CURRICULUM FRAMEWORK FOR THREE YEAR UG DEGREE/FOUR YEAR UG DEGREE (HONOURS WITHOUT RESEARCH)/ FOUR YEAR UG DEGREE (HONOURS WITH RESEARCH) IN BOTANY

(As per NEP 2020)

As approved by Board of Studies in Botany held on 09.06.2026

DEPARTMENT OF BOTANY
NORTH LAKHIMPUR UNIVERSITY
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LAKHIMPUR, ASSAM
2026-27

1.0 Introduction

The Department of Botany was established in 1966 and is dedicated to excellence in teaching and research, focusing on a wide range of disciplines. With expertise in areas of plant sciences, the department offers students a comprehensive education in both theoretical and practical aspects of Botany. Programmes like undergraduate (BSc) are designed to foster critical thinking, research skills and a deep understanding of plant biology. The department is equipped with state-of-the art laboratory facilities, supporting advanced research opportunities for students.

Botany is the scientific study of plants including their structure, properties and how they interact with the environment. This is a branch of science requiring theory as well as practical oriented knowledge. The model curriculum has a multidisciplinary approach keeping in mind The New Education Policy 2020. It helps to develop skills to empower the cadre required towards innovation, incubation and entrepreneurship along with professional and employable skills. The practical or hands on experience with Project work/internship/fieldwork would help and build capacities for conducting different research activities among the students. The curriculum has been structured to prepare the undergraduates to achieve skills to move forward with the development of the society/community/nation and entrepreneurship in particular. The course curriculum encompasses multidimensional fundamental, core and aspects of ability enhancement, skill enhancement and various disciplines with Graduate Attributes (GAs) such as theoretical knowledge, recent trends, technological equipment, disciplinary knowledge, laboratory/field driven practical's, self-learning, critical thinking, analytical and problem solving abilities, use of ICT, application of knowledge, lifelong learning, research-related skills, team spirit, multicultural competencies, leadership qualities, developing moral and social values, fundamental rights and duties, gender equality, maintaining balanced personality, career counselling, global vision, professional commitment and sensitizing with Sustainable Development Goals (SDGs) of United Nations. It also aims to build a society based on human values**.**

1.1 Nature and extent of the B.Sc (Botany)

The curriculum in Botany is an outcome based framework designed on the expected learning outcomes and to meet the academic standards. The key outcomes that help curriculum planning at the Under Graduate level include Graduate Attributes, Qualifications Descriptors, Programme Learning Outcomes (PLO) and Course level Learning Outcomes (CLO). The overall objectives of the learning outcomes-based curriculum framework are to:

- Maintain national standards and international comparison of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility;
- Help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes that are expected to be demonstrated by the holder of a qualification;
- Enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitude and values) or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study.

- Provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning levels, and periodic review of programmes and academic standards.

1.3 Aim of Bachelor's degree Programme in Botany

- To decipher the basic and applied knowledge in all the major domains of Botany and its allied areas.
- To develop competency in application of knowledge i.e. theory and practical aspects.
- To impart and develop skills for professional life, focus on income generated courses like mushroom technology, tea cultivation techniques and nursery techniques.
- To impart the knowledge related to floriculture, ethnobotany, plant diversity and human welfare, biofertilizer, etc.
- To create professionals in different related areas, foster research and development, teaching, government and public service and entrepreneurship as well.

1.4 Graduate Attributes

- ❖ The graduate attributes for the undergraduate students pursuing Botany (Honours) Programme include capabilities that help them to strengthen their abilities for widening current knowledge base and skills, gaining new knowledge and skills in the areas like Plant diversity, cytology and biomolecules, genetics and plant breeding, morphology and reproduction of Spermatophytes, microbiology, plant pathology, anatomy of angiosperms, embryology, plant systematics, horticulture, ecology, plant physiology, plant metabolism, molecular biology, phytogeography, analytical techniques in plant sciences, industrial and environmental microbiology, plant biotechnology, research methodology, economic botany and natural resource management.
- ❖ Graduate attributes are fostered through meaningful learning experiences made available through the updated curriculum, and a process of critical and reflective thinking.
- ❖ The graduate attributes reflect the particular quality and feature or characteristics of an individual, including the knowledge, skills, attitudes and values that are expected to be acquired by a graduate of B.Sc (Honours) Botany through studies at the higher education institution (HEI).

Few characteristics attributes of graduates of Botany (Honours) Programme include:

1. ***Reflective thinking:*** Capable of identifying appropriate resources required for a project, and manage a project through to completion, while observing responsible and ethical scientific conduct.
2. ***Digital Literacy***: Competency in accessing relevant and authentic information and data from Electronic media with a motive to learn.
3. ***Disciplinary knowledge and skills:*** Capable in demonstrating basic theoretical and practical knowledge and understanding

4. ***Communication Skills :*** Ability to communicate precisely, confidently and with clarity.
3. ***Critical thinking, Analytical reasoning and Problem solving:*** Ability to employ critical thinking in identifying the problem, developing analytical skills and capabilities to resolve the problems efficiently.
4. ***Research and Scientific reasoning:*** Skills in undertaking small researches by way of project paper, Case Studies, Field visits, Laboratory Experiments etc.
5. ***Team Player:*** Capability of working enthusiastically and united with the working teams in organizing events in the classroom, outside the classroom, laboratory and extension activities etc.
6. ***Self-directive learning:*** Potential to complete the assigned projects successfully either at Residential / Commercial level or Community level by managing the resources independently and wisely.
7. **Multicultural competence:** Ability to learn about different structures and patterns in world perspective.
8. ***Moral and Ethical awareness/reasoning:*** Development of a sense of moral responsibility and values by practising awareness programme or field activities.
9. ***Leadership readiness/ qualities:*** Persuasion to imbibe leadership skills by providing hands of experience to exercise the leadership skill.
10. ***Lifelong Learning:*** Motivation to be updated regularly and consistently throughout the life.

1.5 Qualification Descriptors

- The qualification descriptors indicate the common academic standards for the qualification and help the degree-awarding bodies in designing, approving, assessing and reviewing academic programmes.
- The learning experiences and assessment procedures are expected to be designed to provide every student with the opportunity to achieve the intended programme learning outcomes.
- A qualification descriptor of Botany (Honours) undergraduate programme indicates the generic outcomes and graduate attributes expected for the award of the Bachelor's degree with Honours in Botany.
- The qualification descriptors also describe the academic standard for a specific qualification in terms of the levels of knowledge and understanding, skills and competencies and attitudes and values that the holders of the qualification are expected to attain and demonstrate in terms of actual outputs.
- The qualification descriptors reflect disciplinary knowledge, professional skills. The students who will complete three years of full–time study of an undergraduate programme of study of Botany will be awarded Bachelor's Degree with Honours.

1.6 Programme Specific Outcome (PSO)/Course learning Outcome

PSO1: Core Knowledge & Conceptual Understanding

Demonstrate in-depth knowledge and understanding of advanced concepts in plant biology, systematics, molecular biology, physiology, ecology, and biotechnology.

PSO2: Critical Thinking and Problem Solving

Analyze complex biological systems and interpret scientific data to solve real-world problems related to agriculture, environment, and plant biotechnology using logical reasoning and scientific methodology.

PSO3: Application and Research Competence

Apply botanical principles in experimental design, laboratory techniques, and fieldwork to develop innovative solutions in areas such as sustainable agriculture, climate change mitigation, and biodiversity conservation.

PSO4: Communication Skills

Communicate scientific ideas clearly and effectively through oral, written, and digital formats, using appropriate terminology, data visualization tools, and presentation techniques for both academic and non-academic audiences.

PSO5: Individual and Team Work

Work effectively both independently and in multidisciplinary teams, demonstrating leadership, collaboration, and time management in research projects, seminars, and field studies.

PSO6: Ethics and Professional Responsibility

Demonstrate ethical conduct and integrity in scientific research, data handling, publication, and in the application of botanical knowledge for societal benefit.

PSO7: Environment and Sustainability

Evaluate environmental challenges and advocate sustainable practices by integrating ecological principles and plant-based solutions to support environmental health and resource conservation.

PSO8: Lifelong and Self-Directed Learning

Engage in continuous learning through self-study, critical reading of scientific literature, and participation in research and professional development programs.

PSO9: Design and Innovation Mindset

Develop a design-thinking approach to address botanical and ecological challenges, incorporating creativity and innovation in projects related to plant science and biotechnology.

PSO10: Computational and Data Literacy

Utilize computational tools, bioinformatics, and statistical methods for modeling biological processes, analyzing plant genome data, and managing biodiversity information.

PSO11: Effective Citizenship and Global Perspective

Demonstrate awareness of global and national botanical issues, and contribute as informed and responsible citizens to policy-making, conservation, and education.

PSO12: Aesthetic and Cultural Engagement

Appreciate the aesthetic value of plant life and integrate traditional botanical knowledge with modern science, promoting cultural heritage and sustainable living.

1.7 Teaching Learning Methodologies

Various teaching-learning methodology used in the Under-Graduate courses of Botany are as follows:

- **Lecture method:** The lecture method is a teaching style in which the instructor conveys a topic to students through a structured presentation. In this approach, the teacher primarily speaks while students listen and take notes.
- **Chalkboard:** Chalkboards are used by the teacher for a gradual progression from basic to more advanced concepts and also to incorporate diagrams, symbols, charts and to make immediate adjustments during the lesson.
- **Smart board and projector method**: These teaching aids combine both visual and auditory elements to effectively communicate information, concepts, and ideas to students in the form of slideshows, videos, animations, interactive presentations etc.
- **Demonstration:** The demonstration method of teaching involves the teacher performing a task in front of the class, allowing students to observe and learn how to do it themselves.
- **Practical and Experimentation (lab-based):** This learning method emphasizes hands-on experience and real-world application rather than just theoretical knowledge. It encourages students to learn through active involvement, allowing them to engage directly with the subject matter.
- **Experimentation (field-based):** It involves the study of plant species in the field, where they are found, why they are found there, and where else they might occur.
- **Internship:** Internships are temporary programs aimed at giving students practical experiences to work with experienced professionals, improve skills, learn about industry practices, and build professional network.
- **Seminars and presentations:** Classroom seminars and National seminars are organized to provide the students opportunity to participate in methods of scientific analysis and research procedures.
- **Tutorials:** Tutorials are small group sessions intended to support lectures and are typically more relaxed in format.
- **Educational excursions and field trips:** Educational excursions and field trips are trips or outings organized for learning purposes, where students visit locations outside the classroom to gain hands-on experience and explore topics related to their studies.

- **Institute and research lab visits:** During an institute visit, students may explore different academic programs, facilities, and meet faculty members. A lab visit focuses on giving students the opportunity to observe experiments, research projects, and scientific practices in action, providing them with practical insight into their field of study.
- **Project-based Learning Pedagogy:** It is an approach that emphasizes reflective practice and collaboration, allowing students to link concepts to real-life situations.
- **ICT and web based sources:** Use of ICT and web based sources is highly recommended to make the teaching learning process interactive and interesting.

1.8 Assessment and Outcome Measurement Methods

A variety of assessment methods that are appropriate within the disciplinary area of Botany will be used.

- Oral and written examinations,
- closed-book and open-book tests;
- problem-solving exercises,
- practical assignment, observation of practical skills,
- individual project reports,
- seminar presentation;
- viva voce
- project activities,
- surprise and sudden tests,
- group discussion
- home assignments.

1.9 Certification Criteria

- **UG Certificate**: Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant discipline/subject provided they secure 4 credits in work-based vocational courses offered during the summer term or internship/apprenticeship in addition to 6 credits from skill-based courses earned during the first and second semester.
- **UG Diploma**: Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant discipline/subject.
- **3-year UG Degree:** Students who wish to undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 120 credits.
- **4-year UG Degree (Honours):** A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree programme with 160 credits.
- **4-year UG Degree (Honours with Research):** A four year UG Degree in Honours with Research will be awarded to those Students who complete a four-year degree programme with 160 credits, including 12 credits from a research project/dissertation in the major discipline.

