Nehru Gram Bharati (Deemed to be University)
Prayagraj, Uttar Pradesh, INDIA

Syllabus

[As per NEP-2020 Regulations]
[NHEQF Level 4.5 to 6.0]

Four Year Undergraduate Programme

B.Sc./ B.Sc. (Honours)/ B.Sc. (Honours with Research)
in

Botany

[Effective From 2025-26 Onwards]

Board of Studies

Dated: 04.04.2025

1. Dr. Shakti Nath Tripathi, Assistant Professor, Dept. of Botany, NGB (DU), Chairperson
2. Mr. Pradeep Upadhyay, Assistant Professor, Dept. of Botany, NGB (DU), Member
3. Dr. Adi Nath, Head, Department of Botany, NGB (DU), Member
4. Dr. Dheeraj Pandey, Assistant Professor, Dept. of Botany, NGB (DU), Member
5. Prof. D.K. Chauhan, Ex-Head, Department of Botany, University of Allahabad, External Member

Introduction of the Programme:

[a] Introduction:

The NEP-2020 offers an opportunity to affect a paradigm shift from a teacher-centric to a student-centric higher education system in India. It is based on Outcome Based Education, where the Graduate Attributes are first kept in mind to reverse-design the Programs, Courses and Supplementary activities to attain the graduate attributes and learning outcomes. The learning outcomes-based curriculum framework for a degree in B.Sc. (Honours/Honours with Research) in Botany is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of the knowledge and skills, as well as to develop Scientific temper, spirit of enquiry, problem solving skills and human and professional values which foster rational and critical thinking in students.

[b] Graduate Attributes:

- Focus:

The NEP curriculum emphasizes a multidisciplinary, student-centric, and outcome-based approach to education.

- Content:

The syllabus covers fundamental concepts in botany, including:

  - Plant diversity: Morphology, anatomy, physiology, reproduction, and evolution of various plant groups.
  - Microbes and their interactions: Study of viruses, bacteria, and algae, their roles in ecosystems, and interactions with plants.
  - Plant biotechnology: Techniques and applications of biotechnology in plant sciences.
  - Economic botany: Study of plants with economic importance, including medicinal and agricultural uses.
  - Ecology and environment: Understanding plant-environment interactions, biodiversity, and conservation.

- Teaching-Learning:

The curriculum promotes discovery-based learning, practical skills development, and integration of modern pedagogical trends like e-learning and flipped classrooms.

2. Program Outcomes (POs):

- Overall Goals:

The program aims to develop students who are knowledgeable, skilled, and responsible citizens capable of contributing to society and nation-building through their plant science knowledge.

- Specific POs:
  - PO1: Ability to describe, identify, and classify plant and microbial life forms using botanical terms.
  - PO2: Knowledge of plant and microbial structure, life cycles, and life processes through model organism studies.
  - PO3: Understanding of plant-microbe interactions and the dynamics of nature.
  - PO4: Ability to understand variations in the living world through comparative morphological and anatomical studies.
  - PO5: Ability to explain diversity and evolution based on empirical evidence in morphology, anatomy, embryology, physiology, biochemistry, molecular biology, and life history.
  - PO6: Skill development in collecting, preserving, and recording information from observations and analysis.
  - PO7: Awareness of scientific and technological advancements in plant sciences.
- Other POs:
  - Develop critical thinking and research-oriented behavior.
  - Gain knowledge on local flora and ethno-botanical facts.
  - Be aware of the economic contribution of plants to the nation.

- Understand the principles of plant taxonomy, evolution, and ecology.
- Be competent in analytical and technical skills related to plant sciences.
- Be able to identify various life forms of plants and design experiments related to basic studies in plant sciences.
- Perform short research projects using various tools and techniques in plant sciences.

3. Learning Outcomes (COs):

- Course-Specific Goals:

Learning outcomes define what students should be able to do after completing a specific course or module.

- Examples of Learning Outcomes:
  - Identify edible types of mushrooms and learn their cultivation and pest management.
  - Understand the origin of life on earth and illustrate diversity among viruses and prokaryotic organisms.
  - Evaluate the ecological, ethnic, and economic value of microbes, viruses, and bacteria.
  - Understand the habit, habitat, and diversity of higher cryptogamic plants, their classification, structure, growth, and life cycle.
  - Acquaint with differentiation and structure of different plant organs.
  - Develop critical understanding on morphology, anatomy, and reproduction of Bryophytes, Pteridophytes, and Gymnosperms.
  - Understand plant evolution and their transition to land habitats.

4. Ordinance:

- Definition: Ordinances are rules or regulations that govern the conduct or operation of a specific institution or program.

[c] Flexibility:

The programmes are flexible enough to allow liberty to students in designing them according to their requirements. The Learner is given freedom of choice in selecting disciplines. Students may select his/her own stream. He/She may select three major disciplines from his er own stream or two major disciplines from his own stream and one major discipline from any other stream. Along with major disciplines, a student can select minor disciplines from other streams, languages, generic electives, ability enhancement courses, Vocational/Skill Enhancement Courses (SEC) and Value-added Courses including Extra Curricular activities.

Multiple Entry & Exit Options:

ENTRY &EXIT OPTIONS	Credits Required
Certificate upon the Successful Completion of the First Year (Two Semesters) of the multidisciplinary Four-year Undergraduate Programme**.** **+ 04 Credit Mandatory Internship in Case of Exit.**	**44**
Diploma upon the Successful Completion of the Second Year (Four Semesters) of the multidisciplinary Four-year Undergraduate Programme. **.** **+ 04 Credit Mandatory Internship in Case of Exit.** For Entry to NHEQF Level 5.0, must have completed the NHEQF 4.5 Level of Four Year Undergraduate Programme as per NEP-2020.	**84**
Basic Bachelor Degree at the Successful Completion of the Third Year (Six Semesters) of the multidisciplinary Four- year Undergraduate Programme. For Entry to NHEQF Level 5.5, must have completed the NHEQF 5.0 Level of Four Year Undergraduate Programme as per NEP-2020.	**120**
Bachelor Degree with Honours / Honours with Research in a Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme. For Entry to NHEQF Level 6.0, must have completed the NHEQF 5.5 Level of Four Year Undergraduate Programme as per NEP-2020.	**160**

SUGGESTED METHODOLOGY FOR TEACHING, LEARNING AND EVALUATION
TEACHING-LEARNING

The whole programme is an Outcome Based Education. Different methods are to be usedfor teaching learning evaluation; in order to attain the fixed outcomes.

Theory:

Student*:* Review of Literature, Assignment, Presentation, e-learning, Discussion andDebate with peer group, teachers and experts.

Teacher: Lecture, Demonstration, Presentation, Discussion and Debate.

Practical:

Student: Identification, Comparison, Differentiation and Categorization of different plants and their parts by observing Permanent Slides, Hand sectioning etc., Demonstration, Experimentation, Field visit, Report Writing and Keeping records ***Teacher:*** Demonstration, Experimentation, Field visit, Certification

Project: The finalization of the topic should be done at the beginning of the fourth semester and the list should be kept with the HOD for the perusal of the University Examination authorities. There should be at least three projects from a department. The selection of thetopic and group should be student centered as far as possible. A project log book/register is to be maintained by each student and submitted along with the project report during thefinal submission.

Student: Suggestion of Topic, Discussion with the Project guide and Peer group, Review of Literature, Project planning and Designing, Experimentation, Data Analysis and Project Report Preparation and Presentation.

Teacher: Confirmation of Topic, Demonstration, Planning of Experimentation, Guidanceand Correction and Certification.

Experiential Learning (Internships etc.):

Student should choose one of the topics for self-study from the beginning of the seventh semester. A report should be submitted by the end of Eighth Semester.

Suggested topics include: Studies on mangroves / Sacred groves / Campus flora; Cultivation of RET / Fruit / Vegetable / Medicinal plants / Mushroom; Topics related to social responsibility- River restoration, PBR (People Biodiversity Register) preparation, Herbarium arrangement, VFC (Village Forest Committee), VNRC (Village Natural Resource Committee) formation, Landscaping and Green Auditing.

Field Study / Study Tour**:**

The plant diversity studies should be carried out with the support of Field Study / Study Tour. During each year there should be a field study of 1-5 days duration, with aminimum of 5 days for the completion of the programme.

EVALUATION

External Evaluation:

External assessment by the University level examinations on specified times announced by the University for all the courses, theory, practical and Project/Viva Voce. Each student should go through the evaluation process according to the University Regulations 2021-2022

End Semester Evaluation-Theory:

The components of external evaluation and their unit wise and each theory and practical course and the time of examination will be in accordance with the calendar prepared by the University for each academic year. At the end of each semester, there will be an examination for theory courses. The duration of examinations for all theory and practical courses in Botany will be three hours, except for the Generic Elective Course papers.

External –Practical:

Practical Courses have external examination for all semester. There will be an external practical examiner and an internal examiner / skilled assistant for every practical examination of three-hour duration. The external evaluation should be carried out by the team of examiners.

Sl. No.	COMPONENTS	WEIGHTAGE
1	**Attendance**	**10**
2	**RECORD:**	
	Scientific Accuracy	**30**
	Completeness	**20**
	Neatness and Legibility	**10**
3	**Field Study Report/ Slide / Herbarium submitting**	**30**

EXTERNAL – PROJECT / FIELD STUDY / VIVA VOCE

The Project/Field Study/General Viva Voce will be conducted in I/II/III/IV/V/VI/VII/ VIII Semester Practical Examination.
Viva should be based on:
Project work
Experiential Learning (Internships etc)
Field Study
General Learning Activity of four years:

For the external evaluation the components and weightage of Project/Field Study/ Viva Voce canbe discussed and determined finally by the Board of Examiners; the suggested components and their weightage is given below. The project viva should be based on the Project and importance should be given to the Scientific method undertaken in that project. The general viva should beon based the changes in the outlook of the student after the learning activity of the 4-year programme, field study and Experiential Learning (Internships etc.). Time taken for each practical batch should be 3 hrs, by giving nearly 10-15 minutes for each student. The project/field study/viva voce evaluation should be conducted by external examiners and internal examiner.

Sl. No.	COMPONENTS	WEIGHTAGE
1	**Attendance**	**10**
2	**PROJECT REPORT:**	
	Report With All General Parts – Relevance, Objective, Methodology, Data Analysis, Discussion, Conclusion AndReference etc.	**10**
	Presentation Skill	**30**
	Viva	**30**
3	Field Study Report	**10**
4	Viva	**10**

ELIGIBILITY TO APPEAR FOR PRACTICAL EXAMINATION

1. 80% Attendance (All Sem.)
2. Certified Bona-fide Record (All Sem.)
3. Herbarium and Field Book (Respective Sem.)
4. Field Study Reports (Respective Sem.)
5. Certified Bona-fide Project Report (Eighth Sem.)
6. Report on Experiential Learning (Internships etc.) (Eighth Sem.)

CONTINUOUS INTERNAL EVALUATION

Internal evaluation is a continuous evaluation in all types of courses- theory/ practical / Project / Field study. The teacher has flexibility in deciding the components and their weightage in accordance with the University Regulations, 2021-22. Internal evaluation should be very transparent to the students and the components and relative weightage should be announced at thebeginning of each learning activity by the concerned teacher. Internal evaluation should be published in the notice board, one week before the closure of each semester.

INTERNAL –THEORY

The percentile system can be adopted for calculating the internal component, test paper

Sl. No.	COMPONENTS	WEIGHTAGE
1	**Attendance**	**10**
	Test Papers	**40**
2	**Assignment**	**20**
	Seminar	**20**
	Viva	**10**

INTERNAL – PRACTICAL

The internal evaluation may be regular internal assessment on hourly basis or unit wise,whichever is communicated with the student.

Sl. No.	COMPONENTS	WEIGHTAGE
1	**Regularity**	**25**
2	**Practical Skill**- (Sectioning, Drawing, Labeling, Record Keeping Etc)	**50**
3	**Regular Viva/Model Examination**	**25**

INTERNAL - PROJECT/FIELD STUDY/VIVA VOCE

Internal evaluation of the project should start with the beginning of the project and can be finalized by the project viva.

