total Marks on Presentation & Viva-voce		**50**
Full Marks of the Paper		**225**

- **Evaluation Process:** Evaluation of this paper will be conducted at the University with both the internal members from the University and External Members from the colleges.
- **The candidate has to submit 03 (three) hard-bound copies at the time of examinations, duly signed by the mentor and the Head of the Department.** The board of examiners will examine and endorse the copies during the evaluation process.
- **For survey-oriented work, relevant documents, such as questionnaires duly signed by the mentor and the candidate, are to be attached as Annexure at the end of the dissertation copies.**

Question Pattern and Marks Distribution for BOTANY Major, Minor and MDC as per NEP, 2020 Syllabus

1. Question & marks pattern for **THEORY** papers of **NEP 2024 batch mentioned below**.

A. MAJOR and MINOR- NEP-2024 batch papers divided into four modules each

Sl No	Marks	No of question to be attend	Options to be given	Total allotted Marks
1	**01**	**06**	09	**06**
2	**06***	**04** (One from Each Module)	08 (Two from Each Module)	**24**
Total Theory Marks				**30**

*6 marks may have part marking of 2 or >2 and 4 or <4 for each question for the maximum benefit of the students

B. MDC paper of NEP-2024 batch - papers divided into three modules each

Sl No	Marks	No of question to be attend	Options to be given	Total allotted Marks
1	**01**	**10**	14	**10**
2	**10***	**03** (One from Each Module)	06 (Two from Each Module)	**30**
Total Theory Marks				**40**

*10 marks may have part marking of 2 or >2 and 8 or <8 for each question.

2. The question pattern for **PRACTICAL** papers of **Major** and **Minor** is mentioned in the syllabus batch will be as per existing marks distribution pattern mentioned in the revised syllabus.

FORMAT OF QUESTION PAPER (for Paper Setters)

MAJOR and **MINOR** papers [2024-batch of NEP] FM=30 for Theory

Q.1. Answer any **Six** from the Following Questions	1 mark each x 6
Q.2. **[MODULE-1]** Answer any one **Q2A or Q2B**	6 marks each
Q.3. **[MODULE-2]** Answer any one **Q3A or Q3B**	6 marks each
Q.4. **[MODULE-3]** Answer any one **Q4A or Q4B**	6 marks each
Q.5. **[MODULE-4]** Answer any one **Q5A or Q5B**	6 marks each

For MDC papers [2024-batch of NEP] FM=40 for Theory]

Q.1. Answer any **Ten** from the Following Questions	1 mark each x 10
Q.2. **[MODULE-1]** Answer any one Q2A or Q2B	10 marks each
Q.3. **[MODULE-2]** Answer any one Q3A or Q3B	10 marks each
Q.4. **[MODULE-3]** Answer any one Q4A or Q4B	10 marks each

For Internal Assessment

For Internal Assessment of **Botany Major**

1. Students must prepare Charts for presentation. For each Paper, students must prepare charts separately.
2. The Charts must be hand made with proper information.
3. Theme of the chart will be any one from their existing syllabus.
4. Selection of topics solely depends on the candidates not by the department or faculty members.
5. Teachers may give suggestions in preparing the chart but not selection of the topics.
6. The department must collect information about the topics prior to chart preparation so that repetition of the topics may be avoided.
7. Chart will be submitted separately by the candidates during the evaluation. The following informations must be clearly indicated
    a. The size of the chart must be 1/4th of an art paper.
    b. There will be no restriction of using the colour, designing of the chart.
    c. Candidate Name, Roll No., Registration No., Session, Paper and Topic Title must be clearly indicated on the chart.

d. Any print out material except pictures of Scientist must be avoided.

8. Before submission, the charts must be endorsed by the Head or and Faculty Members of the Department.
9. For Evaluation, External and Internal Examiners should ask to present the chart from their submission. For Presentation, examiners can ask for only one, two or all the charts of their submission.
10. For Viva-voce, examiners can ask questions from all the submissions although He/She presented one chart.
11. Examiners are requested to give maximum benefit to the candidates.
12. All the submissions must be kept in the department for future reference.

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UG SYLLABUS OF BOTANY (SEMESTER SYSTEM)
[as per National Education Policy-2020]

Disciplinary Minor Course in Botany

Course Code- BOT-DCM

Course Title

PLANT DIVERSITY: PROCESSES AND APPLICATION

w.e.f. Academic session 2023

REVISED 2024

SEMESTER: I - VIII

COURSE OBJECTIVES

- To develop basic knowledge among students in the field of plant diversity.
- To explore the knowledge about evolutionary groups.
- To develop basic knowledge about the processes in plants.
- To generate knowledge regarding the application of plant sciences in brief mode.

YEAR-I

SEMESTER-I

BOTDCM- 101 T: Basic Concept in Plant Sciences

Module 1: Overview of plant science
Module 2: Introduction to Microbes
Module 3: Introduction to Thallophytes-Algae
Module 4: Introduction to light microscopy

SEMESTER-II

BOTDCM- 201 T: Fungi, Lichens and Archegoniate

Module 1: Fungi
Module 2: Lichens
Module 3: Bryophytes
Module 4: Pteridophytes

YEAR-II

SEMESTER-III

BOTDCM- 301 T: Gymnosperms, Paleobotany and Plant Ecology

Module 1: Gymnosperms
Module 2: Palaeobotany
Module 3: Ecology-Basic Concepts
Module 4: Adaptive Ecology

SEMESTER-IV

BOTDCM- 401 T: Plant Anatomy and Embryology

Module 1: Meristimatic and permanent tissues
Module 2: Structure of Xylem and Phloem tissue
Module 3: Structure of anther and pollen
Module 4: Embryo and endosperm

YEAR-III

SEMESTER-V

BOTDCM- 501 T: Plant Morphology and Taxonomy of Angiosperms

Module 1: Morphology and plant taxonomy of angiosperms
Module 2: Taxonomic hierarchy

Module 3: Classification
Module 4: Diagnostic features of Families

SEMESTER-VI

BOTDCM- 601 T: Plant Physiology and Plant Metabolism

Module 1: Plant-water relations
Module 2: Photosynthesis, Respiration
Module 3: Biomolecules
Module 4: Enzymes

YEAR-IV

SEMESTER-VII

BOTDCM- 701 T: Cell Biology and Genetics

Module 1: The cell
Module 2: Cell division
Module 3: Mendelian genetics
Module 4: Changes in chromosome number and structure.

SEMESTER-VIII

BOTDCM- 801 T: Plant Breeding, Biostatistics and Plant Biotechnology

Module 1: Plant Breeding
Module 2: Biostatistics
Module 3: Rules of probability
Module 2: Plant Biotechnology

YEAR-I

SEMESTER-I

BOTDCM- 101 T: BASIC CONCEPT IN PLANT SCIENCES

Topic content of THEORY part [03Credits] (Teaching hours = 45) (FM-30)

MODULE 1: Overview of Plant Science: General introduction to different plant groups Thallophytes (Algae, Fungi) Bryophytes and Tracheophytes with general examples.

MODULE 2: Introduction to Microbes – Virus and Bacteria. Cell wall structure of Gram positive and Gram negative bacteria (Concept), Types of Virus, DNA and RNA, structure of bacteriophage. Economic importance of microbes.

MODULE 3: Introduction to Thallophytes- Algae - general characters of algae, ecology and distribution, ecological and economic importance of algae. Morphology and lifecycle of *Nostoc* sp and *Chara* sp.