2.0 Other Key Criteria for UG Programme

- Summer internship/apprenticeship is mandatory for all the students; UG certificate, UG Diploma, 3-year UG Degree, 4-year UG Degree (Honours) and 4-year UG Degree (Honours with Research).
- However, for UG certificate it has to be completed during the summer break at the end of 2nd semester, for UG Diploma it has to be completed either during the summer break at the end of 2nd semester or 4th semester, and for other it has to be mandatorily completed by the 5th semester.
- The students will select a vocational course for internship from the basket of vocational courses provided in the common structure.
- Exit and re-entry option in the degree programme in Botany will be allowed at 2nd (first year) and 4th semester (second year) to those students who have been awarded UG Certificate and UG Diploma respectively.
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Course Categories: **DSC**: Discipline Specific Core, **DSE**: Discipline Specific Elective, **MDC**: Multidisciplinary Course, **IDC**: Interdisciplinary Course, **AECC**: Ability Enhancement Compulsory Course, **SEC**: Skill Enhancement Course, **VAC**: Value Addition Course

Course Transaction: **L**: Lecture, **T**: Theory, **Tu**: Tutorial, **P**: Practical
Evaluation Categories: **IA:** Internal Assessment, **ES**: End Semester Examination

Summary of the UG Course Structure as per NEP Guidelines
Department of Botany
Structure of Syllabus
SEMESTER I

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
B.Sc.	Plant Diversity	MAJ-T4-BOT-101	4	80	56	24
	Practical based on theory	MAJ-P1-BOT-101	1	20	20	0
	Diversity in Plant life	MIN-T4-BOT-101	4	80	56	24
	Practical based on theory	MIN-P1-BOT-101	1	20	20	0
	Traditional Medicinal Practices	MDC/IDC-T3-BOT-101	3	60	42	18
	Communicative English-I	AECC	2			
	Mushroom Cultivation-I	SEC-T3-BOT-101	1	40	28	12
	Practical based on theory	SEC-P1-BOT-101	2	40	0	0
	VAC (Project)		2	60	60	0
Total			**20**			

SEMESTER II

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
B.Sc.	Cytology and Biomolecules	MAJ-T4-BOT-201	4	80	56	24
	Practical based on theory	MAJ-P1-BOT-201	1	20	20	0
	Cell Biology	MIN-T4-BOT-201	4	80	56	24
	Practical based on theory	MIN-P1-BOT-201	1	20	20	0
	Intellectual Property Rights	MDC/IDC-T3-BOT-201	3	60	42	18
	AECC Language and Literature	AECC	2			
	Mushroom Cultivation-II	SEC-P1-BOT-201	1	40	28	12
	Practical based on theory	SEC-P2-BOT-201	2	40	0	0
	VAC (Project)		2	60	60	0
Total			**20**			

Award of Under Graduate Certificate (after 1 year: 40 credits)

*Students exiting the programme after securing 42 credits will be awarded UG Certificate in the relevant Discipline/Subject provided they secure 4 credits in work based vocational courses offered during summer term or Internship/Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester***.**

SEMESTER III

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
B.Sc.	Morphology and Reproduction of Angiosperms	MAJ-T3-BOT-301	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-301	1	20	20	0
	Anatomy of Angiosperms	MAJ-T3-BOT-302	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-302	1	20	20	0
	Tea Cultivation Techniques (Optional For Major)	MOP-T2-BOT-301	2	40	28	12
	Forestry (Optional For Major)	MOP-T2-BOT-301	2	40	28	12
	Morphology and Reproduction of Angiosperms	MIN-T1-BOT-301	1	40	28	12
	Practical based on theory	MIN-P1-BOT-301	1	20	20	0
	Plant Diversity and Human Welfare	MDC-T3-BOT-301	3	60	42	18
	AECC		2			
	Biofertilizer for current students Mushroom Cultivation-III for new students	SEC-P1-BOT-301	1	40	28	12
	Practical based on theory	SEC-P2-BOT-301	2	40	0	0
Total			**20**			

SEMESTER IV

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
B.Sc.	Plant Pathology	MAJ-T3-BOT-401	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-401	1	20	20	0
	Genetics	MAJ-T3-BOT-402	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-402	1	20	0	0
	Plant Physiology	MAJ-T3-BOT-403	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-403	1	20	20	0
	Horticulture	MIN-T3-BOT-401	3	60	42	18
	Practical based on theory	MIN-P1-BOT-401	1	20	20	0
	AECC-IV		2			
	VAC-II (EVS)		2			
Total			**20**			
Award of Under Graduate Diploma (after 2 years: 80 credits) ***Students existing the programme after securing 80 credits will be awarded UG diploma in the relevant Discipline/Subject provided they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term***						

SEMESTER V

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
B.Sc.	Plant Metabolism	MAJ-T4-BOT-501	4	80	56	24
	Practical based on theory	MAJ-P1-BOT-501	1	20	20	0
	Molecular Biology	MAJ-T3-BOT-502	3	80	56	24
	Practical based on theory	MAJ-P1-BOT-502	1	20	20	0
	Morphology and Taxonomy of Angiosperm-I	MAJ-T3-BOT-503	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-503	1	20	20	0
	Environmental Biology	MIN-T2-BOT-501	2	40	28	12

	Practical based on theory	MIN-P1-BOT-501	1	20	20	0
	Internship	Industrial/Agricultural Botany	4	80	80	0
Total			**20**			

SEMESTER VI

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
B.Sc.	Plant Biotechnology	MAJ-T4-BOT-601	4	80	56	24
	Practical based on theory	MAJ-P1-BOT-601	1	20	20	0
	Microbiology	MAJ-T3-BOT-602	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-602	1	20	20	0
	Morphology and Taxonomy of Angiosperms-II	MAJ-T3-BOT-603	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-603	1	20	20	0
	Natural Resource Management	MAJ-T3-BOT-604	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-604	1	20	20	0
	Economic Botany (Practical)	MIN-P3-BOT-601	3	60	60	0
Total			**20**			
Award of Bachelor of Arts/Science (Honours in Discipline) (after 3 years: 120 credits)						

SEMESTER VII

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
B.Sc.	Biochemistry	MAJ-T3-BOT-701	**3**	60	**42**	**18**
	Practical based on theory	MAJ-P1-BOT-701	1	20	20	0
	Cytology and Genetics	MAJ-T3-BOT-702	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-702	1	20	20	0
	Analytical Techniques in Plant Sciences	MAJ-T3-BOT-703	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-703	1	20	20	0
	Plant Tissue Culture	DSE-T3-BOT-701 For major students	3	60	42	18
	Practical based on theory	DSE-P1-BOT-701 For major students	1	20	20	0

	Ethnobotany	MIN-T3-BOT-701 To be opted by students of the other departments	4	80	56	24
Total			**20**			

SEMESTER VIII

Course	Course Title	Course Code	Credit	Marks	End Sem Marks	Internal Assessment
B.Sc.	Industrial and Environmental Microbiology	MAJ-T3-BOT-801	**3**	60	**42**	**18**
	Practical based on theory	MAJ-P1-BOT-801	1	20	20	0
	Methods and Ethics in Research	MAJ-T3-BOT-802	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-802	1	20	20	0
	Basics of Biostatistics	MAJ-T3-BOT-803	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-803	1	20	20	0
	Molecular Cytogenetics	MAJ-T3-BOT-804	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-804	1	20	20	0
	Plant Ecology and Phytogeography	MAJ-T3-BOT-805	3	60	42	18
	Practical based on theory	MAJ-P1-BOT-805	1	20	20	0
	Dissertation of 12 credit in lieu of 3 Core courses of 4 credits each for students opting for UG Honours with Research					
Total			**20**			
Award of Bachelor of Arts/Science (Honours in Discipline/Research) (after 4 years: 160 credits						
****Honours students not undertaking research will do 3 courses for 12 credits in liew of a Research Project/Dissertation. **50% of the total credits from minors must be secured in the relevant subject/discipline and another 50% of the total credits from a minor can be earned from any discipline as per student's choice.**						

DSEIII (2Credits): For the students **who have Major** in the department (Major Students)
DSEIV (2 Credits): For the students **who do not have Major** in the department (Non-Major students)

FIRST SEMESTER

Course Code: MAJ-T4-BOT-101
Course Title: Plant Diversity
Nature of the Course: Major
Component of the course: L-2, T-2, P-1
Total Credit Assigned = 4 **Total Credit Assigned =5 (Theory=4, Practical=1)**

Distribution of credits: **Lecture: 60** **Practical: 00** **Tutorial: 4**

Distribution of Marks: **Full Marks = 80** **End Semester= 56** **In Semester: 24**

Course Contents

Unit	Content	Marks	L	P	T
1	**Algae:** General characteristic features, cell structure, range of thallus structure, methods of reproduction and evolutionary classification (only upto groups), economic importance. Morphology, Reproduction and life cycle of *Volvox, Oedogonium, Chara, Ectocarpus, Nostoc*.	8	9	0	1
2	**Fungi:** General characteristic features, reproduction, classification and economic importance. Myxomycetes and their similarities with fungi, plants and animals, Brief account of *Saccharomyces, Agaricus*. Introduction to lichens.				
3	**Bryophytes:** General characteristic features and reproduction, adaptation to land habit, classification. Life history of *Riccia, Marchantia* and *Anthoceros.*	7	8	0	
4	**Pteridophytes:** General characteristic features and reproduction, broad classification, ecological and economic importance. Life history of *Lycopodium*, *Selaginella*, Apogamy and apospory, heterospory and seed habit.	15	15	0	1
5	**Gymnosperms:** General characteristic features and reproduction, classification, ecological and economic importance. Brief account of *Cycas, Pinus, Ginkgo, Gnetum.*	19	19	0	1
6	**Angiosperms:** General characteristic features and reproduction, Concept of natural, artificial and phylogenetic system of classification and binomial nomenclature.	7	9	0	1
Total		56	60	0	4

Practical
Course title: Plant Diversity

Code: MAJ-P1-BOT-101

Credit: 1
[L=0, T=0, P=1]
Full Marks =20 End Semester= 20

Unit	Content
1	1. To study morphology of *Oedogonium*, *Chara*, *Ectocarpus* (Temporary preparation/specimens/slides). 2. To study *Rhizopus* and *Penicillium* (Temporary preparations), symptoms of rust of wheat, Late and Early blight of potato and Citrus canker. 3. To study *Riccia, Marchantia* and *Anthoceros* (morphology and reproductive structure) 4. To study *Lycopodium, Selaginella* and *Equisetum* (morphology and reproductive structure) 5. To study *Cycas* (megasporophyll and microsporophyll); *Pinus* (male and female cones,). 6. Study of morphology and reproductive parts of *Cycas, Pinus, Ginkgo* & *Gnetum*. 7. Study of Fossil plants (Photographs/specimen). 8. To study the types of inflorescences in angiosperms (through specimens).

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 + 20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 24**

A.Sessional Activity

B.1. Activities selected from the above mentioned list**Sessional Activity**
1. Activities selected from above mentioned list:
a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings

•Campbell,N.A.,Reece,J.B.(2008.) Biology,8thedition,PearsonBenjaminCummings,SanFrancisco.

•Evert,RF.,Eichhorn,S.E.(2012).RavenBiologyofPlants,8th edition,NewYork,NY:W.H.Freemanand Company.

•Bhatnagar,S.P.,Moitra,A.(1996).Gymnosperms.NewDelhi,Delhi:NewAgeInternational(P)

•Tortora,G.J.,Funke,B.R.,Case.C.L.(2007).Microbiology.SanFrancisco,U.S.A:PearsonBenjamin Cummings.

•Vashishta,P.C.,Sinha,A.K.,Kumar,A.(2010).Pteridophyta.NewDelhi,Delhi:S.Chand &CoLtd.

•Singh,G.(2019)PlantSystematicsAnIntegratedApproach.4thedition.CRCPress,TaylorandFrancisGroup.

•Blackmore,S.,Crane,P.(2019)HowPlantsWork–Form,Diversity,Survival,PrincetonUniversityPress; Illustrated edition

•Ingrouille,M.,Eddie,B.(2006)Plants:EvolutionandDiversity.CambridgeUniversityPress.