Sl. No.	COMPONENTS	WEIGHTAGE
1	**Participation**	**50**
2	**Viva**	**25**
3	**Field Study and other Assignment Reports**	**25**

Other Courses:

Minor: To be Choose from POOL B

Skill Enhancement Course (SEC): To be Choose from POOL C

Value Added Course: To be Choose from POOL D

Department of Botany
B.Sc./B.Sc. (Honours/Honours with Research) in Botany
SYLLABUS STRUCTURE Over-All (Based on NEP – 2020)

B.Sc./B.Sc. (Honours/Honours with Research) in Botany											
Year	**Semester**	**Nomenclature of the Courses/Title**	**Com/Ele.**	**Credit**	Credit Distribution			Teaching Hours		
					L	T	P	L	T	P
First Year	I	Microbial Diversity and Technology	Compulsory	4	2	0	2	30	0	60
		Introduction to IKS : Botany	Compulsory	2	1	1	0	15	15	0
		Minor: Microbes & Human Welfare I	Pool B	3	3	0	0	45	0	0
		AEC: Communication Skills & Personality Development	Compulsory	2	2	0	0	30	0	0
		SEC-1	Pool C	3	1	0	2	15	0	60
		VAC-1: Understanding India	Pool D	2	2	0	0	30	0	0
		Other Major (Compulsory)	Pool A	4	2	0	2	30	0	60
		Total Semester Credits		**20**				0	0	0
	II	Diversity of Cryptogams and Gymnosperms	Compulsory	5	3	0	2	45	0	60
		Minor: Microbes & Human Welfare II	Pool B	3	3	0	0	45	0	0
		AEC: Critical Thinking & Problem Solving	Compulsory	2	2	0	0	30	0	0
		SEC-2	Pool C	3	1	0	0	15	0	0
		VAC-2: Indian Constitution	Pool D	2	2	0	0	30	0	0
		Other Major (Compulsory)	Pool A	5	3	0	2	45	0	60
		Total Semester Credits		**20**						
Exit Option: Certificate in Field of Learning/discipline										
Second Year	III	Plant Taxonomy and Resource Botany	Compulsory	4	2	0	2	30	0	60
		Applied IKS-I : Botany	Compulsory	2	2	0	0	30	0	0
		Minor: Plants and Human Welfare-I	Pool B	3	3	0	0	45	0	0
		AEC: Soft Skills	Compulsory	2	2	0	0	30	0	0
		SEC-3	Pool C	3	1	0	2	15	0	60
		VAC-3: Indian Heritage and Culture/NSS/NCC	Pool D	2	2	0	0	30	0	0
		Other Major (Compulsory)	Pool A	4	2	0	2	30	0	60
		Total Semester Credits		**20**						
	IV	Anatomy of Angiosperms and Developmental Botany	Compulsory	5	3	0	2	45	0	60
		Minor: Plants and Human Welfare -II	Pool B	3	3	0	0	45	0	0
		AEC: Content Writing & Editing	Compulsory	2	2	0	0	30	0	0
		SEC-4	Pool C	3	1	0	2	15	0	60

		VAC-4: Food Nutrition & Hygiene	Pool D	2	2	0	0	30	0	0
		Other Major (Compulsory)	Pool A	5	3	0	2	45	0	60
		Total Semester Credits		**20**						
Exit Option: Diploma in Field of Learning/discipline										
Third Year	V	Plant Physiology and Biochemistry	Compulsory	4	2	0	2	30	0	60
		Applied IKS-II : Botany	Compulsory	2	3	0	0	45	0	0
		Minor: Palaeobotany I	Pool B	3	3	0	0	45	0	0
		AEC: Team Building & Leadership	Compulsory	2	2	0	0	30	0	0
		Note: Choose any one Course 1. Medicinal Plants in Health Care 2. Plant Propagation and Tissue Culture	Elective	3	1	0	2	15	0	60
		VAC-5: Environmental Science & Sustainability	Pool D	2	2	0	0	30	0	0
		Other Major (Compulsory)	Pool A	4	2	0	2	30	0	60
		Total Semester Credits		**20**						
	VI	Ecology and Conservation Biology	Compulsory	5	3	0	2	45	0	60
		Note: Choose any one Paper 1. Bioinformatics and Computational Biology 2. Landscaping, Gardening and Green House Technology	Elective	3	1	0	2	15	0	60
		Minor: Palaeobotany II	Pool B	3	3	0	0	45	0	0
		Internship/Apprenticeship	Compulsory	4	0	0	4	0	0	120
		Other Major (Compulsory)	Pool A	5	3	0	2	45	0	60
		Total Semester Credits		**20**						
Exit Option: Basic UG degree in Field of Learning/discipline										
Fourth Year	VII	Cell Biology, Genetics and Plant breeding	Compulsory	5	3	0	2	45	0	60
		2. Research Methodology (Hons. with Research) /Food Processing (Honours)	Compulsory	4	4	0	0	60	0	0
		Note: Choose any Two Course (4+4) 1. Medicinal Plants and Phytochemistry 2. Environmental Biotechnology 3. Plant Biotechnology	Elective	8	4	0	4	60	0	120
		Minor: Plant Pathology	Pool B	3	3	0	0	45	0	0
		Total Semester Credits		**20**						
	VIII	Molecular Biology (Major-I)	Compulsory	5	3	0	2	45	0	60

		Note: Choose any one Course: (4+4) 1. Seed Biology and Seed Technology 2. Organic Farming 3. Natural Resource Management	Elective	3	3	0	3	45	0	45
		Dissertation/Research Project & Viva Voce (Hons. with Research) or Field Visit/Tour based Viva Voce (Honours)	Compulsory	12	0	0	12	0	0	360
		Total Semester Credits		**20**						
Completion: UG (Hons. /Hons. with Research) degree in Field of Learning/discipline										
		Total Credits		**160**						

*** AEC: Ability Enhancement Course**
SEC: Skill Enhancement Course (POOL C)
VAC: Value Added Course (POOL D)
IKS: Indian Knowledge System
Minor or Pool B is for students of Other Discipline

Department of Botany

B.Sc./B.Sc. (Honours/Honours with Research) in Botany

SYLLABUS (Based on NEP – 2020)

Session 2025 – 26

YEAR	SEMESTER	PAPER TITLE	Course Code	MAJOR/ MINOR	COM/ EL	(L)	(T)	(P)	TOTAL CREDIT	TEACHING HOURS
1ST	IST	Microbial Diversity and Technology	BOT-23101	Major	COM	02	00	02	04	90 (30 + 60)
		Introduction to IKS	BOTIKS-2301	Major	COM	02	00	00	02	30
		Minor Paper for Other Discipline [Microbes and Human Welfare I]	MBOT01	Minor	COM	03	00	00	03	45
	IIND	Diversity of Cryptogams and Gymnosperms	BOT-23102	Major	COM	03	00	02	05	105 (45 + 60)
		Minor Paper for Other Discipline [Microbes and Human Welfare II]	MBOT02	Minor	COM	03	00	00	03	45
2ND	IIIRD	Plant Taxonomy and Resource Botany	BOT-23103	Major	COM	02	00	02	04	90 (30 + 60)
		Applied IKS-I	BOTIKS-2302	Major	COM	02	00	00	02	30
		Minor Paper for other discipline [Plant and Human Welfare-I]	MBOT03	Minor	EL	03	00	00	03	45
	IVTH	Anatomy of Angiosperms and Developmental Botany	BOT-23104	Major	COM	03	00	02	05	105 (45 + 60)
		Minor Paper for other discipline [Plants and Human Welfare-II]	MBOT04	Minor	EL	03	00	00	03	45
3RD	VTH	Plant Physiology and Biochemistry	BOT-23105	Major	COM	02	00	02	04	90 (30 + 60)

		Applied IKS-2	BOTIKS-2303	Major	COM	02	00	00	02	30
		Minor Paper for Other Discipline [Palynology I]	MBOT05	Minor	ELE	03	00	00	03	45
		Note: Choose any one Course i. Medicinal Plants in Health Care ii. Plant Propagation and Tissue Culture	BOT-23106A/ BOT-23106B	Major	ELE	01	00	02	03	45
	VI[TH]	Ecology and Conservation Biology	BOT23107	Major	COM	03	00	02	05	105 (45 + 60)
		Note: Choose any one Course i. Bioinformatics and Computational Biology ii. Landscaping, Gardening and Green House Technology	BOT-23108A/ BOT23108B	Major	EL	01	00	02	03	75 (15+60)
		Minor Paper for Other Discipline [Palynology II]	MBOT06	Minor	EL	03	00	00	03	45
		Internship/Apprenticeship	BOT-23109	Major	COM	0	0	04	04	120
4[TH]	VII[TH]	Cell Biology, Genetics and Plant Breeding	BOT-23110	Major	COM	05	00	03	02	105 (45 + 60)
		1. Research Methodology (Honours with Research)/Food Processing (Honours)	BOT-23111A/ BOT23111B	Major	COM	04	00	00	04	60

		Note: Choose any Two Course i. Medicinal Plants & Phytochemistry ii. Environmental Biotechnology iii. Plant Biotechnology	BOT23112A/BOT23112B/BOT23112C	Major	EL	04	00	04	08	180 (60+120)
		Minor Paper for Other Discipline [Plant Pathology]	MBOT07	Minor	EL	03	00	00	03	45
	VIIITH	Molecular Biology	BOT23113	Major	COM	05	00	03	02	105(45+60)
		Note: Choose any one Courses: i. Seed Biology and Seed Technology ii. Organic Farming iii. Natural Resource Management	BOT23114A/ BOT23114B/ BOT23114C	Major	EL	03	00	03	03	45
		Dissertation/Research Project Viva Voce (Hons. with Research)/Field Visit, Educational Tour based Viva Voce	BOT23115A/BOT23115B	Major	COM	00	00	12	12	360

SEMESTER-I

B.Sc./B.Sc. (Honours/Honours with Research) in Botany

Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. I st Year**	**Semester: I**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23101	**Course Title:** Microbial Diversity and Technology	
Course Outcome: After completing this course, the students will be able to - CO.1 Understand the diversity among bacteria, viruses, Lichen & fungi CO.2 Know the systematic, morphology and structure of bacteria, viruses, Lichen & fungi CO.3 Understand the lifecycle pattern of bacteria, viruses, Lichen & fungi CO.4. Understand the useful and harmful activities of Microbes and its interaction with plants. CO.5 Discriminates the steps of isolation, identification and purification of microbes		
Credit: 4	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials +Practical): 30+0+60		

Unit	Topics	No. of Lectures
Unit I.	History and scope of microbial study. Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: Acellular microorganisms and Cellular microorganisms with emphasis on distribution and occurrence, morphology, mode of reproduction. Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Conservation and Economic values of microbial diversity. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Dmitri Iwanowski, E. J. Butler, A. D. Barry, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Elie Metchnikoff, Edward Jenner, K.C. Mehta**.**	6
Unit II	Microbial techniques: Microscopy working principle, Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Scanning and Transmission Electron Microscope. Sterilization (physical and chemical), Microbial growth and measurement. Synthetic microbial cultures, Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria. Microbial culture collections and their importance.	6
Unit III	Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Structure and replication of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Modes of viral transmission. Salient features and replication of TMV, T4 phage. Economic importance of viruses. Bacteria: Structure of a bacterial cell: flagella, cell envelope, cell membrane, chromosome, plasmid and endospore. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls. Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain in bacteria. Reproduction in bacteria; brief account of genetic recombination in bacteria (transformation, conjugation and transduction). Characteristics features and importance of *Escherichia coli, Bacillus subtilis.* Characteristics features and importance of Archea, Actinomycetes, Rickettsiae, Spirochaetes. Economic importance of bacteria.	6
Unit IV	General characteristics of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Fungal cell structure, thallus organization and aggregation, asexual reproduction, sexual reproduction. Heterothallism, Mycotoxins.	6

	Fungal classification (Ainsworth's system), Life history *of Saprolegnia, Albugo, Phytophthora, Rhizopus, Peziza, Aspergillus, Agaricus, Puccinia, Alternaria, Cercospora*. Economic Importance of Fungi with examples in agriculture, environment, Industry, medicine, food and bioremediation. Lichens: Occurrence general structure and reproduction with special reference to *Parmelia*. Economic Importance of Lichens.	
Unit V	Definition and scope: disease and disease-causing organisms, symptoms of plant diseases, dissemination of pathogens, introductory knowledge of epidemiology and forecasting of plant diseases, host-parasite interaction, effect of environment on plant diseases, principles of defense mechanisms and control. Disease cycle and prevention measure of White rust of crucifer, Late blight of potato, Wilt of *Cajanus cajan*, Loose smut of Wheat, Covered smut of Barley, Downey mildew disease of bajara, Sandal spike, Citrus canker, Tobacco mosaic disease. Mycorrhizal fungi and their significance.	6

Suggested Readings:

1. Ananthnarayan R and Panikar JCK. 1986. Textbook of Microbiology. Orient Longman ltd. New Delhi.
2. Arora DR. 2004. Text book of Microbiology, CBS, New Delhi.
3. WilliamCG.1989. Understanding microbes. A laboratory text book for Microbiology. W.H. Freeman and Company. New York.
4. Dubey RC and Maheshwari DK. 2007. A textbook of Microbiology, S. Chand and Company, New Delhi.
5. Dubey RC and Maheshwari DK. 2002. A Text book of Microbiology

6.S.C. Chand and Company, Ltd. Rajnagar, New Delhi.

7. Sharma R.2006. Textbook of Microbiology. Mittal Publications. New Delhi.305pp.
8. Sharma PD. 1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India.
9. VasanthkumariR.2007. A textbook of Microbiology, BI Publications Pvt. Ltd., New Delhi.