MODULE 4: Introduction to light microscopy (Simple and compound): Different types of optical microscope: Simple and compound microscope, their parts and functions.

Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)
BOTDCM-101 P (Practical) (FM-20) Duration: 2 Hrs.

1. Study of vegetative and reproductive structures of *Nostoc, Oedogonium* (Macrandrous), and *Chara* through temporary preparations and permanent slides.
2. Electron Micrographs/Models of viruses – T-Phage and TMV.
3. Observation of microorganisms in Curd (Simple staining: Methylene blue)
4. Study from Permanent slides Gram positive and Gram Negative bacteria (No work out)

Suggested readings

- Kumar, H.D. & Singh, H.N. ……Introductory Phycology [East-West Press Pvt. Ltd]
- Bold, H.C. & Wynne, M.J. .....Introduction to Algae: Structure & Reproduction [Prentice Hall]
- Ganguly, H.C. &Kar, A.K.....College Botany Vol.-II [New Central Book Agency]
- Kumar, H.D. & Singh, H.N……..Introductory Phycology [East-West Press Pvt. Ltd]
- Atlas, R.M. .....Principles of Microbiology [McGraw Hill]
- Banerjee, A.K. & Banerjee, N. …….Fundamentals of Microbiology and Immunology [New Central Book Agency]

● Pelczar, M.J., Chan, P.C.S. & Krieg, N.R. .....Microbiology [Tata McGraw Hill]

SEMESTER-II

BOTDCM- 201 T: FUNGI, LICHENS AND ARCHEGONIATE

Topic content of THEORY part [03Credits] (Teaching hours = 45) (FM-30)

MODULE 1: Fungi - General characters of Fungi, Life cycle, economic importance of fungi, Lifecycle of *Rhizopus* sp.

MODULE 2: Lichens- Occurrence; General characteristics; Growth forms and range of thallus organization, ecological and economic importance.

MODULE 3: Bryophytes- General characters, Range of thallus organization, Life cycle of *Marchantia* and *Funaria*. Ecological and economic importance of bryophytes.

MODULE 4: Pteridophytes- General characters, life cycle with reference to Apospory and Apogamy. Life cycle of *Lycopodium* and *Pteris* sp, ecological and economic importance of pteridophytes.

Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)
BOTDCM-201 P (Practical) (FM-20) : Duration 2 Hrs.

1. Asexual stage from temporary mounts of *Rhizopus and Ascobolous* / *Peziza* (No work out)
2. Lichens: Morphological Study of growth forms of lichens from museum/preserved specimen (crustose, foliose and fruticose)
3. Type study using semi permanent mounts: Morphological and Anatomical features of *Marchantia* (antheridial and archegonial heads) and *Funaria* (Capsule)
4. Type study using semi permanent mounts: Morphological and Anatomical features *Lycopodium* Strobilus (L.S) and *Pteris*- morphology, rachis (T.S).

Suggested readings

- Hoek, C., Mann, D.G. & Jahns, H.M. 1995 …….....Algae: an Introduction [Cambridge Univ. Press]
- Seaward, M.R.D. (1977) (Ed.) ……...Lichen ecology, Academic Press, London.
- Sharma, P.D. (2011). ……..Plant Pathology, Rastogi Publication, Meerut, India.
- Agrios, G.N. (1997) ……Fungi, 4th edition, Academic Press, U.K.
- Puri, P. .....Bryophyte [Atmaram& Sons]

- Rashid, A. .....An Introduction to Bryophyta [Vikas Publishing House]
- Vashishta, B.R. .....Bryophyta [S. Chand & Co.]
- Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). ……..…Pteridophyta. S. Chand. Delhi, India.
- Gifford, E.M. & Foster, A.S. .....Morphology and Evolution of Vascular Plants [Freeman & Co.]
- Mukherjee, R.N. & Chakraborty, K. .....An Introduction to Vascular Cryptogams (Pteridophytes)

YEAR II

SEMESTER-III

BOTDCM- 301 T: GYMNOSPERMS, PALEOBOTANY AND PLANT ECOLOGY

Topic content of THEORY part [03Credits] (Teaching hours = 45) (FM-30)

MODULE 1: Gymnosperms - General characters, morphology and anatomy and life cycle of *Cycas* and *Pinus*. Ecological and economic importance of Gymnosperms

MODULE 2: Palaeobotany – Introduction to paleobotany, fossils, definition and types, fossilization process. Type study of *Glossopteris* (leaf) and *Calamites* (Stem).

MODULE 3: Ecology: Basic concepts, Levels of organization, tropic structure, concept of food chain, food web, ecological pyramid and models of energy flow.

MODULE 4: Adaptive Ecology of hydrophytes and xerophytes (Morphological and anatomical features)

Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)
BOTDCM-301 P (Practical) (FM-20)

1. Morphological and anatomical features of Leaflet (T.S) and Morphological studies of Megasporophyll and Microsporophyll of *Cycas*.
2. Morphological and anatomical features of Needle (T.S) and Morphological studies of Male and Female Cones of *Pinus*.
3. Fossils (Museum specimen) Morphological studies of leaf fossil *Glossopteris* and anatomical structures (T.S.) of *Calamites.*
4. Adaptive Morphological and Anatomical studies of Hydrophyte: (*Eichhornia, Hydrilla* and *Ludwigia*) and Xerophyte: (*Opuntia* and *Nerium*)

Suggested Readings

- Puri, P. .....Bryophyte [Atmaram& Sons]
- Rashid, A. .....An Introduction to Bryophyta [Vikas Publishing House]
- Vashishta, B.R. .....Bryophyta [S. Chand & Co.]
- Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). …..…….Pteridophyta. S. Chand. Delhi, India.
- Gifford, E.M. & Foster, A.S. ...Morphology and Evolution of Vascular Plants [Freeman & Co.]
- Mukherjee, R.N. & Chakraborty, K. …….....An Introduction to Vascular Cryptogams (Pteridophytes) [Kalyani Publishers]
- Rashid, A. .....An Introduction to Pteridophyta [Vikas Publishing House]

- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). …Biology. Tata McGraw Hill, Delhi.
- Verma, P.S. & Agarwal, V.K. .....Concept of Ecology [S. Chand & Co.]
- Kumar, H.D. .....Modern Concept of Ecology [Vikas Pub House]

SEMESTER-IV

BOTDCM- 401 T: PLANT ANATOMY AND EMBRYOLOGY

Topic content of THEORY part [03Credits] (Teaching hours = 45) (FM-30)

MODULE 1: Meristematic and permanent tissues: Organization of shoot apex (Tunica-corpus concept) and organization of root apex (Korper-Kappe concepts); Structure of dicot and monocot leaf

MODULE 2: Structure of Xylem and Phloem tissue; Types of stele; Vascular bundle -types and function, Anatomy- Study of stem and root of monocot (*Zea mays)* and dicot (*Helianthus* sp).