Course Code: MIN - T4-BOT-101
Course Title: Diversity in Plant Life
Nature of the Course: Minor
Component of the course: L-3, T-1, P-1
Total Credit Assigned = 5 (Theory=4, Practical=1)

Full Marks = 56
Course Contents

Unit	Content	Marks	L	P	T
1	**Algae:** General characteristic features, cell structure, range of thallus structure, methods of reproduction and classification (only upto groups), economic importance. Morphology, Reproduction and life cycle of *Volvox, Oedogonium, Chara, Ectocarpus, Nostoc*.	10	11	0	1
3	**Fungi:** General characteristic features, reproduction, classification and economic importance. Myxomycetes and their similarities with fungi, plants and animals, Brief account of *Saccharomyces, Agaricus*. Introduction to lichens.				
4	**Archegoniates:** **Bryophytes:** General characteristic features and reproduction, adaptation to land habit, classification and economic importance. Life history of *Riccia, Marchantia* and *Anthoceros.* **Pteridophytes:** General characteristic features and classification, ecological and economic importance. Apogamy and apospory, heterospory and seed habit. Life history of *Lycopodium*, *Selaginella*, **Gymnosperms:** General characteristic features and reproduction, classification, ecological and economic importance. Brief account of *Cycas, Pinus, Ginkgo, Gnetum.*	10 12 11	11 14 11	0 0 0	2
5	**Angiosperms:** General characteristic features and reproduction, classification and binomial nomenclature.	12	12	0	1
Total		56	60	0	4

Practical
Course title: Diversity in plant life

Code: MIN-P1-BOT-101

Credit: 1
[L=0, T=0, P=1]
Full Marks =20 End Semester= 20

Unit	Content
1	1.To study morphology of *Volvox*, *Oedogonium* (Temporary preparation/specimens/slides). 2.To study *Rhizopus* and *Penicillium* (Temporary preparations), symptoms of rust of wheat 3To study *Riccia, Marchantia* (morphology and reproductive structure) 4.To study *Lycopodium,Selaginella* (morphology and reproductive structure) 5.To study *Cycas* (megasporophyll and microsporophyll); *Pinus* (male and female cones).

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 + 20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 24**

A.Sessional Activity

1. Activities selected from above mentioned list:
a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings

•Campbell,N.A.,Reece,J.B.(2008.) Biology,8thedition,PearsonBenjaminCummings,SanFrancisco.

•Evert,RF.,Eichhorn,S.E.(2012).RavenBiologyofPlants,8th edition,NewYork,NY:W.H.Freemanand Company.

•Bhatnagar,S.P.,Moitra,A.(1996).Gymnosperms.NewDelhi,Delhi:NewAgeInternational(P)

•Tortora,G.J.,Funke,B.R.,Case.C.L.(2007).Microbiology.SanFrancisco,U.S.A:PearsonBenjamin Cummings.

•Vashishta,P.C.,Sinha,A.K.,Kumar,A.(2010).Pteridophyta.NewDelhi,Delhi:S.Chand &CoLtd.

•Singh,G.(2019)PlantSystematicsAnIntegratedApproach.4thedition.CRCPress,TaylorandFrancisGroup.

•Blackmore,S.,Crane,P.(2019)HowPlantsWork–Form,Diversity,Survival,PrincetonUniversityPress; Illustrated edition

•Ingrouille,M.,Eddie,B.(2006)Plants:EvolutionandDiversity.CambridgeUniversityPress.

Course Code: MDC-T3-BOT-101
Course Title: Traditional Medicinal Practices
Nature of the Course: MDC/IDC
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 3

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Introduction:** Concept, scope and objectives; the relevance of traditional medicine (ethnomedicine) in the present context.	5	7	0	1
2	**Methods of Ethnomedicinal studies:** a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.	8	7	0	
3	**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 tenuiflorum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* , Role of ethnobotany in modern medicine with special reference to *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania*.	10	11	0	1
4	**Protection of Traditional Knowledge:** Objective, Concept of Traditional Knowledge, Holders, Issues concerning Bio-Prospecting and Bio-Piracy, Alternative ways, Protect ability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.	12	12	0	1
5	**Ethnobotany and conservation:** Ethnobotany as a tool	7	8		

	to protect interests of ethnic groups. Sharing of wealth concept with few examples from India, Role of ethnic groups in conservation of plant genetic resources, endangered taxa and forest management (participatory forest management).				
Total		42	45	00	3

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20 + 20**

B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

A.Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion

b) Seminars, Workshops

c) Group discussion

d) Self Study and Library Work.

Course Code : SE – T3- BOT- 101

Course Title : Mushroom Cultivation-I

Nature of the Course : SEC

Component of the course : L- 1, T- 1, P-0

Total Credit Assigned = 3 (Theory=1, Practical=2)

Course Contents

Distribution of credits: `Lecture:15 Practical: 0 Tutorial:1

Distribution of Marks : Full Marks = 40 End Semester = 28 In Semester ; 12

Unit	Content	Marks	L	P	T
1	**Introduction to mushrooms:** Mushrooms- Definition, structure and brief account of life cycle of mushroom.	8	3	0	1
2	History and Scope of mushroom cultivation, Edible and Poisonous Mushrooms, Vegetative characters, Nutritional and medicinal values of mushrooms, Therapeutic aspects- antitumor effect.	16	7	0	
3	Cultivation Technology: Infrastructure: substrare (locally available) Polythene bag, Vessels, Inoculation Hook, Inoculation loop, Low cost stove, Sieves, Culture rack, Mushroom unit (Thached house), water sprayer, Tray, Small polythene bag.	16	5	0	
		40	15	00	1

Practical

Course Code : SE – P2- BOT- 101

Course Title : Mushroom Cultivation-I

Nature of the Course : SEC

Component of the course : L- 0, T- 0, P-2

Total Credit Assigned = 3 (Theory=1, Practical=2)

Unit	**Content**

1	1. Identification of edible mushroom and Poisonous mushrooms. 2. Structure and construction of mushroom house, Sterilization and sanitation of mushroom house, sterilization of instruments and substrates

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 + 20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 12**

A.Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion

b) Seminars, Workshops

c) Group discussion

d) Self Study and Library Work.

Suggested readings

1. Marimuthu, T. et al. (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.

2. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

3. Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.

4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.

5.Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.

6. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi

SECOND SEMESTER

Course Code: MAJ-T4-BOT-201
Course Title: Cytology and Biomolecules

Nature of the Course: Major
Component of the course: L-3, T-1, P-0
Total Credit Assigned = 5 (Theory=4, Practical=1`)

Distribution of credits: **Lecture: 60** **Practical: 0** **Tutorial: 4**

Distribution of Marks: **Full Marks = 80** **End Semester= 56** **In Semester: 24**

Course Contents

Unit	Content	Marks	L	P	T
1	**The Cell:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).	5	6	0	1
2	**Cell Wall and Plasma Membrane:** Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; Plasma membrane Singer and Nicolson's fluid mosaic model of cell membrane; chemical composition of membranes. Membrane transport – passive, active and facilitated transport, endocytosis and exocytosis.	8	9	0	
3	**Cell Organelles: Structure and function of the following organelles:** **Nucleus:** Structure and function (nuclear envelope, nuclear pore complex, nuclear lamina); types of chromatins; nucleolus. **Chloroplast and Mitochondria**: Structural organization; Function; Semi- autonomous nature of mitochondria and chloroplast. **Endomembrane system:** Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, and function of RER and SER, Golgi Apparatus – organization. **Ribosome and Lysosomes**: Structure and function. **Cytoskeleton**: Role and structure of microtubules, microfilaments, intermediary filament.	20	20	0	1

4	**Cell division:** Cell cycle, mitosis and meiosis; regulation of cell cycle – checkpoints, role of protein kinases.	5	5	0	1
5	**Biomolecules:** Types of chemical bonds and their biological significance. Structure and biological roles of carbohydrates, lipids, proteins and enzymes. Structure of nitrogenous bases; structure and functions of nucleotides; types of nucleic acids; structure of A, B, Z types of DNA; types of RNA; structure of tRNA.	10	11	0	
6	**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.	8	9	0	1
Total		56	60	0	4

Practical
Course title: Cytology and Biomolecules

Code: MAJ-P1-BOT-201

Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20

Unit	Content
1	1. Study of cell and its organelles with the help of electron micrographs and other digital resources. 2. Study of plant cell structure with the help of epidermal peel mount of *Allium*. 3. Microchemical tests for carbohydrates (reducing, non-reducing sugars and starch), lipids and proteins. 4. Separation of chlorophyll pigments by paper chromatography/ Thin Layer Chromatography. 5. Separation of amino acids by paper chromatography. 6. Demonstration of the phenomenon of plasmolysis and deplasmolysis. 7. Study of different stages of cell divisions.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 + 20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 24**

A.Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested readings:

1. Cooper, G.M., Hausman, R.E. (2019). The Cell: A Molecular Approach, 7thedition. Sinauer/OUP.
2. Iwasa, J, Marshall, W. (2020). Karps's Cell Biology, 9th edition, New Jersey,U.S.A.: John Wiley & Sons.
3. Majumdar, R., Sisodia, R. (2019). Laboratory Manual of Cell Biology, withreference to Plant Cells. New Delhi, Delhi: Prestige Publication.
4. Nelson, D.L., Cox, M.M. (2021). Lehninger Principles of Biochemistry, 8thedition. New York, NY: W.H. Freeman and Company.
5. Reven, F.H., Evert, R.F., Eichhorn, S.E. (1992). Biology of Plants. New York,NY: W.H.Freeman and Company.
6. Tymoczko, J.L., Berg, J.M., Stryer, L. (2012). Biochemistry: A short course, 2ndedition. New York, NY: W.H.Freeman and Company.

Course Code: MIN-T4-BOT-201
Course Title: Cell Biology

Nature of the Course: Minor
Component of the course: L-3, T-1, P-0
Total Credit Assigned = 5 (Theory=4, Practical=1`)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 80** **End Semester= 56** **In Semester: 24**

Course Contents

Unit	Content	Marks	L	P	T
1	**The Cell:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).	6	6	0	1
2	**Cell Wall and Plasma Membrane:** Structure and function of Plant Cell Wall, Plasma membrane Singer and Nicolson's fluid mosaic model of cell membrane.	10	11	0	
3	**Cell Organelles: Structure and function of the following organelles:** **Nucleus:** Structure and function, types of chromatins; nucleolus. **Chloroplast and Mitochondria**: Structural organization; Function; Semi- autonomous nature of mitochondria and chloroplast. **Endomembrane system:** Endoplasmic Reticulum – Structure and function. Golgi Apparatus, structure and functions. **Ribosome and Lysosomes**: Structure and function. **Cytoskeleton**: Role and structure of microtubules, microfilaments, intermediary filaments.	25	27	0	1
4	**Cell division:** Cell cycle, mitosis and meiosis, regulation of cell cycle.	5	6	0	1
5	**Biomolecules:** Structure and biological roles of carbohydrates, lipids, proteins and enzymes. Structure of nitrogenous bases; structure and functions of nucleotides; structure and functions nucleic acids, ATP an energy currency molecule.	10	10	0	
Total		56	60	00	03

Practical
Course title: Cell Biology

Code: MIN-P1-BOT-201

Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20

Unit	Content
1	1. Study of cell and its organelles with the help of electron micrographs and other digital resources. 2. Study of plant cell structure with the help of epidermal peel mount of *Allium*. 3. Microchemical tests for carbohydrates (reducing, non-reducing sugars and starch), lipids and proteins. 4. Demonstration of the phenomenon of plasmolysis and deplasmolysis. 5. Study of different stages of cell divisions (with the help of permanent slide).

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

C. Sessional Test:	**Marks: 20 + 20**
D. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 24**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Expected Course Learning outcomes

(3=High, 2= Moderate 1= Low)

Suggested readings:

1. Cooper, G.M., Hausman, R.E. (2019). The Cell: A Molecular Approach, 7thedition. Sinauer/OUP.

2. Iwasa, J, Marshall, W. (2020). Karps's Cell Biology, 9th edition, New Jersey,U.S.A.: John Wiley & Sons.

3. Majumdar, R., Sisodia, R. (2019). Laboratory Manual of Cell Biology, withreference to Plant Cells. New Delhi, Delhi: Prestige Publication.

4. Nelson, D.L., Cox, M.M. (2021). Lehninger Principles of Biochemistry, 8thedition. New York, NY: W.H. Freeman and Company.

5. Reven, F.H., Evert, R.F., Eichhorn, S.E. (1992). Biology of Plants. New York,NY: W.H.Freeman and Company.

6. Tymoczko, J.L., Berg, J.M., Stryer, L. (2012). Biochemistry: A short course, 2ndedition. New York, NY: W.H.Freeman and Company.