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[List of Practicals]

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. I st Year**	**Semester: II**
Pedagogy:		
Course Code: BOT-23101	**Course Title: Lab work on** Microbial Diversity and Technology **[List of Practicals]**	
Course Outcome: After completing this course, the students will be able to -		
CO1. Practical understanding through virtual dissection CO2. Prepare permanent slides and museum conservations. CO3. Know about Taxonomic identification and characteristic features. CO4: Know about permanent slide preparation		
Credit: 2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 0+0+2		
Unit:	**Topics**	**Practicals (Hrs.)**
Practical 1: Safety measures in microbiology laboratory and study of equipment/appliances used for microbiological studies (Microscopes, Hot air oven, Autoclave/Pressure Cooker, Inoculation needles/loop, Petri plates, Incubator, Laminar flow hood, Colony counter, Haemocytomer, Micrometer etc.). **Practical2:** Enumeration of soil/food/seed as microorganisms by serial dilution technique.		60

Practical3: Preparation of culture media (NA/PDA)sterilization, inoculation, incubation of *Ecoli/ B.subtilis* /Fungi and study of cultural characteristics. **Practical 4:** Determination of cell count by using Haemocytometer and determination of microbial cell dimension by using Micrometer. **Practical 6:** Simple staining of bacteria (Crystal violet /Nigrosine blue) / Gram's staining of bacteria. **Practical7:** Isolation and study of morphology of *Rhizobium* from root nodules of legumes **Practical8:** Preparation of spawn and cultivation of paddy straw (Oyster) mushroom. **Practical9:** Study of vegetative structures and reproductive structures-*Albugo ,Phytophthora/Pythium, Rhizopus/Mucor, Saccharomyces, Neurospora/ Sordaria,Puccinia,Agaricus,Lycoperdon,Aspergillus/Penicillium,Trichoderma.(Dependingon local availability)* **Practical10:** Preparation of agar slants, inoculation, incubation, pure culturing and preservation of microbes by oil overlaying. **Practical 11:** Study of late blight of Potato, Downy mildew of Bajra, Citrus canker, Tobacco mosaic disease, Sandal spike disease. **Practical 12:** Study of well-known microbiologists and their contributions through charts and photographs. **Practical-13:** Visit to water purification units/Composting/ microbiology labs/dairy and farms to understand role of microbes in day today life. (Note: Botanical study tour to a floristic rich area for 1-2 days and submission of study report is compulsory)	
1. Ananthnarayan R and Panikar JCK. 1986. Textbook of Microbiology. Orient Longman ltd. New Delhi. 2. Arora DR. 2004. Text book of Microbiology, CBS, New Delhi. 3. WilliamCG.1989. Understanding microbes. A laboratory text book for Microbiology. W.H. Freeman and Company. New York. 4. Dubey RC and Maheshwari DK. 2007. A textbook of Microbiology, S. Chand and Company, New Delhi. 5. Dubey RC and Maheshwari DK. 2002. A Text book of Microbiology 6.S.C. Chand and Company, Ltd. Rajnagar, New Delhi. 7. Sharma R.2006. Textbook of Microbiology. Mittal Publications. New Delhi.305pp. 8. Sharma PD. 1999. Microbiology and Plant Pathology. Rastogi publications. Meerut, India. 9. VasanthkumariR.2007. A textbook of Microbiology, BI Publications Pvt. Ltd., New Delhi.	
Suggested continuous Evaluation methods-	
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks	

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Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. 1st Year**	**Semester: Ist**
Pedagogy: Lectures, Practicals, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOTIKS-2301	Course/Paper Title:	**Introduction to Indian Knowledge System**
Course Outcomes: After completing this course, the students will be able to -		
CO 1: explain the foundational Concepts & Principles of IKS.		
CO 2: explain the historical development and evolution of Indian Intellectual traditions.		
CO 3: explain the knowledge key texts, thinkers, and schools of thought within the IKS.		
CO 4: analyze the interdisciplinary nature of Indian knowledge, integrating philosophy, spirituality, science, arts, and literature though the study of IKS.		
CO 5: explain the holistic and multidimensional nature of Indian Thought.		

Credit: 03	Paper (Core Compulsory / Elective): Core Compulsory
Max. Marks: **40+60**	**Min. Marks: 35**
Total Number of Lectures (Lecture – Tutorials – Practical): 3 + 0 + 0	

Units:	Topics	No. of Lectures
I	**Introduction to Indian Knowledge System** • Definition, Concepts and Scope of IKS • IKS based approache on Indian Knowledge System & Role of Guru (teacher) • Understanding the concepts of dharma, karma, and the four purusharthas (goals of life)	09
II	**Vedic Knowledge and Philosophy** • Study of the Vedas, including the Rigveda, Yajurveda, Samaveda, and Atharvaveda • Introduction to Upanishads and their metaphysical and philosophical teachings • Analysis of the six orthodox (astika) schools of Indian philosophy (e.g., Nyaya, Vaisheshika, Yoga, Samkhya, Mimamsa, and Vedanta)	09
III	**Unit 3: Spiritual and Mystical Traditions** • Exploration of Hindu spiritual traditions, including Bhakti, Karma, Jnana, and Raja Yoga • Study of Advaita Vedanta and its nondualistic philosophy • Introduction to other spiritual paths like Tantra and Sufism in the Indian context	09
IV	**Scientific and Technological Advancements** • Examination of ancient Indian contributions to mathematics, astronomy, and medicine • Study of scientific treatises such as Aryabhatiya, Sushruta Samhita, and Charaka Samhita • Exploration of the Indian concept of time, measurement, and cosmology	09
V	**Indian Arts, Literature, and Aesthetics** • Analysis of Indian classical music, dance, and theater traditions • Study of classical Sanskrit literature, including the works of Kalidasa and Valmiki • Understanding the concept of rasa (aesthetic experience) and its manifestations in Indian arts • Modern Interpretation and Contemporary Relevance	09

Suggested Readings:

- "Indian Philosophy: A Very Short Introduction" by Sue Hamilton
- "A History of Indian Philosophy" by Surendranath Dasgupta
- "Indian Philosophy: A Critical Survey" by Chandradhar Sharma
- "India: A History" by John Keay
- "The Wonder That Was India" by A.L. Basham
- "Ancient India" by R.S. Sharma
- "The Oxford History of India" edited by Percival Spear
- "A History of Indian Literature" (multiple volumes) by Sisir Kumar Das
- "Indian English Literature" by M. K. Naik
- "The Norton Anthology of World Literature: India, Pakistan, and Bangladesh" edited by Sarah Lawall
- "Indian Art" by Partha Mitter
- "The Art and Architecture of the Indian Subcontinent" by J.C. Harle
- "Indian Architecture: Buddhist and Hindu Period" by Percy Brown
- "The Crest of the Peacock: Non-European Roots of Mathematics" by George Gheverghese Joseph
- "Indian Science and Technology in the Eighteenth Century" by Dharampal
- "Raga Mala: The Autobiography of Ravi Shankar" by Ravi Shankar

- "The Ragas of North India" by Walter Kaufmann
- "The Complete Book of Ayurvedic Home Remedies" by Vasant Lad
- "Ayurveda: The Science of Self-Healing" by Vasant Lad
- "The Heart of Yoga: Developing a Personal Practice" by T.K.V. Desikachar
- "The Yoga Sutras of Patanjali" translated by Swami Satchidananda

Suggested continuous E-Valuation Methods –

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Minor Course: For Students of Other Discipline/Subject

Programme: B.Sc. (Honours/Hounours with Research) in Botany	**Year: B.Sc. I st Year**	**Semester: I**
Pedagogy:		
Course Code: MBOT01	**Course Title: Microbes and Human Welfare-1 (Minor)**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand Microbial Diversity – Explain the general characteristics, and significance of different types of microbes in various environments. CO.2 Apply Microbial Knowledge in Agriculture & Environment – Analyze the role of microbes in soil fertility, biofertilizers, biopesticides, and environmental sustainability. CO.3 Explore Industrial and Biotechnological Applications – Describe microbial applications in industries such as fermentation, enzyme production, wastewater treatment, and genetic engineering. CO.4. Assess the Impact of Microbes on Human Health – Understand the role of normal microbiota, pathogenic microbes, probiotics, vaccines, and antibiotic resistance in human health. CO.5 Evaluate the Role of Microbes in Food and Dairy Industry – Discuss microbial applications in food processing, preservation, and quality control, along with their role in foodborne diseases. CO. 6 Develop a Holistic View of Microbial Contributions – Integrate knowledge of beneficial and harmful microbes to assess their impact on human welfare and global sustainability.		
Credit: 3	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials +Practical): 3+0+0		

Unit	**Topics**	**No. of Lectures**
Unit I.	**Introduction to Microbes and their Diversity:** Historical perspective of Microbiology, Introduction to microbiology: scope and importance, Bacteria, Fungi, Viruses, cyanobacteria, Beneficial vs. harmful microbes	9
Unit II	**Basic tools and Techniques:** Microscope Types and uses, Microbial cultures Sterilization: Physical, chemical sterilization, Aseptic conditions, Incubation.	9
Unit III	**Role of Microbes in Agriculture:** Role of microbes in soil fertility and plant growth**,** Biofertilizers: Rhizobium, Azotobacter, Mycorrhiza**,** Role of Cyanobacteria in Agriculture**,** Biopesticides and eco-friendly farming**,** Microbial applications in wastewater treatment and pollution control	9
Unit IV	**Role of Microbes in Industry:** Microbial fermentation products: Alcohol, Cheese, Yogurt, antibiotics, and organic acids, Microbial applications in food and textile industries, Fermentation: Role of yeast and bacteria in making beverages, Food spoilage and food preservation, Industrial uses of microbes (antibiotics, enzymes, organic acids), Genetically modified microbes in biotechnology	9
Unit V	**Microbes in Public Health and Awareness:** Introduction to public health: definition, scope, and importance, microbial association of water, air and soil., Air and water born infections and their management, Food borne diseases and food poisoning and food hygiene.	9

	Hospital acquired infections, disposal of infective hospital and laboratory material.	

Suggested Readings:

1. Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. – Microbiology
2. Prescott, Harley & Klein – Microbiology
3. Dubey, R.C. & Maheshwari, D.K. – A Textbook of Microbiology
4. Stanier, R.Y. – General Microbiology, NCERT Text Book

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Other Courses to Opt:

Ability Enhancement Course
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course : To be Choosed from POOL D

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SEMESTER-II

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. I st Year**	**Semester: II**
Pedagogy: Lectures, Practicals, Field and laboratory visits, participatory learning, seminars, assignments, MOOCs and specimen preparation and submission		
Course Code: BOT-23102	**Course Title: Diversity of Cryptogams and Gymnosperms**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Know the systematic, morphology and structure of Algae CO.2 Understand the morphological diversity of Bryophytes CO.3 Understand the morphological diversity of Pteridophytes CO. 4 Understand Gymnosperms with respect to distinguishing characters, comparison with Angiosperms, economic importance and classification CO.5 Understand the features of Lichens		
Credit: 5	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials +Practical): 3+0+2		

Unit:	**Topics**	**No. of Lectures**
Unit I.	General Characteristics and Classification of Algae, Life history of Cynophyceae, Chlorophyceae, Xanthophyceae, Phaeophyceace and Rhodophyceae. Life cycle of Chlamydomonas, *Volvox, Oedogonium.Vaucheria, Ectocarpus*, and *Polysiphonia.* Economic importance of Algae.	10
Unit II	General Characteristics and classification of Bryophytes.Reproduction in Bryophytes, Life history of *Riccia, Marchantia, Pellia, Anthoceros, Sphagnum*.Economic Importance of Bryophytes	08
Unit III	General Characteristics of Pteridophytes, Affinities of Pteridophytes, Classification of Pteridophytes, Important characters of various Sub-divisions.General life cycle of Pteridophyte.Stealer systems. Study of Morphology, Anatomy and Reproduction of Early (fossil) land Plants (*Rhynia), Lycopodium, Selaginella, Equisetum, Pteris,*	09

	Marsilea. Heterospory and seed habitat.Telome theory.Economic importance of Pteridophyte.	
Unit IV	General Characteristics, Distribution and Classification of Gymnosperm, Affinities of Gymnosperms. Morphology, Anatomy, Reproduction and life cycle of Cycas, *Pinus& Ephedra*. Economic importance of Gymnosperms.	10
Unit V	An elementary knowledge of Paleobotany, Geological Time Scale, Process of fossilization, types of fossils, Factors affecting fossil preservation. Methods and significance of fossil Study.	08

Suggested Readings:

1. Chopra,G.L.AtextbookofAlgae.Rastogi&Co.,Meerut,Co.,NewDelhi,Depot.Allahabad.
2. Thomas N. Taylor, Edith L.Taylor and Michael Krings. Paleobotany; The biology and evolution of fossil plants, 2009. ISBN-10: 0123739721, Academic Press
3. Johri,Lata anfTyagi,2012, AText Bookof, Vedame Books,NewDelhi.
4. Sharma,O.P.1990.TextBookofPteridophyta.McMillanIndiaLtd.NewDelhi.
5. Sharma,O.P.1992.TextBookofThallophytes.McGrawHillPublishingCo.NewDelhi.
6. Sharma,O.P.,2017,AlgaeSingh-Pande-Jain2004-05. ATextBookofBotany.RastogiPublication, Meerut.
7. S.P. Bhatnagar, Moitra and Pant; An Introduction to Gymnosperm, 1966

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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[List of Practicals]