MODULE 3: Structure of anther and pollen; Structure and types of ovules; Structure of mature embryo sac.; Pollination and fertilization: Pollination mechanisms and adaptations; Double fertilization;

MODULE 4: Embryo and endosperm: Endosperm types, structure and functions; Dicot and monocot embryo; Apomixis and polyembryony (Concept only)

Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)
BOTDCM-401 P (Practical) (FM-20)

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ permanent slides, T.S of monocot (*Zea mays*) and dicot (*Helianthus* sp) stems.
2. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ permanent slides, T.S of monocot (*Zea mays*) and dicot (*Helianthus* sp) roots.
3. Ultra -structure of mature egg apparatus cells through electron micrographs.
4. Dissection of embryo/endosperm from developing seeds

Suggested Readings

- Fahn, A. ……..….....Plant Anatomy [Pergamon press]
- Foster, A.S. .....Practical Plant Anatomy [D. Van Nesten and Co.]
- Ganguly, H.C. & Kar, A.K. ……..…....College Botany Vol. I [New Central Book Agency]
- Mitra, D., Guha, J. & Chowdhury, S.K…….....Studies in Botany, Vol.I [Moulik Library]

- Nair, P.K.K. .....Pollen Morphology of Angiosperms [Scholar Publication]
- Maheswari, P. ..... Introduction to the Embryology of Angiosperms [Tata McGraw Hill]
- Bhojwani, S.S. & Bhatnagar, S.D. …..The Embryology of Angiosperms [Vikas Publishing House]

YEAR III

SEMESTER-V

BOTDCM- 501 T: PLANT MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Topic content of THEORY part [03Credits] (Teaching hours = 45) (FM-30)

MODULE 1: Morphology and plant taxonomy of angiosperms, Leaf: Types, Margin, Base, Venation and Phyllotaxy, Petiole and modifications., Inflorescence: types with examples; Flower: Floral parts, Thalamus and insertion of floral parts, Calyx, Corolla, Aestivation, Perianth, Stamen: Types and anther shape. Carpel : types, placentation-types, ovule structure and types; Fruit types with examples.

MODULE 2: Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Basic principles of ICN,

MODULE 3: Classification: Concept of natural, artificial and phylogenetic system of classification with one example each (detailed classification not included).

MODULE 4: Diagnostic features of Families: Dicotyledons Malvaceae, Solanaceae, Labiateae, Monocotyledons- Poaceae .Advanced characteristic features of Asteraceae and Orchidaceae.

Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)
BOTDCM-501 P (Practical) (FM-20)

1. **Morphology:** Morphological studies (No working out): Different types of phyllotaxy in plants; Types of special inflorescence; Placentation;
2. Different types of fruits. (Simple, composite and aggregate)
3. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification); Identification up to Family only
   - **A.** Malvaceae- *Sida/ Abutilon*
   - **B.** Lamiaceae/ Labiatae – *Leucas/ Leonurus*
   - **C.** Solanaceae- *Solanum/ Nicotiana*

Suggested Readings

- Eames, A.J. .....Morphology of Angiosperms [McGraw Hill]
- Esau, K. .....Plant Anatomy [Wiley Eastern]
- Lawrence, G.H.M. .....Taxonomy of Vascular Plants [Oxford & IBH]
- Datta, S.C. .....Systematic Botany [Wiley Eastern]
- Mukherjee, S. .....College Botany Vol. III [New Central Book Agency]
- Mitra, D., Guha, J. & Chowdhury, S.K……....Studies in Botany, Vol. I [Moulik Library]

SEMESTER-VI

BOTDCM- 601 T: PLANT PHYSIOLOGY AND PLANT METABOLISM

Topic content of THEORY part [03Credits] (Teaching hours = 45) (FM-30)

MODULE 1: Plant-water relations: Importance of water, water potential and its components (concept only). plasmolysis, deplasmolysis, Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation, Mineral nutrition: Essential elements, macro and micronutrients, Phloem loading and unloading

MODULE 2: Photosynthesis: Light absorption in plants, Light and dark reactions of photosynthesis, basic of Calvin cycle (C3 cycle), Respiration- Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation.

MODULE 3: Biomolecules Carbohydrates: Nomenclature and classification; Monosaccharides ; Disaccharides; Oligosaccharides, Polysaccharides, Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Structure of amino acids and classification, biological roles of proteins. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids DNA and RNA, (structure of t- RNA).

MODULE 4: Enzymes- Definition**,** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes, secondary metabolites , Alkaloids- precursor and significance.

Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)
BOTDCM-601 P (Practical) (FM-20)

1. Determination of Stomatal frequency and rate of transpiration per stomata per hour.
2. Measurement of oxygen uptake by respiring tissue (per gram / hr.) by germinating seeds.
3. Effect of carbon dioxide on the rate of photosynthesis. (varying HCO- 3 concentration using
4. bicarbonate in an aquatic plant to find out the optimum and toxic concentration)
5. Qualitative detection of the nature of carbohydrate- glucose, fructose and starch from laboratory samples.

Suggested reading

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

YEAR IV

SEMESTER-VII

BOTDCM- 701 T: CELL BIOLOGY AND GENETICS

Topic content of THEORY part [03Credits] (Teaching hours = 30)(FM-30)

MODULE 1: The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Overview of membrane function; fluid, mosaic model; Ultra structure of Nucleus and Chloroplast.

MODULE 2: Cell division: Mitosis and Meiosis- Different stages and significance.Cell Cycle-Definition, and different phases of eukaryotic cell cycle; Regulation of cell cycle.

MODULE 3: Mendelian genetics: Mendelism: Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosome, Incomplete dominance and co-dominance; Multiple alleles, basics of linkage and crossing over, Sex linkage.

MODULE 4: Changes in chromosome number and structure: Euploidy and aneuploidy, chromosomal rearrangements, deletion, duplication, inversion, and translocation. Fine structure of genes.

Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)
BOTDCM-701 P (Practical) (FM-20)

1. Study of Mitotic Chromosomes: Metaphase chromosome preparation, free hand drawing, determination of 2n number and comment on chromosome morphology of root tips of *Allium cepa*.
2. Study of Meiotic Chromosomes, Smear preparation of meiotic cells, identification of different stages (at least two) and free hand drawing of those stages- from flower buds of *Allium cepa*
3. Identification from permanent slides : Different normal stages of Mitosis and Meiosis
4. Determination of goodness of fit in normal and modified mono and dihybrid ratios (3:1, 9:7, 13:3; 9:3:4, 12:3:1, 9:3:3:1) by Chi-square analysis and comment on the nature of inheritance.

Suggested Readings

- Powar, C.B. .....Cell Biology [Himalaya Publishing House]
- Verma, P.S. & Agarwal, V.K. .....Concept of Cell Biology [S. Chand & Co.]
- Bhojwani, S.S. and Razdan, M.K., (1996). ……Plant Tissue Culture: Theory and Practice. Elsevier, Science Amsterdam. The Netherlands.
- Gardner, E.J., Simmons, M.J. & Snustad, D.P……...Principles of Genetics [John Wiley]
- Gupta, P.K. .....Genetics [Rastogi Publications]

SEMESTER-VIII

BOTDCM- 801 T: PLANT BREEDING, BIOSTATISTICS AND PLANT BIOTECHNOLOGY

Topic content of THEORY part [03Credits] (Teaching hours = 45) (FM-30)

MODULE 1: Plant Breeding: Introduction; Breeding systems: modes of reproduction in crop plants. Methods of crop improvement: Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Heterosis and Hybrid vigour; Concept of Inbreeding depression and heterosis.

MODULE 2: Biostatistics: Introduction to Biostatistics: Characteristics, Usefulness and Limitation, Types of Data. Sampling methods-concept of sampling of population, measures of central tendency and dispersal: determination of mean, mode, median, variance, standard deviation and standard error.

MODULE 3: Rules of probability (Addition and Multiplication theorem), Null-hypothesis, Tests of significance: chi square test, t-test (student and paired t-test).

MODULE 4: Plant biotechnology: Totipotency: Organogenesis; Embryogenesis (somatic and zygotic); Micropropagation and its application. Restriction Endonucleases, types and examples. Recombinant DNA Techniques (Concepts) Northern, Southern and Western Blotting, DNA Finger printing; Molecular DNA markers i.e. RAPD, RFLP; DNA sequencing: Principles of PCR and its application.

Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)
BOTDCM-801 P (Practical) (FM-20)

1. Study of floral structure of self-pollinated and cross pollinated crops. (Work out)
2. Emasculation and hybridization techniques in self and cross pollinated crops. (Demonstration)
3. Familiarization with basic equipment in tissue culture- Demonstration of transfer of explants under sterile conditions.
4. Univariate analysis of statistical data: Statistical tables, mean mode, median, standard deviation, and standard error (using seedling population / leaflet size).

Suggested Readings

- Glick, B.R., Pasternak, J.J. (2003). ……..Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
- Dubey, R.C. .....Biotechnology [S. Chand & Co.]
- Chawdhuri, H.K. .....Elementary Principles of Plant Breeding [Oxford & IBH]
- Poehlman, J.M. & Barthakur, D. .....Plant Breeding [Oxford & IBH]
- B.D. .....Plant Breeding: Principles and Methods [Kalyani Publishers]
- Sokal, R.R. & Rohlf, F.J. .....Introduction to Biostatistics [W H Freeman]

Practical Marks Distribution
Major Course- BOT-DCM
Duration: 2 hours

Sl No	Description	Marks
1	**Workout of Specimen (where only workout to be done)** OR Workout of specimen (where work out and demonstration both have to perform)	**10** OR 05
2	**Demonstration**	05
3	**Identification 2 specimens (2.5 X 2)**	05
4	**Submission** of Laboratory Records/ Slide/ Excursion copy	03
5	**Viva-voce**	02
Total		**20**

FOR INTERNAL ASSESSMENT OF **BOTANY MINOR**

1. Students have to submit an assignment for their internal assessment.
2. The topic of the assignment is to be done within the contents of the syllabus of the subject/paper.
3. Teachers may provide suggestions for preparing the chart, but not for selecting the topics.
4. The department must collect information on the topics before preparation to avoid repetition.
5. The assignment must be handwritten and submitted during the examination. The department will keep the assignment for the record.
6. Viva-voce will be conducted on the topic of their assignment or relevant topics.

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UNIVERSITY OF GOUR BANGA

(Established under West Bengal Act XXVI of 2007)
Recognized by UGC u/s 2f & 12B
N.H.-34 (Near Rabindra Bhawan), P.O.: Mokdumpur,
Dist..: Malda, West Bengal, Pin-732 103

UG SYLLABUS OF BOTANY
(SEMESTER SYSTEM)
[NEP-2020]

MULTIDISCIPLINARY (MDC) COURSE
MDC COURSE ID: MDCS5
POOL NAME: SCIENCE MULTIDISCIPLINARY

Name of Multidisciplinary Course

AGRICULTURAL TECHNOLOGY AND ITS APPLICATION

(Finalized on 31 July 2025)
w.e.f. **Academic session 2023**
REVISED & CODED 2024
SEMESTER: I - III

SEMESTER I

COURSE CODE- **MDCS5/101**

(ECONOMIC BOTANY, CROP PROTECTION AND ETHNOAGRICULTURE)

OBJECTIVES

- To develop basic knowledge among students in the field of sustainable agricultural practices.
- To explore the knowledge about ethnic agricultural practices.
- To develop basic knowledge about crop protection.
- To generate knowledge regarding plant disease and its management.

COURSE CURRICULUM

MODULE 1: Economic Botany: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions: Crop domestication (Paddy), Utilization of economically important plants: Cereals - Wheat and rice, legumes - Chick pea, Pigeon pea, beverage crops-Tea, Coffee, Spices- clove and black pepper, Oil yielding mustard and coconut, Fibre –Jute.

MODULE 2: Crop Protection: Introduction to crop protection, Disease concept, Symptoms, Epidemic and Endemic, Sporadic and Pandemic Disease. Koch's postulate, Concept of plant disease management (biotic and abiotic) - Chemical, Biological, and Quarantine. Concept of crop rotation.

MODULE 3: Ethnoagriculture: Definition, plants used by ethnic communities as Food sources-Medico-ethnobotanical uses of (a) *Azadirachta indica* (b) *Ocimum sanctum*.

Suggested Readings

- Agrios, G.N. (1997) ……Plant Pathology, 4th edition, Academic Press, U.K.
- Melhotra R.S and Aggarwal…….... II Ed. Plant Pathology, Mc.Graw Hill Education.
- Kochhar, S.L. (2012). ...Economic Botany in Tropics, MacMillan & Co., New Delhi, India.
- Wickens, G.E. (2001). ……Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
- Chrispeels, M.J. and Sadava, D.E. 1994……. Plants, Genes, and Agriculture. Jones & Bartlett Publishers.
- Sharma, P.D. (2011). ……...Plant Pathology, Rastogi Publication, Meerut, India.

SEMESTER II

COURSE CODE- **MDCS5/201**

(FLORICULTURE, BIOFERTILIZER AND INDUSTRIAL MICROBIOLOGY)

COURSE OBJECTIVES

- To develop students' basic knowledge in floricultural practices.
- To raise awareness about the use of biofertilizers.
- To develop basic knowledge about organic farming in relation to sustainable agriculture
- To generate knowledge about industrially important microorganisms and their role in food and other fields

COURSE CONTENTS

MODULE 1: Floriculture: Importance and scope of floriculture, Types of nursery and their Management, Commercial flowering plants; Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers- Dahlia, Gerbera, Gladiolus, Marigold, Rose. Diseases and Pests of Ornamental Plants and Their Management Strategies.

MODULE 2: Biofertilizer: Plant Growth Promoting Rhizobacteria (PGPR) and Plant Growth Promoting Fungi (PGPF): Characterization and effect on plant growth and disease suppression; Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation. Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural, and Industrial wastes- biocompost making methods, types and methods of vermicomposting and their field Application.

MODULE 3: Industrial microbiology: Fermentation processes- Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor; types of fermented products, general concept of industrial production of cheese, bread, and Beer (overview concept).

Suggested Readings

- Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application-based approach. Tata McGraw-Hill Education Pvt. Ltd., Delhi.
- Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A., 9th edition.
- Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

- Dubey, R.C., 2005 A Textbook of Biotechnology S.Chand & Co, New Delhi.
- Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
- John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
- Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
- Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
- Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

SEMESTER III

COURSE CODE- **MDCS5/301**

(MUSHROOM CULTURE TECHNOLOGY, FOOD SAFETY AND SECURITY AND AGRICULTURE ENTREPRENEURSHIP)

OBJECTIVES

- To develop practical skills among students in mushroom cultivation.
- To generate awareness regarding food safety and security.
- To develop basic knowledge about entrepreneurship in relation to sustainable agriculture
- To generate awareness and interest among students regarding agripreneurship.
- To generate knowledge regarding different funding agencies in relation to entrepreneurship development.

COURSE CONTENTS

MODULE 1: Mushroom culture technology: Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms; Concept of spawn preparation and cultivation of Oyster mushroom. Post-harvest Processing: Short-term storage (Refrigeration - up to 24 hours), long-term storage (canning, pickles, papads), drying, storage in salt solutions.

MODULE 2: Food safety and security: Definition, four pillars of food security, levels of food security, food safety and standards, Importance of food security and safety (FSSAI), outline of agricultural food security access.

MODULE 3: Agricultural entrepreneurship: Concept of Entrepreneurship, IPR, Agri-preneurship, entrepreneur, role of funding agency NBARD, ADC, Business and marketing medicinal plants development; Marketing of agricultural inputs with special reference to fertilizers and seeds, Role of ICAR, IARI; Classification of agricultural products with particular reference to seasonality.