Course Code: MDC-T3-BOT-201
Course Title: Intellectual Property Rights

Nature of the Course: MDC/IDC
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 3

Distribution of credits: **Lecture: 45** **Practical: 0 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Introduction to Intellectual property rights (IPR):** Concept and kinds, IPR in India and world: Genesis and scope, IPR and WTO (TRIPS, WIPO).	6	6	0	1
2	**Protection of Plant Varieties:** Plant Varieties Protection- Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers, National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.	8	9	0	
3	**Geographical Indications:** Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.	10	10	0	1
4	**Legal aspects:** Patents- Objectives, Patent Act 1970 and its amendments, Procedure of obtaining patents, Working of patents, Copyrights- Introduction, Works protected under copyright law, Transfer of Copyright, Infringement, Trademarks- Objectives, Types, Rights, Protection of goodwill, Passing off, Defenses, Domain name.	12	14	0	
5	**Biotechnology and Intellectual Property Rights:** Patenting biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting	6	6	0	1

	Biotechnological inventions. Protection of traditional knowledge.				
Total		42	45	00	03

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

E. Sessional Test: **Marks: 20 +20**

F. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings:

1. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.

2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxweel.

3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.

Course Code : SE – T3- BOT- 201

Course Title : Mushroom Cultivation-II

Nature of the Course : SEC

Component of the course : L- 1, T- 1, P-0

Total Credit Assigned = 3 (Theory=1, Practical=2`)

Course Contents

Distribution of credits: `Lecture:15 Practical: 0 Tutorial:1

Distribution of Marks : Full Marks = 40 End Semester = 28 In Semester ; 12

Unit	Content	Marks	L	P	T
1	**Common edible mushrooms:** Button mushroom (*Agaricus bisporus*), Milky mushroom (*Calocybe indica*), Oyster mushroom (*Pleurotus sajor-caju*) and paddy straw mushroom (*Volvariella volvcea*), *Termitomyces, Cordyceps* (zombi fungus).	10	5	0	1
2	Mushroom bed preparation – paddy strow, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation – Low cost technology, Composting technology in mushroom production.	10	5	0	
3	**Basic requirements:** Requirements for mushroom cultivation, small village unit and large commercial unit; layout of mushroom farm, equipment and facilities, growing rooms.	8	5	0	
		28	15	0	1

Practical

Course Code : SE – P2- BOT- 201

Course Title : Mushroom Cultivation-II

Nature of the Course : SEC

Component of the course : L- 0, T- 0, P-2

Total Credit Assigned = 3 (Theory=1, Practical=2`)

Unit	Content
	1. Mushroom bed preparation- Preparation of mother culture, media preparation,

1	inoculation, incubation and spawn production. 2. Spawning, spawn running, harvesting and Cultivation of oyster mushroom using paddy straw/agricultural wastes.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 + 20**
B. Other Sessional Activities:	**Marks: 10**

In- Semester Assessment **Marks: 12**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings

1. Marimuthu, T. et al. (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.

2. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

3. Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.

4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.

5.Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.

6. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi

THIRD SEMESTER

Course Code: MAJ-T3-BOT-301

Course Title: Morphology and Reproduction of Angiosperms

Nature of the Course: Major

Component of the course: L-2, T-1, P-0

Total Credit Assigned = 4 (Theory=3, Practical=1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Morphology of Angiosperms:** Morphology and types of root, stem, and leaves; phyllotaxy and venation, hairs and trichomes, inflorescence and its types; aestivation. Arrangement and types of reproductive parts of flower, placentation and its types.	10	10	0	1
2	Anther and pollen biology: Anther wall: structure and functions, microsporogenesis; microgametogenesis; pollen wall structure, MGU (male germ unit) structure, NPC system.	10	10	0	1
3	Palynology and scope (a brief account); pollen wall proteins; pollen viability, storage and germination. Ovule: Structure and types of ovule; female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis.	10	12	0	
4	Pollination, fertilization and post fertilization developments: Pollination types and significance; adaptations for pollination; Double fertilization; Structure and types; general pattern of development of dicot and monocot embryo and endosperm; suspensor: structure and functions; embryo-endosperm relationship; polyembryony, apomixes and parthenocarpy.	12	13	0	1
Total		42	45	0	3

Practical
Course title: Morphology and Reproduction of Angiosperms

Code: MAJ-P1-BOT-301

Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Study of different types of roots (Morphology only). 2.Types of leaves, venation, hairs and trichomes, phyllotaxy, inflorescence and aestivation. 3.Typesof placentation and ovule (Preparation of temporary slides) 4. Study of pollen morphology and pollen tube formation. 5. Study of types of embryos and endosperms (Permanent slides/ photographs).

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 + 20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 24**

A. Sessional Activity

1. Activities selected from above mentioned list:
a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

SUGGESTED READINGS:

1. Bhatnagar, S.P. &Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5 th edition.

3. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.

4. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.

5. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Course Code: MAJ-T3-BOT-302
Course Title: Anatomy of Angiosperms

Nature of the Course: Major
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 4 (Theory=3, Practical=1`)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Structure and Development of Plant Body** The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.	4	6	0	1
2	**Tissues** Classification of tissues; Simple and complex tissues; Pits and plasmodesmata; Wall ingrowths and transfer cells, Hydathodes.	8	5	0	
3	**Apical meristems** Apical cell theory, Histogen theory, Tunica Corpus theory; Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root.	10	12	0	1
4	**Vascular Cambium and Wood** Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses;	10	11	0	1

	Dendrochronology. Development and composition of periderm, rhytidome and lenticels.				
5	**Adaptive and Protective Systems** Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.	10	11	0	
Total		42	45	00	03

Practical
Course title: Anatomy of Angiosperms

Code: MAJ-P1-BOT-302

Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Section and Staining of Monocot/Dicot Stem. 2. Section of Root-Monocot/Dicot (Section + Drawing Labelling). OR Section of Leaf-Isobilateral/Dorsiventral/C_4 (kranz). 3. Adaptive Anatomy (Xerophyte/Hydrophyte). 4. Permanent Slide submission. 5. Practical Note Book. 6. Viva-Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20 +20**
B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

A. Sessional Activity

1. Activities selected from above mentioned list:
a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.

2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.

3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

Course Code: MOP-T2-BOT-301 (Optional For Major Students)
Course Title: Tea Cultivation Techniques

Nature of the Course: Optional
Component of the course: L-1, T-1, P-0
Total Credit Assigned = 2

Distribution of credits: **Lecture: 30** **Practical: 0** **Tutorial: 2**

Distribution of Marks: **Full Marks = 40** **End Semester= 28** **In Semester: 12**

Course Contents

Unit	Content	Marks	L	P	T
1	History of tea cultivation, classification; Botany of tea plant, morphology and anatomy of tea plants; Climate and tea production, temperature, rainfall, humidity, sunshine, shade trees, soil characteristics, organic matter, soil nutrients, nutrients application, economy.	10	11	0	1
2	Cultivation Practices: Tea culture and Propagation techniques, seed propagation, vegetative propagation, grafting, nursery management; Selection of planting sites, land preparation, plant spacing and staking, irrigation, organic Tea cultivation. Manuring, pruning, tipping and plucking, shade tree.	10	11	0	
3	Production and processing: Black tea, Green tea and Oolong tea. Tea grades; storing of tea; Organic tea preparation, instant tea, herbal tea health benefits of tea, employment generation, revenue earner.	8	8	0	1
Total		28	30	00	02

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20+20**
B. Other Sessional Activities: **Marks: 10**
In- Semester Assessment **Marks: 12**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Course Code: MOP-T2-BOT-301 (Optional For Major Students)
Course Title: Forestry

Nature of the Course: Major
Component of the course: L-2, T-1, P-1
Total Credit Assigned = 2

Distribution of credits: **Lecture: 30** **Practical: 0** **Tutorial: 2**

Distribution of Marks: **Full Marks = 40** **End Semester= 28** **In Semester: 12**

Course Contents

Unit	Content	Marks	L	P	T
1	**General introduction to forests:** Types of Forest- Natural and Manmade; Tropical, temperate, evergreen semi- evergreen, deciduous; Monoculture, multipurpose, social and industrial. Forest and gene conservation.	6	6	0	1
2	**Silviculture:** concept and scope of study of natural and artificial regeneration of forests. Clear felling, uniform shelter, wood selection, coppice and conservation systems. Silviculture of some of the economically important species in India such as Azadirachta indica, Tectona grandis, Eucalyptus indica, Swietenia mahagoni, Dalbergia sisso and Santalum album, Artocarpus heterophyllus, Hevea brasiliensis.	7	9	0	
3	**Wood:** Homogenous and heterogenous- spring and autumn wood- Porous and non porous wood- Heart and sap wood.	6	4	0	1
4	Social and agro forestry. Selection of species and role of multipurpose trees. food, Avenue plantation. Sacred plants- definition, importance of sacred trees like Ficus religiosa, Emblica officinalis, Aegle marmelos. Forest resources and utilization. Forest products- timber, pulp wood, secondary timbers, non timber forest products (NTFPs). Forest laws- necessity, General principles, Indian forest act 1927 and their amendment.	9	11	0	
Total		28	30	00	02

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study

and Library Work.

Mode of In-Semester Assessment:

1. Sessional Test:	**Marks: 20 +20**
2. Other Sessional Activities:	**Marks: 10**

In- Semester Assessment **Marks: 18**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

(3=High, 2= Moderate 1= Low)

Suggested Readings:

1. Anil Kumar Dhiman. (2003). Sacred plants and their medicinal uses. Daya publishing house, New Delhi.

2. B.S. Chundawat and S.K.Gautham. (1996). Text book of Agroforestry. Oxford and IBH Publishing House , NewDelhi.

3. Kollmann and Cote (1988). Wood science and Technology. Vol.I& II Springer verlag.

4. Parthiban K T (2016) Forestry, Competition Tutor publishers.

5. Praveen Dhar T .(2018). Introduction to Forestry Narendra Publishing House, New Delhi.

6. Sagreiya, K.P. (1994). Forests and Forestry (Revised by S.S. Negi). National book trust. NewDelhi.

7. Sharma P.D. (2004). Ecology and Environment. Rastogi publications, Meerut

8. Singh M.P. and Vinita Vishwakarma.(1997) .Forest environment and Biodiversity. Daya publishing house, NewDelhi.

9. Tiwari K.M. (1983). Social forestry inIndia.

10. Tribhawan Mehta, (1981). A handbook of forest utilization. Periodical Expert Book Agency, New Delhi.

Course Code: MIN-T2-BOT-301
Course Title: Morphology and Reproduction of Angiosperms

Nature of the Course: Minor
Component of the course: L-1, T-1, P-0
Total Credit Assigned = 2 (Theory =1, Practical = 1)

Distribution of credits: **Lecture: 30** **Practical: 0** **Tutorial: 2**

Distribution of Marks: **Full Marks = 40** **End Semester= 28** **In Semester: 12**

Course Contents

Unit	Content	Marks	L	P	T
1	Morphology of Angiosperms: Morphology and types of root, stem, and leaves; phyllotaxy and venation, hairs and trichomes, inflorescence and its types; aestivation. Arrangement and types of reproductive parts of flower, placentation and its types.	7	7	0	
2	Anther and pollen biology: Anther wall: structure and functions, microsporogenesis, callose deposition and its significance; microgametogenesis; pollen wall structure, MGU (male germ unit) structure, NPC system.	7	7	0	
3	Palynology and scope (a brief account); pollen wall proteins; pollen germination. Ovule: Structure and types of ovule; female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis.	7	7	0	
4	Pollination, fertilization and post fertilization developments: Pollination types and significance; adaptations for pollination; double fertilization; general pattern of development of dicot and monocot embryo and endosperm; polyembryony, apomixes and parthenocarpy.	7	7	0	
Total		28	30	00	2

Practical
Course title: Morphology and Reproduction of Angiosperms

Code: MIN-P1-BOT-301

Credit: 1
[L=0, T=0, P=2]
Full Marks = 40 End Semester = 40 IA=0

Unit	Content
1	1. Study of morphology and reproductive parts of Cycas, Pinus, Ginkgo&Gnetum. 2. Study of Fossil plants (Photographs/specimen). To Gymnosperms 3. Study of different types of roots (Morphology only). 4.Types of leaves, venation, hairs and trichomes, phyllotaxy, inflorescence and aestivation. 5.Typesof placentation and ovule (Preparation of temporary slides) 6. Study of pollen morphology and pollen tube formation. 7. Study of types of embryos and endosperms (Permanent slides/ photographs).