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. I st Year**	**Semester: II**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23102	**Course Title: Lab work on Diversity of Cryptogams and Gymnosperms [List of Practicals]**	
Course Outcome: After completing this course, the students will be able to -		
CO1. Practical understanding through virtual dissection CO2. Prepare permanent slides and museum conservations. CO3. Know about Taxonomic identification and characteristic features. CO4: Know about permanent slide preparation		
Credit: 2	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 14+21**	
Total Number of Lectures (Lecture +Tutorials + Practical): 0+0+2		

Practicals List No.	**Practical 's (Hrs.)**
Practical-1: Study of morphology, classification, reproduction and lifecycle of *Nostoc*/*Oscillatoria.* **Practical-2:** Study of morphology, classification, reproduction and life-cycle of *Oedogonium& Chara, Sargassum*, *Batrachospermum/ Polysiphonia*. **Practical-3:** Study of morphology, classification, reproduction and life-cycle of *Riccia & Anthoceros.* **Practical-4:** Study of morphology, classification, anatomy, reproduction and life-cycle of *Selaginella and Equisetum.* **Practical-5:** Study of morphology, classification, anatomy, reproduction and life-cycle of *Pteris, Azolla, Salvinia*	60

Practical -6: Study of morphology, classification, anatomy and reproduction in *Cycas*. **Practical -7:** Study of morphology, classification & anatomy, reproduction in *Pinus*. **Practical -8:** Study of morphology, classification & anatomy, reproduction in *Gnetum*. **Practical-9:** Study of important blue green algae causing water blooms in the lakes. **Practical-10:** Study of different methods of cultivation of ferns in a nursery. **Practical-11:** Preparation of natural media and cultivation of *Azolla* in artificial ponds. **Practical-12:** Media preparation and cultivation of *Spirulina*. **Practical-13:** Study different algal products and fossils impressions and slides. **Practical-14:** Visit to algal cultivation units/lakes with algal blooms/Fern house/Nurseries/Geology Museum/lab to study plant fossils. (Note: Botanical study tour to a floristic rich area for 1-2 days and submission of study report is compulsory)	

Suggested Readings:

1. Chopra,G.L.AtextbookofAlgae.Rastogi&Co.,Meerut,Co.,NewDelhi,Depot.Allahabad.
2. Thomas N. Taylor, Edith L.Taylor and Michael Krings. Paleobotany; The biology and evolution of fossil plants, 2009. ISBN-10: 0123739721, Academic Press
3. Johri,Lata anfTyagi,2012, AText Bookof, Vedame Books,NewDelhi.
4. Sharma,O.P.1990.TextBookofPteridophyta.McMillanIndiaLtd.NewDelhi.
5. Sharma,O.P.1992.TextBookofThallophytes.McGrawHillPublishingCo.NewDelhi.
6. Sharma,O.P.,2017,AlgaeSingh-Pande-Jain2004-05. ATextBookofBotany.RastogiPublication, Meerut.
7. S.P. Bhatnagar, Moitra and Pant; An Introduction to Gymnosperm, 1966

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Minor Course : For Students of Other Discipline/Subject

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. I st Year**	**Semester: II**
Pedagogy:		
Course Code: MBOT02	**Course Title: Microbes and Human Welfare II (Minor)**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the Diversity of Microbes – Recognize different types of microbes, their habitats, and their roles in nature. CO.2 Explain Microbes and Human Health – Describe how microbes affect human health, including their role in diseases, medicine, and probiotics. CO.3 Identify the Role of Microbes in Food and Industry – Understand how microbes are used in food production, fermentation, and industrial applications. CO. 4 Analyse the Environmental and Agricultural Importance of Microbes – Explain how microbes contribute to soil fertility, waste management, and pollution control. CO.5 Explore the Societal Impact of Microbes – Assess the role of microbes in biotechnology, forensic science, and climate change. CO.6 Apply Microbial Knowledge to Daily Life – Develop an awareness of the benefits and risks of microbes in everyday activities and public health.		
Credit: 3	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials +Practical): 3+0+0		

Unit:	**Topics**	**No. of Lectures**

Unit I.	**Fundamentals of Microbiology:** Microbiologist and their contributions, Type of staining-simple, differentials, capsule staining. Ultrastructure of Bacteria, fungi, cyanobacteria and viruses, DNA, RNA as genetic material, Experiments of Griffith, Avery, Macleod and McCarty. Hershey and Chase, Lederberg and Tatum.	10
Unit II	**Basics of Recombinant DNA Technology:** Introduction to recombinant DNA technology- tools, enzymes. Gene cloning vectors: features and important examples, Transformation of r-DNA into target host organisms, screening and selection, Agrobacterium mediated DNA transfer. cDNA libraries, PCR and its application. Applications of rDNA technology.	08
Unit III	**Microbes in Human Health and Medicine:** Normal microbial flora of the human body, Pathogenic microbes and infectious diseases, Probiotics and their health benefits, Role of microbes in medicine (antibiotics, vaccines, and probiotics), Good microbes in the human body (gut bacteria, skin microbes)	07
Unit IV	**Microbial pathogens and Plant Diseases:** Concept of plant disease- definition, disease cycle, pathogenicity, symptoms. Types of plant pathogens, infections, invasion, colonization. Virulence factors of pathogens; enzymes, toxins, growth regulators. Concept of resistance (r) gene and avirulence (avr) gene, hypersensitive response, PR proteins, Phytoalexins. Basic principle of disease management	10
Unit V	**Microbial Ecology and Environmental Microbiology:** Environment Ecosystem, Microbial interactions, Role of microbes in nature: Decomposers, nitrogen fixers, and symbionts, Microbes in Aerosol, Allergens, Bacteriological Examinations of Water, Microbiology of Sewage, Bioremediation, BOD, COD	10

Suggested Readings:

1. Dubey, R.C. & Maheshwari, D.K. – A Textbook of Microbiology
2. Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. – Microbiology
3. Prescott, Harley & Klein – Microbiology (Simplified version)

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Other Courses to Opt:

Ability Enhancement Course
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course : To be Choosed from POOL D

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EXIT OPTION: **Undergraduate Certificate(in the field of learning/discipline**)for those who exit after the first year (two semesters) of the undergraduate programme. (Programme duration: first year or two semesters of the undergraduate programme + Mandatory Internship of 04 Credits)
[NHEQF 4.5]

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SEMESTER-III

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IIIrd Year**	**Semester: III**
Pedagogy:		
Course Code: BOT-23103	**Course Title**: Plant Taxonomy and Resource Botany	

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

CO.1 Understand the status of angiosperms in plant kingdom
CO.2 Realize the origin of Angiosperms with respect to time, place, origin and probable ancestors
CO.3 Understand various angiosperm families emphasizing their morphology, distinctive features and biology
CO.4 Know the role of cytology and Phytochemistry in Taxonomy
CO.5 Study of Phenology of fruits, vegetables or flowering crops

Credit: 4	**Paper: Core Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical): 2+0+2

Unit		**No. of Lecture**
Unit I	Fundamental components of taxonomy, Flora, Keys- single access and multi-access. Taxonomic hierarchy: Species, Genus, Family, Order, Class, Division. Herbarium and Botanical Gardens: Role and significance. Significant Contributions of Important Taxonomists.	7
Unit II	Botanical Nomenclature- Principles and rules of ICBN, Type method, Modern trends in Plant Taxonomy, Numerical Taxonomy, Chemotaxonomy and its applications, Brief idea on Phenetics, Biometrics, Cladistics.	6
Unit III	Systems of classification- Artificial, Natural and Phylogenetic. APG system.	6
Unit IV	Taxonomic study of the following families and economic importance, *Ranaculaceae, Malvaceae, Brassicaceae, Apocynaceae, Solanaceae, Curcurbitaceae, Apiaceae Asteraceae, Rubiaceae, Lamiaceae, Ephorbiaceae, Liliaceae, Musaceae, Orchidaceae, Arecaceae,* and *Poaceae.*	6
Unit V	Major plant groups as sources of food, fodder, fiber, and timber, Medicinal and aromatic plants: Ethnobotanical significance, Non-Timber Forest Products (NTFPs): Resins, Gums, Dyes, and Latex, Plant-based biofuels and their economic importance, Traditional knowledge and intellectual property rights (IPR).	5

Suggested Readings:

1. Porter, C.L. ( ): Taxonomy of flowering Plants, Eurasia Publishing House, New Delhi.
2. Lawrence, G.H.M. (1953): Taxonomy of Vascular Plants, Oxford & IBH Publishers, New Delhi, Calcutta.
3. Jefferey, C.(1968) : An Introduction to Plant Taxonomy J.A. Churchill, London.
4. Mathur, R.C.(1970) : Systematic Botany (Angiosperms) Agra Book Stores- Lucknow, Ajmer, Allahabad, Delhi.
5. Maheswari,P(1963) :Recent Advances in the Embryology of Angiosperms(Ed.,) International Society of Plant Morphologists- University of Delhi.
6. Swamy. B.G.L. & Krishnamoorthy. K.V.(1980):From flower to fruit Tata McGraw Hill Publishing Co., Ltd., New Delhi.
6. Maheswari, P.(1985):An Introduction to the Embryology of Angiosperms Tata McGraw Hill Publishing Co.,Ltd., New Delhi.
8. Bhojwani, S.S. & Bhatnagar, S.P. (2000) : The Embryology of Angiosperms (4th Edition) Vikas Publishing House(P)Ltd., UBS Publisher's Distributors, New Delhi.
9. Gurucharan Singh; Plant Systematics; An Integrated Appraoach, 2004; Taylor and Francis, CRC Press, Infield: Science Publishers

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks

Internal Class Test –	10 Marks
Attendance/Behavior –	05 Marks

[List of Practicals]

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IIIrd Year**	**Semester: III**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc.		
Course Code: BOT-23103	**Course Title: Lab work based on theory [List of Practicals]**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 student will learn about practical knowledge on various plant families. CO.2 Student will study about the distribution of plant, natures, habits CO.3 Student will know about the stored grain and their loss CO.4 Student will know about the economic importance of the various cash crops. CO.5 Student will lean by field visit to various industry and centre.		
Credit: 2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture+Tutorials+Practical): 0+0+2		
Practicals List or Details		**Practical (Hrs.)**
Suggested Laboratory Exercises: 1. Systematic study of locally available plants belonging to the families prescribed in theory syllabus. 2. Demonstration of herbarium techniques. 3. Structure of pollen grains using whole mounts (*Catharanthus, Hibiscus, Acacia*, grass). 4. Demonstration of Pollen viability test using *in- vitro* germination (*Catharanthus*), Pollinium *Calotropis*. 5. Study of ovule types and developmental stages of embryo sac using permanent slides /Photographs. 6. Structure of endosperm (nuclear and cellular); Developmental stages of dicot and monocot Embryos using permanent slides / Photographs 7. Isolation and mounting of embryo (using *Symopsis* / *Senna* / *Crotalaria*) 8. Field visits. 9. Study of local flora and submission of field note book		60
Suggested Readings: 1. Porter, C.L. ( ): Taxonomy of flowering Plants, Eurasia Publishing House, New Delhi. 2. Lawrence, G.H.M. (1953): Taxonomy of Vascular Plants, Oxford & IBH Publishers, New Delhi, Calcutta. 3. Jefferey, C.(1968) : An Introduction to Plant Taxonomy J.A. Churchill, London. 4. Mathur, R.C.(1970) : Systematic Botany (Angiosperms) Agra Book Stores- Lucknow, Ajmer, Allahabad, Delhi. 5. Maheswari,P(1963) :Recent Advances in the Embryology of Angiosperms(Ed.,) International Society of Plant Morphologists- University of Delhi. 6. Swamy. B.G.L. & Krishnamoorthy. K.V.(1980):From flower to fruit Tata McGraw Hill Publishing Co., Ltd., New Delhi. 6. Maheswari, P.(1985):An Introduction to the Embryology of Angiosperms Tata McGraw Hill Publishing Co.,Ltd., New Delhi. 8. Bhojwani, S.S. & Bhatnagar, S.P. (2000) : The Embryology of Angiosperms (4th Edition) Vikas Publishing House(P)Ltd., UBS Publisher's Distributors, New Delhi. 9. Gurucharan Singh; Plant Systematics; An Integrated Appraoach, 2004; Taylor and Francis, CRC Press, Infield: Science Publishers.		
Course prerequisite: To study this course, the students must have had subject biology in class 12th		
Suggested continuous Evaluation methods-		