Suggested Readings

- Swaminathan, M. (1990). ……Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
- Kumaresan, V. 2005…….Biotechnology, Saras Publications, New Delhi
- John Jothi Prakash, E. 2004. ……Outlines of Plant Biotechnology. Emkay Publications, NewDelhi

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Dist..: Malda, West Bengal, Pin-732 103

UG SYLLABUS OF BOTANY

(SEMESTER SYSTEM)

[NEP-2020]

SKILL ENHANCEMENT COURSE (SEC)

(Approved Syllabus)

(Finalized on 31 July 2025)

w.e.f. **Academic Session 2023**

REVISED & CODED 2024

SEMESTER: I - III

BOTANY

General Guidelines for Evaluation of Skill Enhancement Course

The following guidelines are to be followed by the Internal as well as External Examiners for conducting the evaluation process of SEC courses of Botany **Major Students of Semester I-III.**

For Botany Major

- Departments shall conduct Orientation for SEC.
- The Internal Examiner(s) will prepare the complete marks following the evaluation modalities provided by UGB **(SEC: 50 marks)** and sit for the final examination (viva-voce and presentation) with the External Examiner.
- The college will maintain the **Record of Attendance, Activity Logbook** and **Syllabus**. On the day of the evaluation the student will produce his/her "***Certificate of Completion***" on the specific course and the internal examiner(s) will produce the **Syllabus of Course, Activity Logbook and Students' Attendance Sheets** before the external **examiner**(s).
- A Certificate of Performance will be issued to the SEC.
- The students are to be guided to submit **2 copies** of the certificate duly signed by the coordinator (s) and Head of the Department; one to be submitted to the department and the other to be produced before the external examiner.
- Students must submit **2 Copy of Short Summary Report** of the SEC paper duly signed by the Head of the Department which may be of maximum 500 words. Relevant Photographs may be attached to the copy. Students must submit the copy before the examiners on the day of evaluation.
- The Short Summary Report preferably handwritten. One copy original and the other copy may be photocopied.
- The **Certificate of Completion** will indicate that the student has completed the course satisfactorily, unsatisfactory, and excellently etc.
- Certificate of Performance (for SEC only: 50 marks) may be based on grades given as follows:

40 and above:	A
30-39:	B
20-29:	C
Below 20:	D

- For evaluation of SEC, Marks Distribution are as follows

Attendance:	05
Activity logbook:	05
Class Performance:	05
Class Test:	15
Viva-voce:	10
Presentation:	10
TOTAL:	**50**

CONTENT

Semester I

Biofertilizer Development and Commercialization
OR
Environmental Challenges and Sustainable mitigation

Semester II

Mushroom Cultivation and its Commercialization
OR
Plant Resources Utilization and Commercialization

Semester III

Phytomedicine Prospects and Utilization
OR
Indian Knowledge System in Plant Sciences

Semester I

Course Title: BIOFERTILIZER DEVELOPMENT AND COMMERCIALIZATION

Course Objectives :

- To generate the basic awareness about use and importance of biofertilizer
- To train the students to prepare biocompost for agricultural application

Course Outcome: The students will be able to

- Compare the role of different biological agents in soil fertility
- Identify bacterial and fungal association of different cultivated plants
- Prepare organic compost using household waste
- To prepare vermicompost and apply in crop production
- To generate entrepreneurship in composting techniques

DETAILED COURSE SYLLABUS

MODULE 1: Introduction to Biofertilizers : Introduction to Bio-fertilizers and types. General account about the microbes used as biofertilizers – *Rhizobium* – isolation and functional characterization, identification, mass multiplication. Different types of beneficial microorganisms: PGPR, AMF, BCA, PGPF, BGA.

MODULE 2: Introduction to Boi-formulation of Biofertilizers: Selection of different types of carrier medium, shelf life, application strategies. Concept of different types of formulations for different groups of beneficial microorganisms, concept of microbial consortia and application. Importance of organic manure in organic farming systems. Types of organic manure (e.g. compost, vermicompost, farmyard manure). Benefits and challenges of using organic manure.

MODULE 3: Concept of Commercialization of Biofertilizers and Case Study: Concept of Commercialization of Biofertilizers, Regulations in India and outlines of Bio-fertilizer act. Green Manure and Organic fertilizers, Case studies of few successful Bio-fertilizers/Bio-fertilizer companies in India,

MODULE 4: Hands on training on composting techniques using biological waste, Method of vermicomposting and field Application (Project/ Hands on Training/ Demonstration/ Industrial Visit); Field visit to a nearest Vermi Composting unit / Bio-fertilizer Unit / Hands on training on preparation of solid or liquid bio-formulation of PGPR under *in vitro* conditions.

Suggested Readings

1. Soil Microbiology …….Subha Rao, N.S. 2000, , Oxford & IBH Publishers, New Delhi.
2. Bio-fertilizers and organic Farming …….Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Akta Prakashan, Nadiad
3. Biofertilizer Technology …S. Kannaiyan-Scientific Publishers, ISBN 9789386102485
4. Handbook of Biofertilizers & Biopesticides ……Rajaram Choyal-SIBT publications- ISBN 9789382036685
5. The Complete Technology Book on Biofertilizer and Organic Farming ……...Himadri Panda-Niir Project Consultancy Services

Course Title: ENVIRONMENTAL CHALLENGES AND SUSTAINABLE MITIGATION

Course Objective:

- To develop the theoretical and knowledge foundation on the concept of sustainable development
- To gain an empirical understanding of the emerging global challenges for sustainable environmental and societal governance systems.
- To improve the ability and sophistication in creating the necessary information links and feedback loops within the system to develop sustainable solutions.
- This would enable us to visualise various factors that impact sustainability and propose a plan of action for building sustainable communities.

Course Outcome:

- The students will enable to know about the sustainability considerations can actually be embedded within an individual's and community's day to day activities
- Gain knowledge about the existing sustainable development tools and methods can be adjusted/fine-tuned accordingly
- Able to design sustainability performance metric to assess the impact on community's sustainable development
- Will empower communities set sustainability targets using appropriate metrics

DETAILED COURSE SYLLABUS

MODULE 1: Introduction to Environmental Science & Challenges; Multidisciplinary nature of environmental science, ecological principles, and ecosystem dynamics. Environmental Degradation: Causes and effects of natural and anthropogenic factors. Key Challenges: Global Climate Change (CC), Ozone Layer Depletion, Acid Rain, Deforestation, and Biodiversity Loss.

MODULE 2: Concept of Environmental Challenges and Management: Air Pollution; Sources (natural/anthropogenic), types of pollutants, monitoring, and control technologies; Water Pollution; Water quality standards, groundwater contamination, wastewater treatment technologies. Soil & Land Pollution; Soil erosion, degradation, and salinity.

Solid Waste Management: Municipal solid waste, biomedical waste, E-waste, and management techniques.

MODULE 3: Climate Change Adaptation and Mitigation; Greenhouse effect, carbon footprint, and energy footprints; Mitigation Strategies: Renewable energy adoption, energy efficiency, carbon capture and storage (CCS); Adaptation Techniques: Water conservation, rainwater harvesting, watershed management; Sustainable Agriculture: Impact of agriculture on environment, pesticide problems, and sustainable alternatives. Sustainable Development Goals (SDGs): Concept and pillars (society, environment, economy).