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20+20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 12**

A.Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings:

1. Bhatnagar, S.P. &Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5 th edition.

3. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi. 4. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.

5. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Course Code: MDC-T3-BOT-301
Course Title: Plant Diversity and Human Welfare

Nature of the Course: MDC
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 3

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Course Contents

Unit	Content	Marks	L	P	T
1	Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa. Values and uses of Biodiversity: Ethical and aesthetic values. **10 marks**	10	10	0	1
2	Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management, Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations. **12 marks**	12	13	0	
3	Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, In situ and ex situ conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. **10 marks**	10	11	0	1
4	Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses. **10 marks**	10	11	0	1
Total		42	45	00	3

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

C. Sessional Test:	**Marks: 20 +20**
D. Other Sessional Activities:	**Marks: 10**

In- Semester Assessment **Marks: 18**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested readings:

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.

Course Code: SEC-T1-BOT-301
Course Title: Biofertilizer (For current student)

Nature of the Course: Skill Enhancement Course
Component of the course: L-1, T-0, P-2
Total Credit Assigned = 3

Distribution of credits: **Lecture: 15** **Practical: 0** **Tutorial: 1**

Distribution of Marks: **Full Marks = 40** **End Semester= 28** **In Semester: 12**

Course Contents

Unit	Content	Marks	L	P	T
1	Factors affecting plant growth; essential nutrients; microbes used as biofertilizer (nitrogen fixers, phosphate solubilizers, PGPR) biocontrol agents.	7	3	0	1
2	Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, process of nitrogen fixation, blue green algae and Azollain rice cultivation.	7	4	0	
3	Mycorrhizal association, types of mycorrhizal association; colonization of AM – isolation and inoculum production of AM, and its influence on growth and yield of crop plants.	7	4	0	
4	Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and vermicomposting – field Application.	7	4	0	
Total		28	15	0	

Practical
Course title: Biofertilizer

Code: SEC-P2-BOT-301

Credit: 2
[L=0, T=0, P=2]
Full Marks = 40 End Semester = 40 IA=0

Unit	Content
1	Demonstration/field visit to biofertilizer producing units, identification of some common biofertilizers.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

E. Sessional Test:	**Marks: 20+20**
F. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 12**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested readings:

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

Course Code : SE – T1- BOT- 301 (For New Students)

Course Title : Mushroom Cultivation-III

Nature of the Course : SEC
Component of the course : L- 1, T- 0, P-2
Total Credit Assigned = 3 (Theory=1, Practical= 2)

Course Contents

Distribution of credits: `Lecture:15 Practical: 0 Tutorial:2

Distribution of Marks : Full Marks = 40 End Semester = 28 In Semester ; 12

Unit	Content	Marks	L	P	T
1	Aseptic techniques: Sterilization techniques for mushroom cultivation	7	4	0	1
2	**Spawn production -** culture media preparation, production of pure culture, mother spawn, and multiplication of spawn.	7	5	0	
3	**Post harvest technology:** Problems in cultivation - diseases, pests and nematodes, weed moulds and their management strategies. Preservation of mushrooms - freezing, dry freezing, drying, canning, quality assurance and entrepreneurship. Value added products of mushrooms.	14	6	0	
	Total	28	15	00	01

Practical
Course title: Hands on Training on Mushroom Cultivation Techniques

Unit	Content
1	1. Aseptic techniques: Sterilization techniques. 2. Spawning process for Mushroom cultivation. 3. Casing process for Mushroom cultivation. 4. Fruiting and harvesting process for Mushroom cultivation

	5. Post-harvest processing for Mushroom cultivation

Suggested Readings

1. Marimuthu, T. et al. (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.

2. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

3. Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.

4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.

5.Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.

6. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi

FORTH SEMESTER

Course Code: MAJ-T3-BOT-401

Course Title: Plant Pathology

Nature of the Course: Optional
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 4 (Theory= 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 2**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Introduction:** Principles of plant pathology, terms and concepts, classification of plant diseases on the basis of causative organisms, mechanism of pathogenesis, symptomology and epidemiology.	10	8	0	1
2	**Phytopathology** Geographical distribution of diseases; Etiology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine, role of enzymes and toxins in pathology.	10	14	0	1
3	**Plant disease management:** Regulatory, cultural, physical, chemical, biological control of plant diseases, integrated disease management.	10	8	0	1
4	**Study of following plant diseases-**Bacterial diseases – Citrus canker. Viral diseases- Tobacco Mosaic viruses. Fungal diseases – Early blight of potato, Black stem rust of wheat, Red rot of sugarcane, Ergot disease, Loose smut of wheat, Grey Blight of Tea.	12	15	0	
Total		42	45	00	03

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 + 20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 18**

Practical

Course Code: MAJ-P1-BOT-401
Based on Theory Courses

A. Sessional Activity

1. Activities selected from above mentioned list:
a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings:

Awasthi, L. P., & Das, S. (2024). *Plant pathology*. Taylor & Francis.

Chahal, S. S., Khetarpal, R. K., & Thind, T. S. (Eds.). (2008). *Plant pathology in India*. Scientific Publishers.

Biswas, K. K., Sinha, P., Dua, P., Jambhulkar, P. P., Bashyal, B. M., Behera, S., Hubballi, M., & Viswanathan, R. (Eds.). (2024). *Concepts of plant pathology and disease management*. Indian Phytopathological Society.

Indian Phytopathological Society. (2018). *Recent approaches for management of plant diseases*. Indian Phytopathological Society.

Tripathi, S. K., & Bhale, M. S. (2020). *Fundamentals of plant pathology*. Scientific Publishers.

Agrios, G. N. (2005). *Plant pathology* (5th ed.). Elsevier Academic Press.

Schumann, G. L., & D'Arcy, C. J. (2009). *Essential plant pathology* (2nd ed.). APS Press.

Tronsmo, A. M., Munk, L., Jensen, D. F., Klemsdal, S. S., & Tronsmo, A. (2020). *Plant pathology and plant diseases*. CABI.

Dickinson, M. (2003). *Molecular plant pathology*. Garland Science.

Lucas, J. A. (2020). *Plant pathology and plant pathogens* (4th ed.). Wiley-Blackwell.

Course Code: MAJ-T3-BOT-402
Course Title: Genetics
Nature of the Course: Major
Component of the course: L-2, T-1, P-1
Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Mendelian genetics** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Polygenic inheritance.	8	10	0	1
2	**Extrachromosomal Inheritance** Chloroplast mutation: Variegation in *Mirabilis jalapa*; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*	7	8	0	1
3	**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; Sex Linkage.	8	8	0	
4	**Variation in chromosome number and structure** Deletion, Duplication, Inversion, Translocation, Euploidy and Aneuploidy.	7	7	0	1
5	**Gene mutations** Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents). Role of Transposons in mutation.DNA	12	12	0	

	repair mechanisms.				
Total		42	45	00	03

Practical
Course title: Genetics
Code: MAJ-P1-BOT-302
Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Mitosis/Meiosis through temporary squash/smear preparation 2. Photograph/permanent slides showing translocation ring, inversion bridge, laggards 3. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) 4. Mendel's laws through seed ratios. Laboratory exercises in probability 5. Study of aneuploidy-Down's, Klinefelter's Turner's Syndrome or Human genetic traits-Sickle Cell Anemia, Albinism, Red-Green Colour Blindness, Widow's Peak, Rolling of Tongue, Hitchhiker's Thumb, Xeroderma Pigmentosum, Attached Ear-Lobe 6. Practical Record Book 7. Viva-Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: Marks: 20 +20

B. Other Sessional Activities: Marks: 10

In- Semester Assessment Marks: 18

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Course Code: MAJ-T3-BOT-403
Course Title: Plant Physiology
Nature of the Course: Major
Component of the course: L-2, T-1, P-1
Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Plant-water relations** Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory.Transpiration and factors affecting transpiration, mechanism of stomatal movement.	10	11	0	1
2	**Mineral nutrition** Essential and beneficial elements, macro and micronutrients, criteria for essentiality, mineral deficiency symptoms, roles of essential elements.	6	6	0	
3	**Translocation in the phloem** Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.	6	7	0	1
4	**Plant growth regulators** Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.	8	8	0	
5	**Physiology of flowering** Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.	6	6	0	1
6	**Growth and Development** Definition, phases of Growth, factors affecting growth, physiology of seed dormancy and germination. Movement – Tropic and Nastic.	6	7	0	
Total		42	45	00	03

Practical
Course title: Plant Physiology

Code: MAJ-P1-BOT-403

Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Determination of osmotic potential of plant cell sap by plasmolytic and weight method. 2. To study the effect of environmental factors (light and wind) on transpiration by excised twig. 3. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration. 4. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte. 5. Demonstration of Hill reaction. 6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis. 7. Determination of rate of transpiration. 8.Practical Record Book. 9.Viva-Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: Marks: 20+20
B. Other Sessional Activities: Marks: 10

In- Semester Assessment Marks: 18

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.

2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Course Code: MIN-T3-BOT-401
Course Title: Horticulture
Nature of the Course: Minor
Component of the course: L-2, T-1, P-1
Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits:	**Lecture: 45**	**Practical: 0**	**Tutorial: 1**
Distribution of Marks:	**Full Marks = 60**	**End Semester= 42**	**In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Introduction:** Scope and importance, branches of horticulture; role in rural economy and employment generation, importance in food and nutritional security; urban horticulture and ecotourism.	6	8	0	1
2	**Ornamental plants:** Types of ornamental plants, classification of ornamental plants, identification and salient features of some locally available ornamental plants.	6	7	0	
3	**Fruits and vegetable crops:** Origin of fruit culture; origin, domestication and early culture of fruit crops; origin and distribution of vegetable crops, classification of vegetable crops; description of fruit and vegetables and their economic products, economic importance of fruits and vegetables, role of fruits and vegetables in Indian economy.	10	10	0	1
4	**Horticultural Techniques and Landscaping:** Application of manures, fertilizers, nutrient and PGRs (plant growth regulators), weed control, biofertilizers, biopesticides, irrigation methods, hydroponics. Planning and layout (parks and avenues); urban forestry (establishment, maintenance and benefits of urban forests).	10	10	0	
5	**Post harvest technology:** Importance of post harvest technology in horticultural crops; harvesting and handling of fruits, vegetables and cut flowers, methods of preservation and processing of fruits and vegetables; technologies and practices to reduce post harvest losses.	10	10	0	1
Total		42	45	00	03

Practical
Course title: Horticulture

Code: MIN-P1-BOT-401

Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Tools and implements, layout of nutrition garden- preparation of nursery beds, sawing of vegetable seeds, digging pits for fruit plants and planting, layout of irrigation systems. 2. Preparation of organic manure (vermicompost). 3. Grafting and cuttings of fruit plants. 4. Identification and management of nutritional disorders in fruits and vegetables. 5. Preparation of bonsai.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20+20**
B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

Suggested Readings

Chadha, K. L. (2001). *Handbook of horticulture*. DK Publishers Distributors.

Bailey, L. H. (1914). *The standard cyclopedia of horticulture* (2nd ed.). Macmillan.

Huxley, A., Griffiths, M., & Levy, M. (Eds.). (1992). *The new Royal Horticultural Society dictionary of gardening* (Vols. 1–4). Macmillan.

Royal Horticultural Society. (2008). *Science and the garden: The scientific basis of horticultural practice* (2nd ed.). Blackwell Publishing.

Easton, V. (2007). *A pattern garden: The essential elements of garden making*. Timber Press.

Chadha, K. L. (2001). *Handbook of horticulture*. Indian Council of Agricultural Research.

Chadha, K. L., & Pareek, O. P. (Eds.). (1993). *Advances in horticulture: Volume 1 – Fruit crops (Part 1)*. Malhotra Publishing House.

Chadha, K. L., & Pareek, O. P. (Eds.). (1993). *Advances in horticulture: Volume 2 – Fruit crops (Part 2)*. Malhotra Publishing House.

Chadha, K. L., & Shikhamany, S. D. (1999). *The grape: Improvement, production, and post-harvest management*. Malhotra Publishing House.