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

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Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: Second Year**	**Semester: III**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOTIKS-2302	**Course Title: Applied IKS-1: Botany**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 To understand the history of Vedic fermentation technology CO. 2 To correlate the Modern trends in context to the ancient text CO. 3 To develop the concept of the yoga and plant behaviour CO. 4 To insight the traditional role of conservation of biodiversity ethics CO. 5 To design the alchemist therapy system		
Credit: 2	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 14+21**	
Total Number of Lectures (Lecture +Tutorials +Practical): 30+0+0		
Unit:	**Topics**	**Lectures (Hrs.)**
Unit 1: Introduction to Indian Knowledge Systems • Overview of Indian philosophies and knowledge systems • Importance of integrating traditional wisdom into modern science • Relevance of Indian knowledge in botany and plant sciences		06
Unit 2: Ayurveda and Plant-Based Healing • Principles of Ayurveda and its approach to plant-based medicine • Study of medicinal plants in Ayurvedic texts and their modern applications • Ayurvedic concepts of plant energies, tastes, and qualities		06
Unit 3: Yoga and Plant Connection • Exploration of Yoga's connection with nature and plants • Yoga practices to enhance plant awareness and mindfulness • Ecological implications of Yogic principles on plant life		06
Unit 4: Ethical and Sustainable Plant Use • Ancient Indian perspectives on sustainable plant use • Ethics of plant harvesting, conservation, and biodiversity • Integrating traditional practices into modern sustainable resource management		06
Unit 5: Indigenous Botanical Knowledge • Ethnobotanical studies of indigenous communities in India • Learning from indigenous practices of plant use and conservation • Case studies on the preservation of indigenous botanical knowledge		06
Suggested Readings: • "Traditional Herbal Medicine in India" by P. Pushpangadan and L. Geethakumari • "Indian Medicinal Plants: An Illustrated Dictionary" by C.P. Khare • "Ethnobotany and Medicinal Plants of India and Nepal" by K. L. Mehra and A. K. Joshi • "Indian Systems of Medicine: A Brief Profile" by M. S. Valiathan		

• "Ayurvedic Pharmacopoeia of India"
Course prerequisite: To study this course, the students must have had subject biology in class 12th
Suggested continuous Evaluation methods-
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

MINOR PAPER for Students of Other Discipline/Subject

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IInd Year**	**Semester: III**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: MBOT03	**Course Title: Plants and Human Welfare-I**	
Course Outcome: After completing this course, the students will be able to -		
• CO.1 Identification of exotic plant species, • CO.2 To understand the importance of the Plant biodiversity • CO.3 identification of forest trees based on the characteristics of bark, flowers and fruits, • CO.4 understanding the methods of safe disposal of biodegradable and non-biodegradable wastes. • CO. 5. understanding the preservation methods of fresh and dry fruits		
Credit: 3	**Paper: Elective (Miner)**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+0		

Unit	Topics	No. of Lecture
Unit I	**Biodiversity:** Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agro biodiversity and cultivated plant taxa, wild taxa. Values and uses of biodiversity: Ethical and aesthetic values, Methodologies for valuation, Uses of plants.	9
Unit II	**Biodiversity Loss:** Loss of genetic diversity, loss of species diversity, loss of ecosystem diversity, Loss of agro biodiversity, projected scenario for biodiversity loss. Management of plant biodiversity:	9
Unit III	**Organizations associated with biodiversity management:** Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.	9
Unit IV	**Environmental Impact Assessment (EIA):** Geographical Information System GIS, Participatory resource appraisal, Ecological footprint with emphasis on carbon footprint, Resource accounting; Solid and liquid waste management	9
Unit V	**Forestry and their utilization:** Agro-forestry, social forestry, urban forestry, Rural forestry and commercial aspects. (a) Avenue trees, (b) ornamental plants of India. (c) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood, fiber and their uses.	9

Suggested Readings:

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles andB Practices. Oxford and IBH Publications Co. Pvt. Ltd. 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 SustainableB Development. Prentice Hall of India Private Limited, New Delhi.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Other Courses:

AEC : Ablity Enhancement Course
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course : To be Choosed from POOL D

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SEMESTER-IV

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. II nd Year**	**Semester: IV**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23104	**Course Title:** Anatomy of Angiosperms and Developmental Botany	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the scope & importance of Anatomy CO.2 Know various tissue systems CO.3 Understand the normal and anomalous secondary growth in plants and their causes. CO.4. Understand structure and development in microsporangium and megasporangium CO.5 Know pollination, fertilization, endosperm and embryogeny		
Credit: 3+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials +Practical): 45+0+60		

Unit:	**Topics**	**No. of Lecture**
Unit I.	Introduction to Plant Anatomy and Cell Structure, Overview of cell wall. Histological Techniques: Preparation of permanent and temporary slides, staining techniques. Tissues and Tissue Systems, Meristematic Tissues: Types, characteristics, and functions; Permanent Tissues: Simple tissues: Parenchyma, collenchyma, sclerenchyma; Complex tissues: Xylem and phloem	9
Unit II	Primary and Secondary Growth; Development of root, stem, and leaf from apical meristems; Cambium and Secondary Growth: Structure, types, and functions of vascular cambium, Secondary growth in dicot stems and roots, Anomalous Secondary Growth in monocot- Dracena; dicots- Bignonia, Bougainvillea; Formation of annual rings and dendrochronology, Periderm Formation: Cork cambium, phellem, phelloderm, and lenticels.	9
Unit III	Anatomical Adaptations and Secretory Structures; Anatomical Adaptations: Xerophytes (Nerium), Hydrophytes (Nymphaea) Halophytes (Atriplex), Epiphytes (Vanda); Secretory Structures: External, Glandular hairs, nectaries; Internal: Laticifers, resin ducts, oil glands; Application of Plant Anatomy.	9
Unit IV	Introduction, Scope and contributions of Indian embryologists: P. Maheshwari, B G L Swamy Microsporangium: Development and structure of mature anther; Anther wall layers; Tapetum -types, structure and functions; sporogenous tissue. Microsporogenesis - Microspore mother cells, microspore tetrads and its types; Pollinia.	9

	Microgametogenesis – Formation of vegetative and generative cells, structure of male gametophyte. Pollen embryo sac (Nemec phenomenon).	
Unit V	Megasporangium – Structure of typical Angiosperm ovule.Types of ovules- Anatropous, Orthotropous, Amphitropous, Campylotropous, Circinotropous. Megagametogenesis –Female gametophyte embryosac- monosporic - Polygonum type, bisporic – Allium type, tetrasporic - Fritillaria type. Structure of mature embryosac. Pollination and fertilization: Structural and functional aspects of pollen, stigma and style. Postpollination events; Current aspects of fertilization; Significance of double fertilization, Post fertilizationchanges. Endosperm – Types and its biological importance. Free nuclear (Cocos nucifera), cellular (Cucumis),helobial types. Ruminate endosperm. Embryogenesis: Structure Dicot and Monocot seed, Dicot (Capsella bursa-pastoris) and Monocot (Najas) embryo development.	9

Suggested Readings:

1. Bhojwani and Bhatnagar, Introduction to Embryology of Angiosperms –Oxford & IBH, Delhi
2. Bhojwani Sant Saran, 2014.Current Trends in the Embryology of Angiosperms, Woong-Young Soh, Springer Netherlands,
3. Coutler E. G., 1969. Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
4. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA
5. Eames A. J. - Morphology of Angiosperms - Mc Graw Hill, New York.
6. Esau, K. 1990. Plant Anatomy, Wiley Eastern Pvt Ltd New Delhi
7. Evert, R.F. (2006) Esau's Plant Anatomy: Meristem, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc
8. Fahn, A.1992. Plant Anatomy, Pergamon Press, USA
9. Johri, B.M. l., 1984.Embryology of Angiosperms, Springer-Verlag, Netherlands.
10. Karp G., 1985. Cell Biology; Mc.Graw Hill Company
11. Maheshwari,P 1950. An introduction to the embryology of angiosperms. New York: McGraw-Hill
12. Mauseth, J.D. (1988). Plant Anatomy, the Benjammin/Cummings Publisher, USA.
13. Nair P. K. K - Pollen Morphology of Angiosperms - Scholar Publishing House, Lucknow
14. Pandey S.N. 1997, Plant Anatomy and Embryology.A. Chadha, Vikas Publication House Pvt Ltd.
15. Pandey, B. P., 1997. Plant Anatomy, S.Chand and Co. New Delhi
16. Raghavan, V., 2000. Developmental Biology of Flowering plants, Springer, Netherlands.
17. Saxena M. R. – Palynology – A treatise - Oxford & I. B .H., New Delhi
18. Yash Mangla, Priyanka Khanduri and Charu Gupta (2022) Reproduction Biology of Angiosperm, Chamberlain University Publication

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under

;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Practicals List]

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: Second Year**	**Semester: IV**
Pedagogy:		
Course Code: BOT-23104	**Course Title: Lab work based on theory [Practicals List]**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Student will practically understand about plant morphology, and anatomical section CO. 2 Student will understand the sectioning by practical CO. 3 To know Embryological development by practical method. CO. 4 To know dissection techniques. CO. Diagrammatic study of Morphology, Embryology and Anatomy		
Credit: 0+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	

Total Number of Lectures (Lecture +Tutorials +Practical): 0+0+60	
Practical's List	**Practical (Hrs.)**
Practical No.1: i) Study of meristem (Permanent slides/ Photographs). ii) Study of Simple Tissues: Parenchyma, Collenchyma and Sclerenchyma Practical No.2: Complex Tissues - xylem and phloem; Maceration technique to study elements of xylem and phloem Practical No.3: Study of primary structure of dicot and monocot stem Practical No.4: Study of primary structure of dicot and monocot root and leaf Practical No. 5: Study of Normal secondary growth structure in dicot stem and root (Sunflower) and Anomalous secondary growth: *Aristolochia, Boerhaavia* (dicot stem) Dracaena (monocot stem) Practical No. 6: Study of trichomes (any three types) and stomata (any three types) with the help of locally available plant materials Practical No. 7: Permanent slides of Microsporogenesis and male gametophyte Mounting of Pollen grains of Grass and *Hibiscus* and Pollinia of *Calotropis* Practical No. 8: Pollen germination (hanging drop method) and Effect of Boron and Calcium on pollen germination Practical No. 9: Permanent slides of types of ovules, Megasporogenesis and embryosac development. Practical No. 10: Types of placentation: Axile, Marginal and Parietal types. Sectioning of ovary, for the studied types of placentation Practical No. 11: Mounting of embryo: Any locally available seeds. Tridax and Cyamopsis, Mounting of endosperm: Cucumis Practical No. 12: Histochemical localization of proteins/ carbohydrates Practical No. 13 and 14: Mini project work in groups of 3-5 students, from the following list. This is to be recorded in the practical record book. a) Study of pollen morphology of different flowers with respect to shape, colour, aperture etc. b) Pollen germination of different pollen grains and calculating percentage of germination. c) Calculating percentage of germination of one particular type of pollen grain collected from different localities/ under different conditions. d) Study of placentation of different flowers. e) Any other relevant study related to Anatomy / Embryology.	60

Suggested Readings:

1. Bhojwani and Bhatnagar, Introduction to Embryology of Angiosperms –Oxford & IBH, Delhi
2. Bhojwani Sant Saran, 2014.Current Trends in the Embryology of Angiosperms, Woong-Young Soh, Springer Netherlands,
3. Coutler E. G. , 1969. Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
4. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA
5. Eames A. J. - Morphology of Angiosperms - Mc Graw Hill, New York.
6. Esau, K. 1990. Plant Anatomy, Wiley Eastern Pvt Ltd New Delhi
7. Evert, R.F. (2006) Esau's Plant Anatomy: Meristem, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc
8. Fahn, A.1992. Plant Anatomy, Pergamon Press, USA
9. Johri, B.M. l., 1984.Embryology of Angiosperms, Springer-Verlag, Netherlands.
10. Karp G., 1985. Cell Biology; Mc.Graw Hill Company
11. Maheshwari,P 1950. An introduction to the embryology of angiosperms. New York: McGraw-Hill
12. Mauseth, J.D. (1988). Plant Anatomy, the Benjammin/Cummings Publisher, USA.
13. Nair P .K .K - Pollen Morphology of Angiosperms - Scholar Publishing House, Lucknow
14. Pandey S.N. 1997, Plant Anatomy and Embryology .A. Chadha, Vikas Publication House Pvt Ltd.
15. Pandey, B. P., 1997. Plant Anatomy, S.Chand and Co. New Delhi
16. Raghavan, V., 2000. Developmental Biology of Flowering plants, Springer, Netherlands.
17. Saxena M. R. – Palynology – A treatise - Oxford & I. B .H., New Delhi

Yash Mangla, Priyanka Khanduri and Charu Gupta (2022) Reproduction Biology of Angiosperm, Chamberlain University Publication

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under

;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

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Minor Paper for Students of other Discipline/Subject

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. II nd Year**	**Semester: IV**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: MBOT04	**Course Title: Plants and Human Welfare-II**	
Course Outcome: After completing this course, the students will be able to - • CO.1 Develop conceptual understanding of gardening from historical perspective • CO.2 Analyze various nursery management practices with routine garden operations. • CO.3 Distinguish among the various Ornamental Plants and their cultivation • CO.4 Evaluate Garden designs of different countries • CO.5 Appraise the landscaping of public and commercial places for floriculture		
Credit: 3	**Paper (Code compulsory/Elective): Core**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+0		