MODULE 4: Practical & Applied Components: Field Work: Site visits to study industrial, agricultural, or local ecosystems; Preparation of Green Audit Report of College, University or Institution; Case Studies: Environmental disasters and successful conservation stories.

Suggested Readings

1. Elliott, Jennifer. 2012. ……..An Introduction to Sustainable Development. 4th Ed. Routledge, London.
2. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. ……"An introduction to sustainable development." (2012).
3. Sachs, J. D. 2015. ……..The Age of Sustainable Development. Columbia University Press, New York.
4. Soubbotina, Tatyana P. 2004……. Beyond Economic Growth: An Introduction to Sustainable Development. WBI learning resources series. Washington DC ; World Bank.
5. Kerr, Julie. ……Introduction to energy and climate: Developing a sustainable environment. CRC Press, 2017.
6. Saito, Osamu. …….Sharing Ecosystem Services. Springer Singapore, 2020.
7. Nhamo, Godwell, and Vuyo Mjimba…….. Sustainable Development Goals and institutions of higher education. Springer, 2020.

Semester II

Course Title: MUSHROOM CULTIVATION AND ITS COMMERCIALIZATION

Course Objectives :

- To generate the basic awareness about nutritional values of edible mushroom
- To train the students to culture different edible mushrooms for commercial as well as domestic uses.
- To demonstrate the method of preservation, processing and packaging of mushroom based foods.

Course Outcome: The students will be able to

- Identify locally available edible and poisonous mushrooms
- Demonstrate nutritional values of common edible mushroom
- Set up and culture button and oyster mushrooms for commercial purpose
- To generate entrepreneurship in mushroom cultivation

DETAILED COURSE SYLLABUS

MODULE 1: Introduction to Mushroom Biotechnology: Edible (e.g., *Agaricus, Pleurotus, Calocybe,*); Poisonous types. Biology: Morphology, and life cycle of mushrooms; Nutritional & Medicinal Value: Protein content, vitamins, minerals and therapeutic aspects.

MODULE 2: Infrastructure & Equipment: Mushroom House Design: Structure and construction of mushroom farms (small village units vs. large commercial setups). Equipment: Autoclave, laminar air flow, sterilization tools, sprayer, racks, bags, and trays. Substrates: Selection of agricultural waste (straw, wheat, banana leaf, wood waste).

MODULE 3: Mushroom Cultivation Technique: Spawn Production: Types of spawn, culture media preparation, mother spawn. Composting methods for Button mushrooms. Substrate Preparation: Sterilization methods of substrates. Cultivation Process: Oyster Mushroom: Bed preparation, Polythene bag method; Button Mushroom: Spawning, casing, casing materials, and casing methods Crop Management: Maintaining temperature, humidity, and ventilation.

MODULE 4: Disease & Pest Management: Dry bubble, wet bubble, weed moulds, and fungal competitors; Insect Pests: Mites, nematodes, and mushroom flies; Management Strategies: Preventive measures and sanitation methods.

MODULE 5 : Post-Harvest Management & Commercialization: Harvesting: Identification of the right stage and techniques for harvesting. Processing & Packaging: Grading, storing, and packaging of mushrooms. Value Addition: Preparation of products (Pickle, Sweets, Snacks, soups, dried products). Marketing & Economics: Business module, cost-benefit analysis, and market feasibility.

MODULE 6: Hands-on Training: Preparation of culture media and spawn. Demonstration of spawning and Oyster mushroom cultivation. Field visit to commercial mushroom farms. Researching market variables (SWOT), understanding the product life cycle, and export procedures.

Suggested Readings

1. Hand Book Of Mushroom Cultivation Processing and Packaging by Eiri Board, Engineers India Research Institute
2. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
3. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
4. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications

Course Title: Plant Resources Utilization and Commercialization

Course Objective:

- To generate interest in the students about the different economically important plants.
- To conserve plant species in their natural habitat.
- To learn to maintain an ecosystem.

Course Outcome:

- Gather knowledge about threatened and endangered plant species.
- To get the knowledge about different types of plant diversity.
- Develop management of plant diversity.

DETAILED COURSE SYLLABUS

MODULE 1: Introduction to plant resources; Values and uses of Biodiversity: Ethical and aesthetic values, Role of plants in relation to Human Welfare; a) Importance of forestry, b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops, their commercial importance.

MODULE 2: Cultivated Plants and Their Utilization Introduction and Origin of Cultivated Plants, Importance of Plant Resources; General account, methods of cultivation, climate and uses of Cereals: Maize and Rice Millets: Jowar and Bajra. Pulses: Tur and Gram Oil seeds: Ground nut and Castor Fiber yielding: Cotton, Jute and Coir.

MODULE 3: Medicinal Plants and Their Utilization Identification: Local and Botanical Name, Family, Useful Parts, Chemical constituents and utilization of following medicinal plants: Amla (*Phyllanthus emblica*), Tulsi (*Ocimum sanctum*), Basak (*Adhatoda vasica*), Ginger (*Zingiber officinale*), Turmeric (*Curcuma longa*), Gulancha (*Tinospora cordifolia*), Isabgul (*Plantago ovata*).

MODULE 4: Economic Plant and Their Utilization: Beverages- Tea and coffee (Morphology, Chemistry, Processing and Economic Importance); Tobacco (Morphology, species – *Nicotiana tabacum*), Processing, Products, Economic Importance and Health Hazards); Rubber: (*Hevea brasiliensis*); Timber plant: *Tectona grandis, Dalbergia sisoo, Azadirachta indica, Madhuca indica*.

MODULE 5: Introduction to Nursery Management: Definition, types (retail, wholesale, propagation), scope, and importance of the nursery industry. Propagation Techniques: Seed Propagation: Seed viability, treatments, bed preparation, and sowing techniques; Vegetative Propagation: Cuttings, layering, budding, grafting, and specialized structures; Brief idea about Nursery Management Practices: Media Management, Nutrient & Water Management, Plant Protection, Growth Regulators

MODULE 6: **Hands-on or Practical:** Practical Training & Visits: Visits to commercial nurseries, hands-on training in grafting/cutting, and maintenance of nursery records. Knowledge of Marketing and Economics: Costing, pricing, inventory management, and marketing strategies. Visit to mango orchards/ Cultivated lands of mustard/potato/maize. Hands-on training for preparation of Aamsatto (mango pulp candy)/ Jaggery/pickle.

Suggested Readings

1. Sen, S. 1992. ……Economic Botany, New Central Book Agency, Calcutta.
2. Verma, V. 1974. ……. A Textbook of Economic Botany, Emcay Publication, New Delhi.
3. Kochhar, S.L. (2016). ……..Economic Botany-A Comprehensive Study, 5th Edition. New Delhi, India: Cambridge University Press.
4. Hill, A. 1976. ……Economic Botany, Tata Mc Graw Hill Publishing Co., Ltd., New Delhi.
5. Bendre, A., Kumar, A. ……..Economic Botany, Rastogi Publication, New Delhi.
6. Wickens, G.E. (2001). ……Economic Botany: Principles & Practices. The Netherlands: Kluwer Academic Publishers.

7. Singh, V, Pande, P C and Jain, DK (2009)..... A Text Book of Economic Botany. Rastogi Publications, Uttar Pradesh.
8. Trivedi, PC (2006). ……...Medicinal Plants: Ethnobotanical Approach. Agrobios, India.
9. Fuller, KW and Gallon, JA (1985). ……Plant Products and New Technology. Clarendon Press, Oxford, New York.
10. Wickens, G.E. (2001). ……Economic Botany: Principles & Practices. The Netherlands: Kluwer Academic Publishers.