Manilal, K. S. (2008). *Van Rheede's Hortus Malabaricus* (Malayalam Edition, Vols. 1–12). University of Kerala**.**

FIFTH SEMESTER

Course Code: MAJ-T4-BOT-501

Course Title: Plant Metabolism

Nature of the Course: Major

Component of the course: L-3, T-1, P-0

Total Credit Assigned = 5 (Theory = 4, Practical = 1)

Distribution of credits: **Lecture: 60** **Practical: 0** **Tutorial: 4**

Distribution of Marks: **Full Marks = 80** **End Semester= 56** **In Semester: 24**

Course Contents

Unit	Content	Marks	L	P	T
1	**Concept of metabolism** Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).	6	7	0	1
2	**Carbon assimilation** Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C4pathways; Crassulacean acid metabolism; Factors affecting CO2 reduction.	12	13	0	
3	**Carbohydrate metabolism** Synthesis and catabolism of sucrose and starch.	6	5	0	1
4	**Carbon Oxidation** Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle,amphibolic role, anaplerotic reactions, regulation of the cycle, cyanide-resistant respiration, factors affecting respiration.	12	12	0	

5	**ATP-Synthesis** Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase:Structure and function, Racker's experiment, Jagendorf's experiment; role of uncouplers.	6	8	0	1
6	**Lipid metabolism** Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.	6	7	0	1
7	**Nitrogen metabolism** Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.	8	8	0	
Total		56	60	00	03

Practical
Course title: Plant Metabolism

Code: MAJ-P1-BOT-501

Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Experiments based on theory syllabus. 2. Demonstration of florescence by isolated chlorophylls and demonstration of Absorption Spectrum of photosynthetic pigments. 3. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins. 4. Cytochemical staining of : DNA- Feulgen and cell wall in the epidermal peel of

	onion using Periodic Schiff's (PAS) staining technique. 7. Estimation of plant proteins by Biuret/Lowry method. 8. Estimation of reducing and non-reducing sugars in plant samples. 9. Practical Record Book. 10. Viva – Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A.Sessional Test: **Marks: 20 +20**

B.Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 24**

A. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.

2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

4. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.

5. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

6.Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Course Code: MAJ-T3-BOT-502
Course Title: Molecular Biology
Nature of the Course: Major
Component of the course: L-2, T-1, P-1
Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Nucleic acids : Carriers of genetic information** Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.	6	5	0	1
2	**The Structures of DNA and RNA / Genetic Material** DNA Structure: Miescher to Watson and Crick-historic perspective, DNA structure, Salient features of double helix, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA-Prokaryotes, Viruses, Eukaryotes. Structure of RNA, DNA. The Nucleosome_Chromatin structure-Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.	10	10	0	
3	**The replication of DNA** Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.	10	10	0	1

4	**Transcription and processing of RNA** Central dogma, genetic code, transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism. Eukaryotes: transcription factors. Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail); Ribozymes.	10	12	0	
5	**Translation** Ribosome activation and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides.	6	8	0	1
Total		42	45	00	03

Practical
Course title: Molecular Biology
Code: MAJ-P1-BOT-502
Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. DNA isolation from plant sample. 2. DNA estimation. 3. Demonstration (preparation of LB medium and raising *E. coli*). 4. Practical Note Book. 5. Viva-Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20+20**
B. Other Sessional Activities:	**Marks: 10**

In- Semester Assessment **Marks: 18**

A. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Expected Course Learning outcomes:

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.

4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Course Code : MAJ – T3- BOT- 503

Course Title : Morphology and Taxonomy of Angiosperms – I

Nature of the Course : Major

Component of the course : L- 2, T- 1, P-1

Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Course Contents

Distribution of credits: `Lecture:45 Practical: 0 Tutorial:03

Distribution of Marks : Full Marks = 60 End Semester = 42 In Semester ; 18

Unit	Content	Marks	L	P	T
1	Detail study of (i) Origin of angiosperms, (ii) Inflorescence - types and evolution, (iii) Carpel polymorphism, (iv) Phyllode theory, (v) Role of morphology in the classification of the flowering plants.	8	10	0	1
2	Taxonomic hierarchy and different taxonomic categories, Concept of Taxa; Concept of Species, Genus, Family and Infra specific categories	8	10	0	1
3	Taxonomic evidences: Morphology, Anatomy, Palynology, Embryology, Cytology; Chemotaxonomy, Serology.	8	4	0	
4	Systems of angiosperm classification: Artificial, Natural, Phylogenetic, APG system of classification; Relative merits and demerits of major systems of classification.	10	10	0	1
5	Study of following families with particular reference to systematic position, phylogeny, evolutionary trends and economic importance. – Poaceae, Arecaceae, Zingiberaceae, Orchidaceae, Magnoliaceae, Fabaceae, Euphorbiaceae Lamiaceae, Solanaceae, Brassicaceae, Cucurbitaceae, Asteraceae,	8	11	0	
		42	45	00	03

Course Title : Morphology and Taxonomy of Angiosperms – I

Code: MAJ – P1- BOT- 503

Credit : 1

[L= 0, T= 0, P=2

Full marks = 20 End Semester = 20

Unit	Content
1	1. Drawing, description and identification of plant specimens from selected group of Dicot families. 2. Identification of unknown plants with the help of keys from different floras and manuals. 3. Preparation and Submission of Herbarium specimens.

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20+20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 18**

Course Code: MIN-T2-BOT-501

Course Title: Environmental Biology

Nature of the Course: Minor

Component of the course: L-1, T-1, P-0

Total Credit Assigned = 3 (Theory = 2, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 40** **End Semester= 28** **In Semester: 12**

Course Contents

Unit	Content	Marks	L	P	T
1	**Introduction to Environment:** Component of environment, Basic environmental principles, Scope, importance and categorization of environment	7	5	0	1
2	**Environmental pollution**: Causes and effects of Air pollution, Water pollution, Soil pollution, Marine pollution, Radioactive pollution, Noise pollution and Thermal pollution.	7	6	0	
3	**Biotic interactions** **Environmental degradation and management**: Deforestation, Coal mining, Crude oil exploration, Industrial contamination, Water quality of river Brahmaputra, Green house effect, Depletion of ozone layer, Acid rain, Solid waste management, Invasive species and its impact on local vegetation and soil, Bioremediation of emerging contaminants. Concept of EIA; GPS, GIS and remote sensing and their application in environmental management.	7	5	0	1
4	Environmental problems associated with North East India with special reference to Assam, Geographical peculiarities of lower subansiri, Flood and erosion problem of Assam, Scope of climate resilient	7	9	0	

	agriculture in Assam.				
Total		28	45	00	2

Practical
Course title: Environmental Biology
Code: MIN-P1-BOT-503
Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Ecological experiments- i. Minimum quadrat size for the study of Herbaceous Vegetation in the College Campus by Species Area Curve method ii. Quantitative analysis of Herbaceous Vegetation for Frequency and comparison with Raunkiaer's Frequency Distribution iii. Quantitative analysis of Herbaceous Vegetation for Density and Abundance iv. Studies on Invasive species and its impact on local vegetation and soil. 2. Study of chemical characteristics of Soil pH, Carbonates, Chlorides, Nitrates, Sulphates, Organic Matter and Base Deficiency. OR Determination of Dissolve Oxygen of water samples from polluted and unpolluted sources 3. Submission of Charts of Biodiversity Hotspots/Biomes of the World/Landscape with distribution of plants 4. Study of plant adaptation 5. Practical Record Book 6. Viva-Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study

and Library Work.

Mode of In-Semester Assessment:

A.Sessional Test:	**Marks: 20+20**
B.Other Sessional Activities:	**Marks: 10**

In- Semester Assessment **Marks: 18**

A. Sessional Activity

1. Activities selected from above mentioned list:
a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.

2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.

3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Course Code: MAJ-IN-4-BOT-501
Course Title: INTERNSHIP/COMMUNITY ENGAGEMENT

Nature of the Course: Internship
Total Credit Assigned = 4

Distribution of credits:	**Lecture: 60**	**Practical:**	**Tutorial: 0**
Distribution of Marks:	**Full Marks = 80**	**End Semester= 80**	**In Semester: 0**

Marks distribution:

Completion of Internship Project Marks 10
[Internship Completion Certificate to be provided]
Submission of Report of the internship project work Marks 20
Distribution of Marks in the Report:
[Objective of the Internship Project Marks 10
About the Works/Responsibilities/Tasks/Experiments done Marks 10
Challenges and Problem-Solving Marks 05
Skills Developed Marks 05
Conclusion Marks 10]

Oral Presentation/Viva Marks 10

[Students will go for internships during summer and winter vacations]

Sixth Semester
Course Code: MAJ-T4-BOT-601
Course Title: Plant Biotechnology

Nature of the Course: Major
Component of the course: L-3, T-1, P-0
Total Credit Assigned = 5 (Theory = 4, Practical = 1)

Distribution of credits: **Lecture: 60** **Practical: 0** **Tutorial: 4**

Distribution of Marks: **Full Marks = 80** **End Semester= 56** **In Semester: 24**

Course Contents

Unit	Content	Marks	L	P	T
1	**Biotechnology-** Introduction**,** Aims and objectives, Scope of Biotechnology.	4	3	0	1
2	**Plant Tissue Culture** Techniques of plant tissue culture, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Tissue culture applications (micropropagation, Soma clonal variation, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Artificial seed).	12	13	0	
3	**Recombinant DNA technology** Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pBR18, pBR19, pBR322, Ti-plasmid, BAC); Lambda phage, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).	12	13	0	1
4	**Gene Cloning** Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony	10	12	0	1

	hybridization.				
5	**Methods of gene transfer** *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).	8	10	0	
6	**Applications of Biotechnology** Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation; edible vaccines. Biosafety concerns, ethical issues.	10	12	0	1
Total		56	60	00	04

Practical
Course title: Plant Biotechnology

Code: MAJ-P1-BOT-601

Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Preparation of MS medium. 2. Photographs of i. study of methods of gene transfer (Agrobacterium-mediated, direct gene transfer by electroporation, micro-injection, micro projectile bombardment. ii. Study of steps of genetic engineering for production (Bt cotton, Golden rice, Flavr Savr tomato). 3. Isolation of Plasmid DNA, Gel Electrophoresis of Plasmid DNA and Restriction Digestion 4. Demonstration of *in-vitro* sterilization and inoculation methods using leaf and nodal explants (Tobacco, Datura, Brassica). 5. Photographs of Anther culture, Embryo and Endosperm culture, Micropopagation,

	Somatic Embryogenesis and Artificial Seeds. 6. Practical Record Book. 7. Viva – Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20+20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 24**

A.Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.

2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.

4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.

5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Course Code: MAJ-T3-BOT-602
Course Title: Microbiology
Nature of the Course: Major
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 30** **Practical: 0** **Tutorial: 2**
Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Introduction to microbial world** Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).	10	10	0	1
2	**Viruses** Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions.	5	5	0	1
3	**Bacteria** Discovery, general characteristics; Classification of bacteria (Modern Trends), eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types.	10	9	0	
4	**Fungi:** Introduction, affinities with plants and animals, thallus organization, cell wall composition, reproduction and economic importance. Introduction to lichens and myxomycetes- their similarities with fungi, plants and animals.	9	8	0	1
5	Microbiology of air, water and soil, Techniques of sterilization, population estimation, (direct spore count, spectrophotometric method), CFU, pure culture methods, visualization techniques, culture preservation, and maintenance.	10	11	0	
Total		42	45	00	03

Practical Scheme

Unit	Contents
1	1. Isolation of Bacteria, and Gram Staining Method. 2. Practical on fungi based on theory syllabus 3. Serial dilution method

	4. Preparation of Culture Media 5. Colony counting 6. Determination of BOD, COD, TDS and TOC of Water Samples 7. Demonstration of Microbiological Instrument 8. Practical Record Book

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 +20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 18**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings

Bauman, R. W. (2017). *Microbiology with diseases by body system (5th ed.). Pearson.*

Mahon, C. R., Lehman, D. C., & Manuselis, G. (2014). *Textbook of diagnostic microbiology (5th ed.). Saunders.*

Dubey, R. C., & Maheshwari, D. K. (2022). *A textbook of microbiology: Library edition* (5th ed.). S. Chand Publishing.

Stanier, R. Y., Doudoroff, M., & Adelberg, E. A. (1963). *The microbial world* (2nd ed.). Prentice-Hall.

Postgate, J. (2000). *Microbes and man* (4th ed.). Cambridge University Press.

Knipe, D. M., Howley, P. M., & Kirkegaard, K. (Eds.). (2020). *Fields virology* (7th ed., Vol. 1). Wolters Kluwer Health.