Unit	Topics	No. of Lecture
Unit I	**Introduction**: Importance and scope of floriculture and landscape gardening. Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.	9
Unit II	**Ornamental Plants:** Flowering annuals; perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and fern allies; Cultivation of plants in pots; Indoor gardening; Bonsai.	9
Unit III	**Principles of Garden Designs:** English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden, Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flowerbeds, Shrubbery, Borders, Water-garden. Some Famous gardens of India.	9
Unit IV	**Floriculture and green house technology:** Commercial aspects and exporting of flowers and ornamental plants. Quranatine and testing requirements.	9
Unit V	**Landscaping places of public importance:** Landscaping highways And Educational institutions. Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (*Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Lilium, Orchids*). Diseases and Pests of Ornamental Plants.	9

Suggested Readings:

1. Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.
2. Adams, C., M. Early and J. Brrok (2011). Principles of Horticulture. Routledge, U.K.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Other Courses:

AEC : Ablity Enhancement Course
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course : To be Choosed from POOL D

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Exit Option: **Undergraduate Diploma** (in the field of learning/discipline) for those who exit after two years (four semesters) of the undergraduate programme (Programme duration: First two years or four semesters of the undergraduate programme +Mandatory Internship of 04 Credits)
[NHEQF Level 5.0]

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SEMESTER-V

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IIIrd Year**	**Semester: V**
Pedagogy:		
Course Code: BOT-23105	**Course Title:** Plant Physiology and Biochemistry	
Course Outcome: After completing this course, the students will be able to -		
CO.1 To understand the plants and plant cells in relation to water CO.2 Understand the process of photosynthesis in higher plants with particular emphasis on light and dark reactions, C3 and C4 pathways CO.3 Understand the respiration in higher plants with particular emphasis on aerobic and anaerobic respiration CO.4 Learn about the movement of sap and absorption of water in plant body CO.5 Recognize the impact of Biochemistry on socio-economic aspects of life		
Credit: 2+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 30+0+60		

Unit	Topics	No. of Lecture
Unit I	Physical properties of water, Importance of water to plant life. Diffusion, imbibition and osmosis; Water potential; concept and components. Absorption and transport of water and ascent of sap. Transpiration –Definition, types of transpiration, structure and opening and closing mechanism of stomata.	6
Unit II	Photosynthesis: Photosynthetic pigments, photosynthetic light Harvesting Complex, photo- phosphorylation, carbon assimilation pathways: C3, C4, and CAM, Regulation of Calvin Cycle, RUBISCO, Photorespiration and its significance. EMP Pathway, TCA Cycle, ETS, PPP, Glyoxylate cycle, Translocation of organic solutes: mechanism of phloem transport, source-sink relationships.	6
Unit III	Mineral Nutrition: Essential elements (macro and micronutrients) and their role in plant metabolism, deficiency symptoms. Mineral ion uptake (active and passive transport). Nitrogen metabolism- Biological nitrogen fixation in *Rhizobium,* Biochemistry and Genetics of Nitrogen fixation, Nitrate Assimilation, Ammonia Assimilation, Nitrogen control of nitrogen assimilation.	6
Unit IV	Growth and development: definition, phases and kinetics of growth. Physiological effects of phytohormones - auxins, gibberellins, cytokinins, ABA, ethylene and brassinosteroids. Physiology of flowering -photoperiodism, role of phytochrome in flowering; vernalization. Physiology of scenescence,	6

Unit V	Structure and Function of Biomolecules: Carbohydrates, Lipids, Proteins, Nucleic Acids, Fundamentals of Enzymology: Allosteric Enzymes, Mechanism of enzyme action, Enzyme Inhibitors, Isoenzymes	6

Suggested Readings:

1. Steward. F.C (1964): Plants at Work (A summary of Plant Physiology) Addison-Wesley Publishing Co., Inc. Reading, Massachusetts, Palo alto, London.
2. Devlin, R.M. (1969): Plant Physiology, Holt, Rinehart & Winston & Affiliated East West Press (P) Ltd., New Delhi.
3. Noggle, R.& Fritz (1989): Introductory Plant Physiology Prentice Hall of India.
4. Lawlor.D.W. (1989): Photosynthesis, metabolism, Control & Physiology ELBS/Longmans-London.
5. Mayer, Anderson & Bonning (1965): Introduction to Plant Physiology D.Van Nostrand. Publishing Co., N.Y.
6. Mukherjee, S. A.K. Ghosh (1998) Plant Physiology, Tata McGraw Hill Publishers(P) Ltd., New Delhi.
7. Salisbury, F.B & C.W. Ross (1999): Plant Physiology CBS Publishers and Printers, New Delhi.
7. Plummer, D. (1989) Biochemistry–the Chemistry of life, McGraw Hill Book Co., London, N.Y. New Delhi, Paris, Singapore, Tokyo.
9. Day, P.M.& Harborne, J.B. (Eds.,) (2000): Plant Biochemistry Harcourt Asia (P) Ltd., India & Academic Press, Singapore.

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Practicals List]

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IIIrd Year**	**Semester: V**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23105	**Course Title: Lab work based on theory [Practicals List]**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Preparation of cytological fixative and stains CO.2 To study the activity of enzyme lipase in germinating seeds CO.3 To study on morphology, taxonomy of thallus organization, reproduction, life cycle, phylogeny and interrelationships CO. 4 Extraction and separation of free amino acid of germinating seed by circular paper chromatography CO.5 Extraction and Detection of secondary plant metabolites from suitable plant material		
Credit: 2	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture+Tutorials+Practical): 0+0+2		
Practicals List		**Practical (Hrs.)**
Suggested laboratory exercises: 1. Osmosis – by potato osmoscope experiment 2. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of *Rhoeo / Tradescantia.* 3. Structure of stomata (dicot & monocot) 4. Determination of rate of transpiration using cobalt chloride method. 5. Demonstration of transpiration by Ganongs' photometer 6. Demonstration of ascent of sap/Transpiration pull. 6. Effect of Temperature on membrane permeability by colorimetric method. 7. Study of mineral deficiency symptoms using plant material/photographs. 8. Separation of chloroplast pigments using paper chromatography technique. 9. Rate of photosynthesis under varying Co2 concentrations.		60

10. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott' bubbler.	

Suggested Readings:

1. Bentley P.J.: Comparative Vertebrate Endocrinology S. Chand & Company Ltd, Ram Nagar New Delhi,
2. Chester-Jones: Fundamentals of Comparative Vertebrate Endocrinology Plenum Press, New York &
3. Gardner, David G. & Dolores M. Shobac: Greenspan's Basic and Clinical Endocrinology, 10th edition (A&L
4. Goldsworthy G J et al: Endocrinology, Blackie, 1981
5. Goodenough et al.: Perspectives on Animal Behaviour. Wiley & Sons, New York. 1993.
6. Grier, JW: Biology of Animal Behaviour, Mosby, 1984
7. Halliday, T.R.: Animal Behaviour Vol. 1 & 2 Communication, 1983
8. Krebs, NB & JR Davies: An Introduction to Behavioural Ecology (3rd ed.), Blackwell, 1993

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Programme: B. Sc. (Honours/Honours with Research) in Botany	**Year: Third Year**	**Semester: V**
Pedagogy:		
Course Code: BOTIKS-2303	**Course Title: Applied IKS-2: Botany**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 To understand the concept of plant-people relationship in ancient literature CO. 2 To insight the meta philosophy of vedic literature in plant science CO. 3 To know about the role of plants leaf and flower in worship CO. 4 To develop the modern concept and correlate the ancient facts of ayurveda CO. 5 To periods of the civilization of crop cultivation		
Credit: 2	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials +Practical): 30+0+0		
Unit:	**Topics**	**Lectures (Hrs.)**
Unit-1: Plant Ecology and Vedic Sciences • Vedic insights into plant ecology, life cycles, and interdependence • Ecological wisdom from ancient texts and its alignment with modern ecology • Harmonizing traditional and scientific approaches to studying ecosystems		06
Unit-2: Ayurvedic Plant Identification • Practical techniques for identifying plants based on Ayurvedic characteristics • Field trips for plant identification and collection • Creating a bridge between Ayurvedic and botanical plant classification		06
Unit-3: Integration of Indian Knowledge in Modern Botany • Collaborative research between traditional healers and modern scientists • Case studies of successful integration of Indian knowledge in botanical research, Flower Diversity in Ancient Literature used in Worship of God/Goddess and its relevance. • Challenges and benefits of combining ancient wisdom with modern methods		06

Unit-4: Presentations and Projects • Student presentations on selected topics related to integrating Indian knowledge in botany • Group projects on developing innovative applications combining traditional and modern approaches	06
Unit-5: Practical Workshops and Field Trips • Workshops on herbal medicine preparation, Ayurvedic remedies, and Yoga practices • Field trips to botanical gardens, Ayurvedic centers, and indigenous communities	06

Suggested Readings:

- "Traditional Herbal Medicine in India" by P. Pushpangadan and L. Geethakumari
- "Indian Medicinal Plants: An Illustrated Dictionary" by C.P. Khare
- "Ethnobotany and Medicinal Plants of India and Nepal" by K. L. Mehra and A. K. Joshi
- "Indian Systems of Medicine: A Brief Profile" by M. S. Valiathan
- "Ayurvedic Pharmacopoeia of India"

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Minor Course : For Students of Other Discipline/Subjects

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IIIrd Year**	**Semester: V**
Pedagogy:		
Course Code: MBOT05	**Course Title: Palynology- I (Minor)**	

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

CO.1 Explain the definition, scope, historical background, and interdisciplinary significance of Palynology.
CO.2 Describe the morphology, ultrastructure, and chemical composition of pollen grains and spores.
CO.3 Understand pollen development, viability, storage, and the mechanism of pollen germination and tube growth.
CO.4 Analyse pollen dispersal mechanisms, pollination efficiency, and the role of pollination in biodiversity conservation.
CO.5 Demonstrate various palynological techniques, including pollen collection, analysis, and slide preparation.

Credit: 3	**Paper: Core Compulsory**
Max. Marks: 40+60	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+0

Unit		No. of Lecture
Unit I	**Introduction to Palynology** • Definition, scope, and historical background of Palynology • Relationship with other branches of science • Importance of Palynology in botany and applied sciences	9
Unit II	**Structure and Composition of Pollen and Spores** • Morphology and ultrastructure of pollen grains and spores • Sporoderm stratification: Exine and intine • Chemical composition of sporoderm (sporopollenin and cellulose)	9
Unit III	**Pollen Development and Germination** • Microsporogenesis and pollen development • Pollen viability and storage • Mechanism of pollen germination and pollen tube growth	9

Unit IV	**Pollen Dispersal and Pollination Biology** • Pollen dispersal mechanisms: Anemophily, hydrophily, entomophily, ornithophily, chiropterophily • Pollination efficiency and pollen-pistil interaction • Role of pollination in plant reproduction and biodiversity conservation	9
Unit V	**Palynological Techniques** • Methods of pollen collection and storage • Pollen analysis techniques: Acetolysis method, LM, SEM, and TEM • Preparation of permanent and temporary slides of pollen grains	9

Suggested Readings:

1) Introduction to Palynology – G. Erdtman
2) Textbook of Pollen Analysis – K. Faegri & J. Iversen
3) An Introduction to Fossil Pollen Analysis – V. R. Bryant Jr. & R. G. Holloway
4) Pollen and Spores: Applications with Special Emphasis on Aerobiology and Allergy – S. Agashe
5) Forensic Palynology – Vaughn M. Bryant & Dallas Mildenhall
6) Aerobiology: The Ecological Systems Approach – F. Isard & M. Gage
7) Paleopalynology– Alfred Traverse
8) Palynology: Principles and Applications – J. Jansonius & D. C. McGregor
9) Pollen and Spores: Morphology and Biology– S. Blackmore & S. H. Barnes
10) Textbook of Palynology- K. Bhattacharya,Manas.R. Majumdar, Swati G. Bhattacharya

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Major (Elective): Choose Any One Course

Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: Third Year**	**Semester: V**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23106A	**Course Title: Medicinal Plants in Health Care**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Recognize the basic medicinal plants CO.2 Apply techniques of conservation and propagation of medicinal plants. CO.3 Setup process of harvesting, drying and storage of medicinal herbs CO.4 Propose new strategies to enhance growth of medicinal herbs considering the practical issues pertinent to India CO.5 Know the value of medicinal plants of tribal people		
Credit: 3	**Paper: Elective (Major)**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		

Unit	Topics	No. of Lecture
Unit I	History, Scope and Importance of Medicinal Plants; Traditional systems of medicine; Definition and Scope. **Ayurveda:** History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, **Siddha:** Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. **Unani:** History, concept: Umoor-e-tabiya, tumors treatments / therapy, polyherbal formulations.	3
Unit II	Conservation of endemic and endangered medicinal plants, Red list criteria; ***In situ*** conservation: Biosphere reserves, sacred groves, National Parks; ***Ex situ*** conservation: Botanic Gardens, Seed bank pollenbank cryopreservation.	3