Semester III

Course Title: PHYTOMEDICINE PROSPECTS AND UTILIZATION

Course Objectives :

- In this unit students will get an overview of different systems of indigenous medicinal sciences in India.
- They will become acquainted with several plants used in Ayurveda, Siddha and Unani medicinal systems.

Course Outcome: The students will be able to

- Discuss the history, scope and importance of plants as sources of medicines;
- Describe methods for sustainable utilization of plant herbal resources;
- Apply the knowledge gained in utilising plants used as traditional/ folk medicines and strategies their conservation.
- Medicinal plant gardens have played a significant role in education and research of plant species used for medicinal purposes.

DETAILED COURSE SYLLABUS

MODULE 1: Introduction, History, and Taxonomy of Medicinal Plants; Phytomedicine, Indian folk medicine; Ayurveda, Siddha and Unani, and evolution of plant-based remedies. Medicinal Plant Diversity: Importance of biodiversity, conservation strategies, and non-timber forest products (NTFP). Active Compounds: Secondary Metabolites and their role in drug development.

MODULE 2: Brief idea of Cultivation, Processing, and Quality Control (Utilization); Good Agricultural Practices (GAP), Good Collection Practices (GCP), and post-harvest technology. Extraction Techniques: Methods of extraction (traditional and modern, high-tech methods), sample preparation, and purification of phytoconstituents. Standardization and Quality Control: Techniques for authentication (macroscopic/microscopic), validation of herbal products, and analytical methods. Adulteration: Identification of adulterants in herbal drugs.

MODULE 3: Phytomedicine Development and Pharmacology; Drug Development: Steps in developing, formulating, and standardizing herbal medicines. Pharmacological Screening: *In vitro* and *In vivo* evaluation methods for pharmacological activity, clinical trials, and toxicological studies. Study of specific medicinal plants (e.g., *Moringa oleifera, Withania somnifera, Aloe vera*) and their uses.

MODULE 4: Industry, Regulatory Status, and Future Prospects; Herbal Industry: Structure of the herbal drug industry and entrepreneurship development. Regulations in India and worldwide, Intellectual Property Rights (IPR), export-import policies for herbal drugs. Future Prospects: Trends in herbal cosmetics, nutraceuticals, and the integration of traditional medicine with modern healthcare

MODULE 5: Practical/Laboratory/ Hands-on Components: Macroscopic and microscopic evaluation of crude drugs. Extraction: Methods to extract phytochemicals (decoctions, alcoholic extracts). Analysis: Thin Layer Chromatography (TLC), spectrophotometric estimation of phytochemicals (phenols, flavonoids). Case study: Capacity to develop, market, and manage herbal products (Manufacturing/Active components/Market size and impact etc) Successful Industries- Dabur India Ltd.; Hamdard Laboratories; Himalaya Herbals; Zandu; Vicco etc)

Suggested Readings

1. Medicinal Plant Cultivation: A Scientific Approach ……..Purohit and Vyas, 2008., 2nd edn. Agrobios, India
2. Glossary of Indian Medicinal Plants…….R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
3. The indigenous drugs of India……..Kanny, Lall, Dey and Raj Bahadur, 1984. International 3. Book Distributors
4. Text Book of Herbal Technology…….CP Singh Verma, S Kumar, S Sehajpal, I Sharma and TK Sharma-Walnut Publication 2023.
5. Medicinal Plants of Uttarakhand by ……..……C.P. Kala (2010).
6. Indian Medicinal Plants by ……P.C. Trivedi (2009).
7. Medicinal Plants of Indian Himalaya by …….……S.S. Samant and U. Dhar.
8. Hand Book of Aromatic Plants by …….……..S.K. Bhattacharjee (2004).
9. Handbook of MAPs by ……..……..……S.K. Bhattacharjee (2009).

Course Title: Indian Knowledge System in Plant Science

Course Objectives:

- To understand the concept of Traditional knowledge and its importance.
- To be aware of the conventional framework of the Indian Medical System.
- To comprehend the therapeutic specialties of Ayurveda.
- To familiarize the conservation strategies of medicinal plants.

Course Outcome: After completing this course, the students will be able to:

- Explain the scope and importance of traditional knowledge system of India
- Paraphrase the framework of Indian Medical System
- Understand the therapeutic approaches in Ayurveda
- Comprehend conservation strategies of medicinal plants

DETAILED COURSE SYLLABUS

Module 1: Introduction to Indian Knowledge System: Introduction to ancient science in Intra and Inter Culture dialogue and coevolution. Traditional agricultural practices, Traditional water-harvesting practices, Traditional Livestock and veterinary Sciences; Traditional Houses & villages, Traditional Forecasting, Traditional Ayurveda & plant based medicine, Traditional writing Technology.

Module 2: Agriculture in India: Krishisuktas, Krishiparashara, Brihatsamhita, Types of crops, Manures; Types of land- Devamatruka, Nadimatruka; **Knowledge about important compound formulations**: Taila / Ghrta Paka (medicated oils and ghees), Avaleha (confectioneries), Asava-Arishtas (fermented preparations), Vati Gutika (pills, tablets), Bhasmas (calcined metals / minerals) and Rasaushadhis (metallic preparations).

Module 3: Ayurveda for Life: Introduction to Ayurveda: understanding Human body and Pancha maha bhuta, the communication between body & mind, health regimen for wellbeing; Concept of Ethno-medicine and Folk medicines. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood Pressure and skin diseases. **Active constituents:** Tulsi, Neem, *Aloe* and Ashwagandha and their roles. (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Module 4: Commercialization of Herbal Medicines: Market of Herbal medicine in India- brief concept. Herbal Drug regulation and Commercialization. Field visit to a medicinal plant garden or Sacred Groove. Collection of herbal plant specimens from market.

Suggested Readings

1. Sharma PV. ……..History of medicine in India, Chowkhamba Orientalia Varanasi.
2. Ved, D. K., S. Noorunnisa Begum and K. Ravikumar. Trade in Indian Medicinal Acharya Sushruta, Sushruta Samhita-Hindi by Dr.Anantaram Sharma, part-1; Acharya Priyavrita Sharma, Dravyaguna-Vijanana– Hindi, part-1, Chowkhamba bharti academy, Varanasi; 2020.
3. Goraya, G.S. & Ved, D.K. 2017. Medicinal Plants in India: An Assessment of their Demand and Supply. National Medicinal Plants Board, Ministry of AYUSH, Government of India, New Delhi and Indian Council of Forestry Research Education, Dehradun.
4. Rajasekharan, P.E., Shabir Hussain Wani (Eds.). 2020. Conservation and Utilization of Threatened Medicinal Plants, Springer International Publishing.
5. Sastry JLN, 2005. ……Dravyaguna Vijnana, Vol-I, Chaukhambha Orientalia, Varanasi.