Course Code: MAJ-T3-BOT-603

Course Title: Morphology and Taxonomy of Angiosperms – II

Nature of the Course: Major
Component of the course: L- 2, T- 1, P-1
Total Credit Assigned = 4 (Theory = 3, Practical = 1)
Course Contents

Distribution of credits: `Lecture: 45 Practical: 0 Tutorial: 3

Distribution of Marks : Full Marks = 60 End Semester = 42 In Semester ; 18

Unit	Content	Marks	L	P	T
1	Principles of taxonomy, characters considered before plant identification; identification keys, floral formula and floral diagram. Salient features of ICN (formerly ICBN). Principles and Major rules, Typification, Effective and Valid Publication, Authors' citation, Principles of Priority and Limitations, synonym, basionym, nomina conservanda, rejection of names, illegitimate names, nomen nudum, later homonym.	10	10	0	1
2	Process of Identification: Herbarium techniques: Methods of Collection, Identification and Documentation; Roles and importance of herbaria, Botanical Gardens and Museums in taxonomic studies, Major Herbaria and Botanic Gardens in World and India.	8	9	0	1
3	**Phenetic Methods: Taxometric:** Principles, OTUs, coding of characters, Measuring Resemblances, Cluster analysis, Application of Taxometric. **Phylogenetic Methods:** Cladistic taxonomy, Character analysis, Cladogram construction and Analysis.	10	8	0	
4	Material basis of Taxonomy: Concept of Character; Character Correlation, Weighing, Variations;	6	8	0	1

	Isolation and Speciation.				
5	Study of following families with particular reference to systematic position, phylogeny, Evolutionary trends and economic importance, Monocot families- Musaceae, Zingiberaceae, Cyperaceae, Poaceae, Orchidaceae.	8	10	0	
		42	45	00	03

Course Title: Morphology and Taxonomy of Angiosperms – II

Code: MAJ – P1- BOT- 603

Credit: 1

[L= 0, T= 0, P=2

Full marks = 20 End Semester = 20

Unit	Content
1	1. Drawing, description and identification of plant specimens from selected group of Dicot families. 2. Identification of unknown plants with the help of keys from different floras and manuals. 3. Preparation and Submission of Herbarium specimens. 4. Taxometric classification of locally available plants.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 +20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 18**

Course Code: MAJ-T3-BOT-604
Course Title: Natural Resource Management
Nature of the Course: Major
Component of the course: L-2, T-1, P-1
Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Natural resources and sustainable utilization** Definition and types, Natural resources of N.E.India. sustainable utilization: Concept, approaches (economic, ecological and socio-cultural).	8	8	0	1
2	**Land and water** Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. Fresh water (rivers, lakes, groundwater, aquifers, watershed, mitigation of flood); Marine; Estuarine; Wetlands; Threats and management strategies.	10	11	0	
3	**Biological Resources** Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).	8	8	0	1
4	**Forests** Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.	5	6	0	
5	**Energy** Renewable and non-renewable sources of energy	4	4	0	1
6	**Contemporary practices in resource management** Ecological Footprint with emphasis on carbon footprint, Waste management. National and international efforts in resource management and conservation.	7	8	0	
Total		42	45	00	03

Practical
Course title: Natural Resource Management
Code: MAJ-P1-BOT-604
Credit: 1
[L=0, T=0, P=1]
Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Estimation of Solid Waste. 2. Analysis of Ecological Foot Print. 3. Distribution Pattern of Woody Plant Species by Quadrat Method. OR Measurement of Dominance of Wood Species by DBH. 4. Practical Record Book. 5. Viva-Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20+20**
B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

Suggested Readings

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.

2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Course Code: MIN-P3-BOT-601 (Practical)
Course Title: Economic Botany
Nature of the Course: Minor
Component of the course: L-0, T-0, P-3
Total Credit Assigned = 3 (Theory = 0, Practical = 3)

Distribution of credits:	**Lecture: 00**	**Practical: 60**	**Tutorial: 1**
Distribution of Marks:	**Full Marks = 60**	**End Semester= 60**	**In Semester: 00**

Unit	Content
1	1. Habit Sketch with Description of major economic plants. 2. Submission of Charts/ Model. 3. Identification. 4. Practical Record Book. 5. Viva – Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20+20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 12**

A. Sessional Activity
1. Activities selected from above mentioned list:
a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.
4. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
7. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
8. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

SEVENTH SEMESTER

Course Code: MAJ-T3-BOT-701

Course Title: Biochemistry

Nature of the Course: Major

Component of the course: L-2, T-1, P-1

Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Carbohydrates:** General account, Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives. Formation of disaccharides, reducing and non- reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids.	14	15	0	**1**
2	**Proteins and Enzymes:** Structure and properties of amino acids; physical and chemical properties of proteins; different level of structural organization of proteins. Nomenclature and classification of enzymes, active sites; lock and key model and induced-fit model; factors affecting enzyme activity; activation energy; allosteric regulation; enzyme inhibition-competition, non-competitive and uncompetitive; cofactors; prosthetic groups; enzyme kinetics; ribozymes.	14	15	**0**	**1**
3	**Lipids and Nucleic acids:** General account of Lipids, Classification and properties of fatty acids; saturated and unsaturated fatty acids; essential fatty acids; phospholipids; glycolipids; steroids. Storage lipids - triacyl glycerol and waxes. Nucleic acids: nucleosides and nucleotides; purines and pyrimidines, types of nucleic acids; physical and	14	15	**0**	**1**

	chemical properties of nucleic acids.				
Total		**42**	**45**	**00**	**03**

Practical

Full Marks =20 End Semester= 20

Content
1. Qualitative test for carbohydrate, lipid, amino acids & proteins 2. Separation of amino acids by chromatography 3. Assay of proteins using Lowry method, standard curve preparation

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20 + 20**

B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

A.Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion b) Seminars, Workshops c) Group discussion d) Self Study and Library Work.

Course Code: MAJ-T3-BOT-702
Course Title: Cytology and Genetics

Nature of the Course: Core Course
Component of the course: L-2, T-1, P-1
Total Credit Assigned = 4

Course	Title	Credit	Marks	ES	IA	L	T	P
CC-102	Cytology and Genetics	3+1=4	60(T)+20(P)	42	18	45	3	1

Theory

Distribution of credits: **Lecture: 45** **Practical: 00** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Contents	Marks	L	P	T
1	**Cell Biology:** Molecular organization of plasma membrane; Membrane lipids & Membrane fluidity, Membrane transport: diffusion, facilitated diffusion, active transport; Carriers & Channel Proteins; Electrical properties of plasma membrane; Dynamics of microfilaments, Role of actin & microtubule cytoskeleton in cell shape, intracellular motility, mitosis & locomotion	10	12	0	1
2	Cellular communication: cell adhesion and roles of different adhesion molecules; Cell signalling; signalling molecules, receptors, second messengers, mechanism of signal transduction, Programmed cell death	8	10	0	
3	**Genetics:** Cell theory and exceptions, Chromosome structure and organization, specialized chromosomes and their cytogenetic significance, chromatin structure, nucleosome, chromosome banding and painting, mitotic apparatus, Synaptenemal complex, concept of karyotype and idiogram.	10	10	0	1
4	Polygenic inheritance: concept, examples of inheritance of kernel colour of wheat, corolla length in tobacco, Monogenic vs polygenic inheritance.	7	8	0	

5	Genetical control of sex: Chromosomal basis of sex determination, balanced theory of sex determination, environmental and hormonal control of sex, concept of sex linked, sex limited and sex influenced characters.	7	5	0	1
Total		**42**	**45**	**0**	**3**

Practical
Full Marks =20 End Semester= 20 IA = 0

1	**Genetics:** 1. Preparation of materials and study of somatic chromosomes of some common plants, camera lucida drawing and karyotype preparation. 2. Collection of flower buds and study of meiosis of some common plants.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20 + 20**

B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

A. Sessional Activity

a) Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Course Code: MAJ-T3-BOT-703
Course Title: Analytical Techniques in Plant Sciences
Nature of the Course: Major
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 4**
Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester:18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Imaging and related techniques** Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy, Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching. Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting.	12	13	0	1
2	**Separation techniques** Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$gradient, analytical centrifugation, ultracentrifugation, marker enzymes. **Chromatography** Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography.	10	10	0	1
3	**Radioisotopes** Principle and use of auto-radiography, Geigor-Muller counter.	6	4	0	
4	**Spectrophotometry** Principle and its application in biological research.	6	8	0	1
5	**Characterization of proteins and nucleic acids** Mass spectrometry; X-ray diffraction; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE.	8	10	0	
Total		42	45	00	03

Practical

Full Marks = 20 End Semester = 20 IA=0

Unit	Content
1	1. Separation of Amino Acid by TLC. OR Separation of N_2 base by Paper Chromatography. 2. Ray Diagram. OR Sample preparation for electron Microscopy. 3. Demonstration Instruments/Photographs. 4. Practical Record Book. 5. Viva-Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A.Sessional Test: Marks: 20+20

B.Other Sessional Activities: Marks: 10

In- Semester Assessment Marks: 18

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion

b) Seminars, Workshops

c) Group discussion

d) Self Study and Library Work.

Suggested readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.

2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.

3. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Course Title: Plant tissue culture

Course Code: DSE-T3-BOT-701

Nature of the Course: Major
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 3

Distribution of credits: **Lecture: 30** **Practical: 0** **Tutorial: 2**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Unit	Content	Marks	L	P	T
1	**Introduction to Plant tissue Culture** Introduction to Plant Tissue culture, Terms and definitions, Historical background, laboratory organization: Design and layout for wash area, media preparation, methods of sterilization, transfer area for aseptic manipulations, Culture rooms, and observation/data collection areas.	8	12	0	1
2	**Tissue Culture Media** Types of Media and its importance; Preparation of stock solutions of macronutrients, micronutrients, PGRs and vitamins, pH and buffers- their significance in media. Plant Growth Regulators: Role of PGRs (auxins, cytokinins, abscissic acid, ethylene and Gibberellins) in plant development.	12	12	0	1
3	**Aseptic Techniques and culture initiation** Methods of sterilization of equipment's, culture media and explants: Washing and preparation of glassware's, packing and sterilization, media sterilization, surface sterilization. Precautions to maintain aseptic conditions, Callus Induction and growth parameters, Callus subculture and maintenance, growth measurements, morphogenesis in callus culture – organogenesis, somatic embryogenesis.	12	12	0	1
4	. **Micropropagation** Micropropagation – stages, advantages, applications, Somatic embryogenesis-induction, factors, comparison with zygotic	10	9	0	

	embryogenesis				
Total		42	45	00	03

Practical

	Contents
1	1. Familiarization with basic equipment in tissue culture techniques- Autoclave, Laminar Air Flow, Hot air oven. 2. Preparation of Murashige and Skoogs (MS) medium. 3. Study of methods of sterilization- Moist heat sterilization, Dry heat sterilization, Filter sterilization, Sterilization of MS medium, Surface sterilization of Explant Material.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20 + 20**
B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

Suggested Readings

1. Robert Smith. Plant tissue culture : Techniques and Experiments. South Asia Edition.

2. Gamborg and Phillip. Plant Cell, Tissue and Organ Culture. Narosa.

3. Dixon and Gonzales. Plant Cell Culture. Panima.

4. Narayanswamy. Plant Cell and Tissue Culture. McGraw Hill.

5. Bhojwani, S.S. and Rajdan, M.K. Plant Tissue Culture : Theory and Practices a revised Edition. Elsevier.

6. Razdan, M.K. Introduction to plant tissue culture. Oxford & IBH Publishers.

7. Chawla, H.S. Introduction to Plant Biotechnology. Oxford & IBH Publishers.

8. Dey, K.K. Plant Tissue Culture.

Course Code: MIN-T3-BOT-701 (To be opted by students of the other departments)
Course Title: Ethnobotany
Nature of the Course: Minor
Component of the course: L-3, T-1, P-0
Total Credit Assigned = 4

Distribution of credits: **Lecture: 60** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 80** **End Semester= 56** **In Semester: 24**

Course Contents

Unit	Content	Marks	L	P	T
1	Ethnobotany: Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science.	4	4	0	1
2	**IKS and traditional scientific knowledge** Indigenous Technological Knowledge (ITK), Indigenous Agricultural Knowledge (IAK), Traditional Ecological Knowledge (TEK), Rural People's Knowledge (RPK), Traditional Botanical Knowledge (TBK), Integrated Knowledge System (IKS).	8	9	0	
3	Methodology of Ethnobotanical studies a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.	8	8	0	
4	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*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina*, *Trichopus zeylanicus*, *Artemisia*, Withania. Role of ethnic groups in conservation of plant genetic resources.	12	14	0	1
5	Ethnobotany and legal aspects Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.	10	10	0	1
Total		42	45	0	3

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20+20**
B. Other Sessional Activities:	**Marks: 10**

In- Semester Assessment	**Marks: 18**

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested readings:

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.