Unit III	***Propagation of Medicinal Plants:*** Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of greenhouse for nursery production, propagation through cuttings, layering, grafting and budding. Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India.	3
Unit IV	Brief description of selected plants and derived drugs, namely Guggul (*Commiphora*) for hypercholesterolemia, *Boswellia* for inflammatory disorders, Arjuna (*Terminalia arjuna*) for cardio protection, turmeric (*Curcuma longa*) for wound healing, *Taxol, Ephedrine*	3
Unit V	antioxidant and anticancer properties, Kutaki (*Picrorhiza kurroa*) for hepatoprotection, Opium Poppy for analgesic and antitussive, *Cinchona* and *Artemisia* for Malaria, *Rauwolfia* as tranquilizer, *Podophyllum* as antitumor. *Vinea rosea* as anticancerous, *Morinda citrifolia, Acorus calamus, ocinunsanchem. Tinospora cordifolia*, *Coleus amboinicu, Piper nigrum*	3

Suggested Readings:

1. Akerele, O., Heywood, V. and Synge, H. (1991). The Conservation of Medicinal Plants. Cambridge University Press.
2. AYUSH (www.indianmedicine.nic.in). About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy. New Delhi: Department of Ayurveda, Yogaand Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.
3. CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow (2016). *Aush Gyanya*: Handbook of Medicinal and Aromatic Plant Cultivation.
4. Dev, S. (1997). Ethno-therapeutics and modern drug development: The potential of Ayurveda. *Current Science* 73:909–928.
5. Evans, W.C. (2009). Trease and Evans Pharmacognosy, 16thedn. Philadelphia, PA: Elsevier Saunders Ltd.
6. Jain, S.K. and Jain, Vartika. (eds.) (2017). Methods and Approaches in Ethnobotany: Concepts, Practices and Prospects. Deep Publications, Delhi
7. Kapoor, L.D. (2001). Handbook of Ayurvedic medicinal plants. Boca Raton, FL: CRC Press.
8. Saroya, A.S. (2017). Ethnobotany. ICAR publication.
9. Sharma, R.(2003). Medicinal Plants of India-An Encyclopaedia. Delhi: Daya Publishing House.
10. Sharma, R. (2013) Agro Techniques of Medicinal Plants. Daya Publishing House, Delhi.
11. Thakur, R.S., H.S. Puri, and Husain, A.(1989). Major medicinal plants of India. Central Institute of Medicinal and Aromatic Plants, Lucknow, India.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under

;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: Third Year**	**Semester: V**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23106B	**Course Title: Plant Propagation and Tissue Culture**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Gain knowledge of the basic techniques involved in plant tissue culture CO2. Understand the concept of cellular totipotency and differentiation as well as the role of plant growth regulators in plant tissue culture. CO3. Gain proficiency in techniques of plant regeneration. CO4. Have an insight of the applications of plant tissue culture in crop improvement CO5. Understand the various methods of plants propagations		
Credit: 3	**Paper: Elective (Major)**	

Max. Marks: 40+60 (30T+30P)	Min Passing Marks: 35	
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		
Unit	**Topics**	**No. of Lecture**
Unit I	Concept and history of plant tissue culture; pioneering work and significant achievements of Indian scientists. Plant tissue culture laboratory design; basic requirements and sterilization practices.	3
Unit II	Washing, packing and sterilization of glassware's; composition, types, preparation and sterilization of culture media; selection, isolation, surface sterilization and inoculation of explants; establishment of invitro cultures, ideal conditions for incubation of cultures, maintenance of cultures and subculture; regeneration of plantlets; acclimatization of tissue cultured plantlets in greenhouse/polyhouse	3
Unit III	Concept of cellular totipotency and differentiation (dedifferentiation and redifferentiation); role of plant growth regulators in tissue culture; role of meristems in tissue culture; characteristics of callus tissue; soma clonal variation; organogenesis and somatic embryogenesis. Preparation of synthetic seeds.	3
Unit IV	Principle, protocol and applications of the following types of culture: callus culture, meristem culture, embryo culture, root culture, anther and pollen culture; micro-propagation. Cell suspension culture - methods for isolation of single cells, testing viability of cells, protocol for cell suspension culture, types of suspension cultures (batch and continuous), growth pattern of cells in batch culture, methods for measurement of growth of cells in suspension and applications of cell suspension cultures.	3
Unit V	Introduction to somatic hybridization; role of enzymes in protoplast isolation, mechanical and enzymatic isolation of plant protoplasts, testing viability of isolated protoplasts, spontaneous and induced fusion of protoplasts, selection of hybrid protoplasts, culture of hybrid protoplasts and applications of somatic hybridization. Cybrids and their applications.	3

Suggested Readings:

1. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford.
2. Misra, S.P. 2009. Plant Tissue Culture. Ane Books Pvt. Ltd., New Delhi.
3. Singh, S.K. and Srivastava, S. 2006. Plant Tissue Culture. Campus Books International, New Delhi.
4. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, NY.
5. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.
6. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice. Elsevier Science, Amsterdam.
7. Razdan, M.K. 2003. An Introduction to Plant Tissue Culture. Oxford & IBH Publishing Co., New Delhi.
8. Chawla, H.S. 2000. Introduction to Plant Biotechnology. Oxford and IBH Publishers, New Delhi.
9. De, K.K. 1992. Plant Tissue Culture. New Central Book Agency (P) Ltd., Calcutta.
10. Jha, T.B. and Ghosh, B. 2005. Plant Tissue Culture. Universities Press Pvt. Ltd., Hyderabad.
11. Ramawat, K.G. 2004. Plant Biotechnology. S. Chand & Company Ltd., New Delhi.
12. Prakash, M. and Arora, C.K. 2005. Cell and Tissue Culture. Anmol Publications Pvt. Ltd., New Delhi.
13. Chawla, H.S. 2002. Introduction to Plant Biotechnology. Science Publishers Inc., USA.
14. Narayanswamy, S. 1994. Plant Cell and Tissue Culture. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
15. Joshi, R. 2006. Agricultural Biotechnology. Gyan Books, New Delhi.
16. Kumar, H.D. 2005. Agricultural Biotechnology. Daya Publishing House, New Delhi.
17. Gautam, H. 2006. Agricultural and Industrial Applications of Bio-technology. Rajat Publications, New Delhi.
18. Harikumar, V.S. 2006. Advances in Agricultural Biotechnology. Regency Publishers, New Delhi.
19. Raghavan, V. 1986. Embryogenesis in Angiosperms: A Developmental and Experimental Study. Cambridge University Press, New York.
20. Chawla, H.S. 2003. Plant Biotechnology: A Practical Approach. Oxford & IBH Publishers, New Delhi.
21. Kumar, U. 2011. Methods in Plant Tissue Culture. Agro-Bios.
22. Nair, L.N. 2010. Methods in Microbial and Plant Biotechnology. New Central Book Agency (P.) Ltd., Kolkata

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Other Courses:

AEC : Ablity Enhancement Course
Value Added Course : To be Choosed from POOL D

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SEMESTER-VI

Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IInd Year**	**Semester: VI**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23107	**Course Title:** Ecology and Conservation Biology	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand plant communities and ecological adaptations in plants CO.2 Learn about conservation of biodiversity, Non-conventional Energy and Pollution CO.3 Discover botanical regions of India and vegetation types CO. 4 Concept forming regards various types of forests in India CO.5 To study role played by green & playhouses in horticulture		
Credit: 03+00+02	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+60		

Unit	Topics	No. of Lecture
Unit I	Concept and scope of ecology, Ecosystem structure and functions, Energy flow and productivity in ecosystems, Biogeochemical cycles (Carbon, Nitrogen, Phosphorus), Ecological succession: types and mechanisms	10
Unit II	Population characteristics and dynamics**,** Growth models: exponential and logistic growth**,** Species interactions: competition, predation, mutualism, commensalism**,** Ecological niche and habitat**,** Community structure and ecological gradients	10
Unit III	Major ecosystems: terrestrial (forests, grasslands, deserts) and aquatic (freshwater, marine)**,** Ecotones and edge effects**,** Biodiversity: levels, importance, and hotspots in India**,** Keystone, indicator, and umbrella species**,** Threats to biodiversity and invasive species	10
Unit IV	Principles and approaches of conservation biology**,** In situ and ex situ conservation strategies**,** IUCN Red List categories and threatened species**,** Sustainable development**,** Wildlife Protection Act (1972), Forest Conservation Act (1980), and Biodiversity Act (2002)**,** Conservation reserves, biosphere reserves, and Ramsar sites in India	10
Unit V	Causes and impacts of climate change**,** Ozone depletion, acid rain, and global warming**,** Sustainable development and ecosystem-based conservation**,** Ecological restoration and rewilding**,** Role of traditional knowledge in conservation	5

Suggested Readings:

1. Sharma, P.D. 2018. Fundamentals of Ecology. Rastogi Publications.
2. Odum E.P. (1975): Ecology By Holt, Rinert& Winston.
3. Oosting, H.G. (1978): Plants and Ecosystem Wadworth Belmont.
4. Kochhar, P.L. (1975): Plant Ecology. (9th Edn.,) New Delhi, Bombay, Calcutta-226pp.,
5. Kumar, H.D. (1992): Modern Concepts of Ecology (7th Edn.,) Vikas Publishing Co., New Delhi.
6. Kumar H.D. (2000): Biodiversity & Sustainable Conservation. Oxford & IBH Publishing Co Ltd. New Delhi.
7. Newman, E.I. (2000): Applied Ecology, Blackwell Scientific Publisher, U.K.
8. Chapman, J.L&M.J. Reiss (1992): Ecology (Principles & Applications). Cambridge University Press,

U.K.
9. Malcolm L. Hunter Jr., James P. Gibbs, Viorel D. Popescu, 2020. Fundamentals of Conservation Biology, 4th Edition. Wiley-Blackwel.
10. Saha T. K., 2017. Ecology and Environmental Biology. Books and Allied Publishers.

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Practicals List]

Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IInd Year**	**Semester: VI**
Pedagogy:		
Course Code: BOT-23104		**Course Title: Lab work based on theory [Practicals List]**
Course Outcome: After completing this course, the students will be able to -		
CO.1 To study on morphology, taxonomy of thallus organization, reproduction, life cycle, phylogeny and interrelationships CO. 2 To understand the synthetic ecology CO.3 To monitor the environment biology CO. 4 To perform the physic-chemical parameters CO.5 To Conceptualize the impact of anthropogenic on environment		
Credit: 0+0+2		**Paper: Core Compulsory**
Max. Marks: 40+60 (30T+30P)		**Min Passing Marks: 35**
Total Number of Lectures (Lecture +Tutorials + Practical): 0+0+60		
Practicals List		**Practical (Hrs.)**
Practical No. Experiments 1 Determination of pH of different types of soils, estimation of salinity of soil/water samples. 2 Study of Ecological instruments – Wet and Dry thermometer, altimeter, hygrometer, soil thermometer, rain gauge, barometer, etc 3 Determination of water holding capacity of soil samples 4 Determination of Biological oxygen demand (BOD) 5 Determination of Chemical oxygen demand (COD) 6 Determination of soil texture of different soil samples. 7 Hydrophytes: Morphological adaptations in *Pistia, Eichhornia, Hydrilla, Nymphaea*. Anatomical adaptations in *Hydrilla* (stem) and *Nymphaea* (petiole). 8 Xerophytes: Morphological adaptations in *Asparagus, Casuarina, Acacia, Aloe vera,* Euphorbia tirucalli. Anatomical adaptations in phylloclade of *Muhlenbackia*. 9Epiphytes: Morphological adaptations in *Acampe, Bulbophyllum, Drynaria*. Anatomical adaptations in epiphytic root of *Acampe/ Vanda*.Halophytes: study of vivipary in mangroves; Morphology and anatomy of Pneumatophores. 10 Study of a pond/forest ecosystem and recording the different biotic and abiotic components 11 Demonstration of different types of vegetation sampling methods – transects and quadrats. Determination of density and frequency. 12 Application of remote sensing to vegetation analysis using satellite imageries 13 and 14 Field visits to study different types of local vegetations/ecosystems and the report to be written in practical record book.		60

Suggested Readings:

1. Sharma, P.D. 2018. Fundamentals of Ecology. Rastogi Publications.
2. Odum E.P. (1975): Ecology By Holt, Rinert& Winston.
3. Oosting, H.G. (1978): Plants and Ecosystem Wadworth Belmont.
4. Kochhar, P.L. (1975): Plant Ecology. (9th Edn.,) New Delhi, Bombay, Calcutta-226pp.,
5. Kumar, H.D. (1992): Modern Concepts of Ecology (7th Edn.,) Vikas Publishing Co., New Delhi.
6. Kumar H.D. (2000): Biodiversity & Sustainable Conservation. Oxford & IBH Publishing Co Ltd. New Delhi.
7. Newman, E.I. (2000): Applied Ecology, Blackwell Scientific Publisher, U.K.
8. Chapman, J.L&M.J. Reiss (1992): Ecology (Principles & Applications). Cambridge University Press, U.K.
9. Malcolm L. Hunter Jr., James P. Gibbs, Viorel D. Popescu, 2020. Fundamentals of Conservation Biology, 4th Edition. Wiley-Blackwel.
10. Saha T. K., 2017. Ecology and Environmental Biology. Books and Allied Publishers.