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UNIVERSITY OF GOUR BANGA

(Established under West Bengal Act XXVI of 2007)
Recognized by UGC u/s 2f & 12B
N.H.-34 (Near Rabindra Bhawan), P.O.: Mokdumpur,
Dist..: Malda, West Bengal, Pin-732 103

UG SYLLABUS OF BOTANY

(SEMESTER SYSTEM)

as per

[National Education Policy -2020]

INTERNSHIP, APPRENTICESHIP, PROJECT, WORKSHOP AND COMMUNITY OUTREACH

IAPWC

(Finalized on 31 July 2025)
w.e.f. **Academic session 2023**
REVISED & CODED 2024

SEMESTER: I- III

BOTANY

General Guidelines for Evaluation of IAPWC

The following guidelines are to be maintained by the Internal as well as External Examiners for conducting the evaluation process of IAPWC courses of Botany **Major Students of Botany Semester I-III** containing 25 marks of the paper in each semester**.**

TOPICS

Semester I:	**COMMUNITY OUTREACH**	**(related to Plant Science or Environment)**
Semester II:	**PROJECT**	**(Plant Science based topics)**
Semester III:	**INTERNSHIP**	**(According to the syllabus)**

For IAPWC

1. As the students already performed the Community Outreach in the previous semester, as per the modalities, students can not opt for the same. They have to opt for a project, Internship, Apprenticeship etc.
2. **Fo**r Project, the Department should assign the work to the students as per their convenience.
3. Students must prepare a Project report of their topic which must be handwritten (not typed) minimum 1000 words.
4. The probable format of the project report must contain the following points:

   - Title of the project
   - Acknowledgement
   - Introduction of the topic
   - Objectives
   - Major Findings / Description
   - Conclusion
   - Future perspectives (if any) / Recommendations
   - Photographs in the report preferably geotagged.

1. Some points may be excluded as per the work performed by the students except the BOLD points. Those are mandatory in the project report.
2. A certificate must be attached to the Project Report duly signed by the Guide and Head of the Department.
3. For Internship and Apprenticeship, students have to submit 2 copies of the summary report of the course along with the Certificate of Completion provided by the concerned authority.
4. Distribution of Marks for the IAPWC are as follows:

Internship/ Apprenticeship/ Project Summary Report	10
Presentation of work:	05
Viva-voce:	10
TOTAL:	**25**

INTERNSHIP IN BOTANY

Under NEP-2020

Duration: 120 Hours

Courses Offered:

INTBOT 301: Application of Plant Sciences for Self-Employability

OR

INTBOT 302: Basic Laboratory Techniques for Plant Tissue Preparation and Microscopy

GUIDELINES FOR CONDUCTING INTERNSHIP

Responsibilities of Host Institute

- The **undergraduate department of Botany** from any college under the University of Gour Banga may conduct the internship programme.
- The department of the **host institute should notify the commencement of the internship programme** at least one month prior to the commencement of **Semester III** courses.
- The Department will choose one **Internship Coordinator** (preferably the Head of the Department) whose name should be clearly indicated in the Notification.
- The Internship Coordinator will **publish a schedule** for the classes mentioning the name of the resource persons.
- The Course Duration should be not less than **90 hours**.
- The mode of conduction of classes may be **both offline and online** (preferably online for the maximum benefit of the students).
- There must be **at least 2 (two) days per week** for the class which will be selected by the Host Institute.
- Host Institute should issue a **Hard Copy of Course Completion Certificate** to the participating students.
- The host Institute must organize an **orientation programme** for the internship in which all the Head or their representatives of the participating institute should be present.
- After successful completion of the course the host institute should **conduct an examination** to evaluate the students' achievement.
- At the end of the internship programme, a **valedictory session** should be organized by the host institute in which the Principal /TIC, Chairman of UG-BoS and other faculty members of participating colleges should be invited.

- It is suggested that the valedictory session should be organized **before the commencement of the Theoretical Examination** of Semester III.
- It is recommended that the host institute **should involve the faculty members of the participating UG Colleges as resource persons** for taking the classes as per their convenience.
- **At least one special lecture should be organized during this course involving the faculty member(s)** of the University Departments.
- For the evaluation process, **Attendance, Class Performance, Response, Examination** should be taken under consideration.

Responsibilities of the College Faculties other than Host Institute

- The College faculty should **intimate the Host Institution** regarding the participants' details.
- The participating candidate should apply for the internship programme in a prescribed format, duly endorsed by the Head of the Department and the College Principal / TIC.
- The faculty must **ensure the submission of a report on internship course** which will be duly signed by the Head / Faculty members of the Department during the Final Examination.

SYLLABUS

INT BOT 301: APPLICATION OF PLANT SCIENCES FOR SELF-EMPLOYABILITY

Credit Score: 4 Credit

Duration: 90 Hours

MODULE 1: Basic concept of plant resources, Importance of plant resources in national economy; origin and domestication of cultivated plants (Vavilov's concept); Conservation of diversity, gene banks, and seed vaults. Economic important plants (Rice, Wheat, Maize, Mustard, Sunflower, Rubber, Cotton, Jute, Soybean, Sugarcane)

MODULE 2: Plant based industry; Processing of Tea, Coffee, Aloe, Neem, Coconut, Pepper, Mint. Application of plant products in MSME. Processing of spices (Cumin, Chilli, Turmeric, Sauf, Clove); Processing of Makhana, Corn.

MODULE 3: Elementary application of plant resources; Horticultural: propagation of plants (marigold, gerbera, tuber rose, petunia, indoor plants); mango, litchi, Dragon Fruits; Commercial micro-propagation for rapid plant cloning; Plant tissue culture technique for commercial plant (*Anthurium, Aglaonema*, Orchids, Banana); Importance of Nursery as a business.

MODULE 4: Commercial Products for Agriculture and Horticulture; Production and processing of Vermicompost, *Azolla*, Plant based pesticides (Neem oil), Economics of Plant based products (Starch, tobacco, poppy seeds, makhana, aam-satto, *Aloe*- products).

MODULE 5: Business strategies for plant based products; Economics in soil-less cultures (hydroponics) set-up, modern agriculture equipment (application of drone), soil and seed testing laboratory set-up for business.

INTBOT 302: BASIC LABORATORY TECHNIQUES FOR PLANT TISSUE PREPARATION AND MICROSCOPY

Credit Score: 4 Credit
Duration: 90 Hours

MODULE 1: Introduction to plant microtechniques; Basic laboratory safety guidelines, safe handling of chemicals and chemical waste disposal; **Microscopy:** basic knowledge of microscope, working principle, types of microscopes (simple, compound, light, fluorescent, electron); Ocular and Stage micrometer, magnification, standardization, calibration; Basic idea about software based microscopes.

MODULE 2: Introduction to plant sample preparation for microscopy; sectioning (L.S, T.S, V.S); Microtome (use and working technique), staining techniques (single, double), basic idea of fluorescent staining (FITC and RITC); Mounting process for permanent slide preparation.

MODULE 3: Introduction to basic laboratory techniques for microbiology; microbiology laboratory instruments (autoclave, laminar airflow, incubator, hot-air oven); sterilization techniques, dilution techniques.

MODULE 4: Introduction to plant sample preservation; preservation techniques: herbarium preparation with special emphasis of herbarium sheet size, thickness, tagging, labelling (plant sample, pathological and lichen); preparation of museum specimen using chemical; Entrepreneurship development through Plant material preservation.

Enrollment Proforma

UNIVERSITY OF GOUR BANGA

Four Years Under Graduate Programme (FYUGP)

INTERNSHIP IN BOTANY

Under NEP-2020

Academic Session: ……..

Name of the Host Institute: ……..…….(Name of College)

Name of the Student* …….

Name of the Institute* …….

College Id. …….

ABC Id.* …….

Semester …….

Address (Home) …….

…….

Mobile No* (Whatsapp) …….

Email Id.* …….

Name of the Course …….

DECLARATION

I Mr. / Ms. ……..(Name) of …… ……(College Name) Semester III student hereby declare that I am willing to do the internship programme in the topic entitled …….. …… conducted by ……...……. ……...…….…….. (Name of Host Institute) under the University of Gour Banga.

…… ……

(Forworded by Head) (Signature of the Student)