2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2ndedn. Agrobios, India.

EIGHTH SEMESTER

Course Code: MAJ-T3-BOT-801
Course Title: Industrial and Environmental Microbiology
Nature of the Course: Major
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 3

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Content	Marks	L	P	T
1	Scope of microbes in industry and environment	3	3	0	1
2	**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, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter	12	14	0	
3	**Microbial production of industrial products** Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; alcohol (Ethanol) and antibiotic (Penicillin).	11	12	0	1
4	**Microbiology of water.** Water pollution, role of microbes in sewage and domestic waste water treatment systems. Microorganisms as indicators of water quality. Microbial remediation of Arsenic and Fluoride	7	8	0	1
5	**Microbes in agriculture and remediation of contaminated soils.** Biological nitrogen fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria,	9	8	0	

	arbuscular mycorrhizal colonization in plant roots. Hydrocarbon removing bacteria.				
Total		42	45	00	03

Practical

Full Marks = 20 End Semester = 20 IA=0

Unit	Contents
1	1. Preparation of Culture Media. 2. Demonstration of Microbiological Instrument. 3. Isolation of microbes from root nodules. 4. Practical Record Book. 5. Viva-Voce.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: Marks: 20+20

B. Other Sessional Activities: Marks: 10

In- Semester Assessment Marks: 18

A. Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion

b) Seminars, Workshops

c) Group discussion

d) Self Study and Library Work.

Suggested readings

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.

2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

Course Code: MAJ-T3-BOT-802
Course Title: Methods and Ethics in Research
Nature of the Course: Major
Component of the course: L-2, T-1, P-0
Total Credit Assigned = 3

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**
Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**
Component of the course:

Total Credit Assigned = 4 (Theory=3, Practical=1)

Course Contents

Unit	Contents	Marks	L	P	T
1	General principles of research: Meaning, objectives and characteristics of research, criteria of good research, significance of research, research proposal, formulation of hypothesis, research problem, research process, research methods and methodology, Types of research, review of literature, interpretation of results and discussion, data collection, analysis and interpretation, sampling techniques, research report.	12	14	0	1
2	Technical writing: Scientific writing that includes the way of writing Synopsis, research paper, research articles, poster preparation and presentation, and dissertation, Research and Publication ethics, Plagiarism.	10	11	0	1
3	Web-based literature search engines: Introduction to Web Sciences, Google Scholar and PubMed, Impact factor metrics, Reviewing process of Journals.	10	10	0	

4	Bio-Entrepreneurship and overview of Plant based Industries: Importance of entrepreneurship and its relevance in career growth, General introduction to Intellectual Property Rights (IPRs), Patent, Trademarks, Domain names and Geographical indications	10	10	0	1
Total		**42**	**45**	**0**	**3**

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: Marks: 20 + 20

B. Other Sessional Activities: Marks: 20

In- Semester Assessment Marks: 24

A. **Sessional Activity**

a) Discussion

b) Seminars, Workshops

c) Group discussion

d) Self Study and Library Work.

Practical

Full Marks =20 End Semester= 20

Content
1.Literature survey using online databases and academic search engines.
2.Identification of research gaps from published research articles.
3.Formulation of research objectives and hypotheses.
4.Writing of title, abstract, keywords, and introduction of a research paper.
5.Preparation of citations and references using standard styles (APA/MLA/Vancouver).

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20 + 20**

B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

A.Sessional Activity

1. Activities selected from above mentioned list:

a) Lecture cum Discussion b) Seminars, Workshops c) Group discussion d) Self Study and Library Work.

Suggested Readings:

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing

for agricultural research scientists – a training reference manual. West Africa Rice

Development Association, Hong Kong.

3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press,

New York, U.S.A.

Course Title: Basics of Biostatistics

Course Code: MAJ-T3-BOT-803

Nature of the Course: Major

Component of the course: L-2, T-1, P-0

Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 3**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester:18**

Course Contents

Unit	Content	Marks	L	P	T
1	**Statistical Data** Importance of Biostatistics, Types of Data: attributes and variables, discrete and continuous data, Primary data, Secondary data, Different types of scales- nominal, ordinal, ratio and interval. Presentation of data: Construction of tables with one or more factors of classification. Diagrammatic and graphical representation of grouped data.	10	15	0	1
2	**Frequency distributions** Cumulative frequency distribution and their representation, histogram, frequency polygon and ogives. Measures of central tendency- mean, median, mode, standard deviation, variance.	14	10	0	1
3	**Test of significance** Test of significance, T- test, F- test, Chi square test, ANOVA, Biostatistical tools, Graphics: Bar, Histogram. Pie Chart, and Scatter plot.	10	10	0	
4	**Testing of hypothesis** Hypothesis Testing, Null hypothesis, Sampling distribution for discrete data. Analyses of contingency tables; hypothesis of homogeneity and independence, Correlations and Regression.	8	10	0	1
Total		42	45	00	03

Practical

1. To work out with Biostatistical sums prescribed in theory syllabus.

References

1. Alan Agresti: Categorical Data analysis; John wiley and Sons, New York, USA.

2. Bhatt B R, Srivenkatramana T and Rao Madhva K S (1996): Statistics: A Beginner's Text, Vol 1, and New Age International (P) Ltd.

3. Goon A M, Gupta M K, Das Gupta B. (1991): Fundamentals of Statistics. Vol 1, World Press, Calcutta.

4. Anderson T W and Sclove S L (1978): An Introduction to Statistical Analysis of Data, Houghton Mffin\Co.

5. Snedecor G W and Cochran W G (1967): Statistical Methods. Iowa State University Press. 6. Spiegel, M R (1967): Theory and Problems of Statistics, Schaum's Publishing Series.

Course Code: MAJ-T3-BOT-804

Course Title: Molecular Cytogenetics

Nature of the Course: Major

Component of the course: L-2, T-1, P-0

Total Credit Assigned = 4 (Theory = 3, Practical = 1)

Distribution of credits: **Lecture: 45** **Practical: 0** **Tutorial: 2**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Unit	Content	Marks	L	P	T
1	**Introduction to Cytogenetics** Overview of cytogenetics and its historical development. Relationship between genetics, cytogenetics, and cytogenomics, C-value paradox, Special types of chromosomes.	12	11	0	1
2	**Genomes and chromosomes** Sex chromosomes and their determination, Chromosome morphology and structure, Chromosomal aberrations and associated genetic diseases, Epigenetic mechanisms, Genomic	10	12	0	1

	analysis techniques, mapping of genomes; genetic mapping and physical mapping.				
3	**Techniques and Molecular Markers Cytogenetics** Principles and applications of cytogenetic tools: Karyotyping-techniques of karyotyping, CGH, DNA microarray, DNA sequencing techniques; Sangers and NGS; gene editing: CRISPR-Cas9. Basics of probe design and labelling. Emerging trends in the field. Molecular markers: VNTR, Single nucleotide polymorphisms (SNPs), DNA barcoding: barcode markers, principles and applications.	13	12	0	1
4	. **Clinical Cytogenetics** Genome instability and its role in cancers, Genetic counselling and Prenatal diagnosis- CVS, Blood cord, Amniotic fluid, tumour tissues, non-invasive test, PGD, Syndromes associated with cytogenetic disorders.	10	10	0	
	Total	42	45	00	03

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Practical

	Contents
1	1. Demonstration of cell culture techniques. 2. Study of Mitosis and Meiosis using permanent slides and squash techniques. 3. Karyotype preparation and analysis of metaphase chromosomes for genetic disorders/abnormalities.

Mode of In-Semester Assessment:

A. Sessional Test: **Marks: 20 + 20**
B. Other Sessional Activities: **Marks: 10**

In- Semester Assessment **Marks: 18**

Essential/recommended readings

1. Marilyn S. Arsham and Margaret J. Barch (2017) The AGT Cytogenetics Laboratory Manual, 4nd Edition

2. J. McGowan-Jordan and A. Simons (2016) An International System for Human Cytogenomic Nomenclature Reprint of: Cytogenetic and Genome Research, Vol. 149, No. 1-2

3. Rooney D.E., Czepulkowski B.H. (2001) Human Cytogeneitcs: A Practical Approach. Volume I og II, Oxford University Press.

4. Wolpert, L. (2002). Principles of Development. II Edition, Oxford University Press.

5. Susan Mahler Zneimer (2014) Cytogenetic Abnormalities: Chromosomal, FISH, and Microarray Based Clinical Reporting and Interpretation of Result.

Course Code: MAJ-T3-BOT-805

Course Title: Plant Ecology and Phytogeography

Nature of the Course: Major

Component of the course: L-2, T-1, P-0

Total Credit Assigned = 3

Distribution of credits: **Lecture: 30** **Practical: 0** **Tutorial: 2**

Distribution of Marks: **Full Marks = 60** **End Semester= 42** **In Semester: 18**

Course Contents

Unit	Contents	Marks	L	P	T
1	Concepts of limiting factors; nutrient cycling with special reference to carbon, nitrogen & phosphorus cycles. Diversity and complexity of ecosystem, indices of diversity, Shannon index, Sympson index.	8	8	0	1
2	Ecosystem dynamics and management: diversity, stability and complexity of ecosystem, energy flow concept and methods of measurement of productivity.	8	9	0	
3	Community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Methods of studying plant communities. Ecological succession- types; mechanisms; changes involved in succession; concept of climax.	8	9	0	
4	Population dynamics: population attributes, biotic potential and environmental resistance, population growth forms, survivorship curves, age structure, population fluctuations, interactions and regulation of population; concept of ecological niche, niche width and overlap, fundamental and realized niche; concept of meta population, demes and dispersal.	10	11	0	1
5	**Phytogeography:** Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division Of India; Vegetation with reference to N. E.India.	8	8	0	1
Total		**42**	**45**	**0**	**3**

Practical

Full Marks =20 End Semester= 20 IA = 0

	Contents
1	**Plant Ecology and Phytogeography:** 1. To study the floristic composition of different stands with respect to biotic disturbances as grazed, protected and extensively disturbed areas. 2. To determine the minimum size and number of quadrat necessary for sampling herbaceous vegetation. 3. To study the percentage frequency of species in different stands and comparison with Raunkiaer's Frequency Classes thereof. 4. To study the vegetation of a grassland community by 'Physiognomic method' – the biological spectrum method. 5. To study the Importance Value Index (IVI) of species in different stands. 6. To study the primary productivity of a fresh water ecosystem by light and dark bottle method.

(L = Lecture, P = Practical, T = Tutorial)

Mode of Transaction: Lecture Cum Discussion, Seminars, Workshops, Group discussion, Seminars, Self Study and Library Work.

Mode of In-Semester Assessment:

A. Sessional Test:	**Marks: 20 + 20**
B. Other Sessional Activities:	**Marks: 10**
In- Semester Assessment	**Marks: 18**

A. Sessional Activity

a) Discussion
b) Seminars, Workshops
c) Group discussion
d) Self Study and Library Work.

Suggested Readings:

Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Cengage Learning.

Dash, M. C. (2001). *Fundamentals of ecology*. Tata McGraw-Hill.

Barbour, M. G., Burk, J. H., & Pitts, W. D. (1999). *Terrestrial plant ecology* (3rd ed.). Benjamin Cummings.

Gurevitch, J., Scheiner, S. M., & Fox, G. A. (2006). *The ecology of plants* (2nd ed.). Sinauer Associates.

Larcher, W. (2003). *Physiological plant ecology* (4th ed.). Springer.

Begon, M., Townsend, C. R., & Harper, J. L. (2021). *Ecology: From individuals to ecosystems* (5th ed.). Wiley-Blackwell.

Molles, M. C. (2019). *Ecology: Concepts and applications* (8th ed.). McGraw-Hill Education.

Smith, T. M., & Smith, R. L. (2020). *Elements of ecology* (10th ed.). Pearson.

Sharma, P. D. (2022). *Ecology and environment* (14th ed.). Rastogi Publications.