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Major (Elective): Choose Any One Course

Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: Third Year**	**Semester: VI**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23108A	**Course Title: Bioinformatics and Computational Biology**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the basic tenets of research, laboratory safety measures, importance of maintaining records and writing of research ideas CO.2 Use bioinformatics tools (BLAST and PIR) for research CO3. Acquire skills in microphotography and field photography. CO.4 Apply basic statistical techniques to research data for a valid scientific conclusion. CO.5 To understanding of Computational biology		
Credit: 3	**Paper: Elective (Major)**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		

Unit	**Topics**	**No. of Lecture**
Unit I	Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System	3
Unit II	Biological Databases: Classification format of Biological Databases, Biological Database Retrieval System. National Center for Biotechnology Information (NCBI): Tools and Databases, Database Sequence Submission to NCBI, Conce0pt of Alignment, Basic Local Alignment Search Tool (BLAST), Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).	3
Unit III	Multiple Sequence Alignment (MSA) and Phylogenetic Tree construction by CLUSTALW and MEGA. Distance and character based Phylogenetic analysis i.e UPGMA, NJ, MP	3
Unit IV	Gene Expression Database. Protein Information Resource (PIR): Introduction of PIR, Resources, Swiss Prot: Introduction and salient features, UNIPROT, TrEMBL,	3

	Macromolecular structure: Protein Structure, DNA Strucrure, RNA Structure Visualization	
Unit V	Homology Modelling, Molecular Docking and molecular Dynamic simulation, Structural bioinformatics in drug discovery, Quantitative structure-activity relationship (QSAR) techniques in drug design, Microbial genomes, Bioinformatics role in crop improvement.	3

Suggested Readings:

1. Danniel, W.W. 1987. Biostatistics. John Wiley Sons, New York, NY.
2. Campbell, A.M. and Heyer, L.J. 2006. Discovering Genomics, Proteomics and Bioinformatics. 2nd edition. Cold Spring Harbor Laboratory Press and Benjamin Cummings.
3. Campbell, R.C. 1974. Statistics for Biologists. Cambridge University Press.
4. Dawson, C. 2002. Practical Research Methods. UBS Publishers, New Delhi.
5. Freedman, P. 1949. The Principles of Scientific Research. Macdonald and Company Limited, Washington DC. B.Sc. Botany Degree Program Goa University, Taleigao Plateau, Goa. Page 46
6. Ghosh, Z. and Bibekanand, M. 2008. Bioinformatics: Principles and Applications. Oxford University Press.
7. Gurumani, N. 2006. Research Methodology for Biological Sciences. MJP Publishers, Chennai, TN.
8. Pevsner, J. 2009. Bioinformatics and Functional Genomics. 2nd edition. Wiley Blackwell.
9. Ruzin, S.E. 1999. Plant Micro Technique and Microscopy. Oxford University Press, New York, NY.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: Third Year**	**Semester: VI**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23108B	**Course Title:** Landscaping, Gardening, and Greenhouse Technology	

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

CO.1 Understand biological data collection and analysis
CO.2 Know about data presentation in various method like charts, graphs,
CO.3 Know about determining the level of data significance and various methods for data testing
CO.4 Student will know about computer use in biostatistics
CO 5. Student will know about statistical software in biostatistics

Credit: 3+0+0	**Paper: Elective (Major)**
Max. Marks: 40+60	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+0

Unit	Topics	No. of Lecture
Unit I	**Introduction to Landscaping and Gardening** • Basics of landscaping: principles, elements, and design concepts • Importance of gardening and landscaping in urban environments • Historical overview of landscape design and gardening practices	8
Unit II	**Plant Selection and Maintenance** • Understanding plant characteristics: growth habits, color, texture, form • Soil requirements for different plant types	9

	• Planting techniques and transplanting guidelines • Pruning, trimming, and shaping plants for optimal growth and aesthetics • Integrated pest management and disease control in landscaping and gardening	
Unit III	**Landscape Design Principles** • Principles of landscape design: balance, unity, rhythm, focal points, scale • Site analysis and assessment for landscape planning • Design styles and themes in landscaping • Hardscape elements: pathways, patios, decks, water features • Incorporating sustainable practices in landscape design	9
Unit IV	**Garden Design and Maintenance** • Types of gardens: formal, informal, cottage, rock, water, etc. • Planting schemes and color palettes for different garden styles • Designing with seasonal interest and biodiversity in mind • Water-efficient gardening techniques: xeriscaping, rain gardens • Maintaining garden health and aesthetics throughout the year	8
Unit V	**Introduction to Greenhouse Technology** • Importance of greenhouse technology in modern agriculture • Components of a greenhouse: structure, ventilation, heating, cooling, shading • Different types of greenhouse structures and materials	11

Suggested Readings:

1. "The Well-Tempered Garden" by Christopher Lloyd
This classic book provides insights into garden design principles, plant selection, and maintenance, making it a great resource for both aspiring landscapers and gardeners.
2. "Planting: A New Perspective" by Piet Oudolf and Noel Kingsbury
This book delves into innovative approaches to planting design, emphasizing the use of perennials, grasses, and other plants to create dynamic and naturalistic landscapes.
3. "The Essential Garden Design Workbook" by Rosemary Alexander
A practical guide to landscape design, this workbook covers various design principles, exercises, and case studies to help students develop their design skills.
4. "The Greenhouse and Hoophouse Grower's Handbook" by Andrew Mefferd
Focusing on greenhouse technology, this book covers essential topics such as greenhouse construction, environmental control, crop production techniques, and sustainable practices.
5. "Greenhouse Operation and Management" by Paul V. Nelson and Robert A. Aldrich
This comprehensive textbook provides in-depth coverage of greenhouse operation, management practices, and techniques for successful crop production in controlled environments.
6. "Introduction to Horticultural Science" by Richard N. Arteca
This book offers a broad overview of horticultural science, including concepts related to plant growth, development, physiology, and cultivation practices relevant to landscaping, gardening, and greenhouse technology.
7. "The Well-Designed Mixed Garden: Building Beds and Borders with Trees, Shrubs, Perennials, Annuals, and Bulbs" by Tracy DiSabato-Aust
Focusing on mixed garden design, this book discusses creating harmonious plant combinations and designing landscapes that evolve through the seasons.
8. "The Greenhouse Gardener's Manual" by Roger Marshall
A practical guide to greenhouse gardening, this book covers topics such as choosing greenhouse structures, managing climate conditions, and cultivating a wide range of crops.
9. "Fundamentals of Plant Physiology" by Lincoln Taiz and Eduardo Zeiger
This textbook provides a strong foundation in plant physiology, helping students understand the physiological processes underlying plant growth, development, and responses to environmental factors.

10. "Sustainable Horticulture: Today and for the Future" by Raymond P. Poincelot - A book focusing on sustainable horticulture practices, discussing environmentally friendly approaches to landscaping, gardening, and greenhouse crop production
Course. prerequisite: To study this course, the students must have had subject biology in class 12th
Suggested continuous Evaluation methods-
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

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Minor Course: For Students of other Discipline/Subject (Other than Major)

Programme: B.Sc./B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IIIrd Year**	**Semester: VI**
Pedagogy:		
Course Code: MBOT06	**Course Title: Palynology- II (Minor)**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Explain the concept of aeropalynology, pollen monitoring, seasonal variations, and pollen allergies with preventive measures. CO.2 Describe the role of pollen in forensic investigations, crime detection, and honey analysis through melissopalynology. CO.3 Analyze the significance of palynology in stratigraphy, oil exploration, climate change studies, and environmental impact assessment. CO.4 Understand the role of pollen in plant breeding, biotechnology, and its applications in pharmaceutical and nutraceutical industries. CO.5 Explain the role of fossil pollen in paleoecology, plant evolution, archeobotany, and biostratigraphy.		
Credit: 3+0+0		**Paper: Core Compulsory**
Max. Marks: 40+60		**Min Passing Marks: 35**
Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+0		

Unit	Topics	No. of Lecture
Unit I	**Aeropalynology and Allergy:** • Concept of aeropalynology and pollen monitoring • Airborne pollen types and seasonal variations • Pollen allergies, allergenic plants, and preventive measures	9
Unit II	**Forensic and Melissopalynology:** • Role of pollen in forensic investigations • Pollen asan evidence in crime detection • Melissopalynology: Honey analysis and pollen spectrum in honey	9
Unit III	**Geological and Environmental Palynology:** • Role of palynology in stratigraphy and fossil pollen analysis • Palynology in oil exploration and climate change studies • Environmental impact assessment through palynological studies	9
Unit IV	**Agricultural and Pharmaceutical Palynology:** • Role of pollen in plant breeding and hybridization • Role of biotechnology in crop improvement • Pollen in pharmaceutical and nutraceutical industries	9
Unit V	**Paleoecology and Evolutionary Palynology:** • Fossil pollen and reconstruction of past vegetation • Palynology in understanding plant evolution • Application in archeobotany and biostratigraphy	9

Suggested Readings:

1) Introduction to Palynology – G. Erdtman
2) Textbook of Pollen Analysis – K. Faegri & J. Iversen
3) An Introduction to Fossil Pollen Analysis – V. R. Bryant Jr. & R. G. Holloway
4) Pollen and Spores: Applications with Special Emphasis on Aerobiology and Allergy – S. Agashe
5) Forensic Palynology – Vaughn M. Bryant & Dallas Mildenhall

6) Aerobiology: The Ecological Systems Approach – F. Isard & M. Gage 7) Paleopalynology– Alfred Traverse 8) Palynology: Principles and Applications – J. Jansonius & D. C. McGregor 9) Pollen and Spores: Morphology and Biology– S. Blackmore & S. H. Barnes 10) Textbook of Palynology- K. Bhattacharya,Manas.R. Majumdar, Swati G. Bhattacharya
Course prerequisite: To study this course, the students must have had subject biology in class 12th
Suggested continuous Evaluation methods-
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Other Courses to Opt:

Internship/Apprenticeship [BOT-23109]

Value Added Course : To be Choosed from POOL D

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Exit Option: Bachelor Degree (Programme duration: Three years or six semesters).

[NHEQF Level 5.5]

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SEMESTER-VII

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23110	**Course Title:** Cell Biology, Genetics and Plant breeding	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Student will understand the concept of Cell and its organelle CO.2 Student will know about Mendelian genetics CO.3 Student will know about the Plant breeding CO4. To understand the Crop Improvement and New Crop Development CO.5 To know about the Cytogenetics		
Credit: 3+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+60		

Unit	Topics	No. of Lecture
Unit I	Cell, the unit of life- Cell theory, prokaryotic and eukaryotic cells; Eukaryotic cell components. Ultra structure and functions of cell wall and cell membranes. Chromosomes**:** morphology, organization of DNA in a chromosome (nucleosome model), euchromatin and heterochromatin.	9
Unit II	DNA as the genetic material: Griffith's and Avery's transformation experiment, Hershey – Chase bacteriophage experiment. DNA structure (Watson and Crick model) and replication of DNA (semi-conservative). Types of RNA (mRNA, tRNA, rRNA), their structure and function.	9
Unit III	Mendel's laws of Inheritance (Mono- and Di- hybrid crosses); backcross and test cross. Chromosome theory of Inheritance. Linkage: concept, complete and	9

	incomplete linkage, coupling and repulsion; linkage maps based on two and three factor crosses. Crossing Over: concept & significance.	
Unit IV	Introduction and objectives of plant breeding. Methods of crop improvement: Procedure, advantages and limitations of introduction, selection, and hybridization.	9
Unit V	Role of mutations in crop improvement. Role of Soma clonal variations in crop improvement. Molecular breeding – use of DNA markers in plant breeding and crop improvement (RAPD, RFLP).	9

Suggested Readings:

1.Old, R.W. and Primrose S.B. 1994, Principles of Gene Manipulation Blackwell Science, London 2. Grierson, D. and Convey S.N. 1989, Plant Molecular Biology, Blackie Publishers, NewYork.
2.Lea, P.J. and Leegood R.C. 1999, Plant Biochemistry and Molecular Biology, John Wiley and Sons, London.
3. Power C.B., 1984, Cell Biology, Himalaya Publishing Co. Mumbai
4. De. Robertis and De Robertis, 1998, Cell and Moleceular Biology, K.M. Verghese and Company.
5. Sinnott, E.W., L.C. Dunn & J. Dobshansky (1958) : Principles of Genetics (5th Edition) McGraw Hill Publishing Co., N.Y. Toronto, London.
6. Winchester, A.M. (1958) : Genetics(3rd Edition) Oxford & IBH Publishing House, Calcutta, Bombay, New Delhi.
7. Singleton, R.(1963) : Elementary Genetics, D. Van Nostrand Co., Ltd., Inc., N.Y. & Affiliated East West Press (P) Ltd., New Delhi.
8. Strickberger, M.W. (1976): Genetics (2nd Edition) MacMillan Publishing Co., Inc., N.Y., London
9. Watson, J.D. (1977): Molecular Biology of the Gene, W.A. Benjamin, Inc., Menlo Park- California, Reading Massachusetts, London, Amsterdam, Don Mills, Ontario, Sydney.
10. Gardner,E.J & Snusted, D.P.(1984): Principles of Genetics (7thedition) John Wiley & Sons, N.Y. Chichester, Brisbane, Toronto, Singapore.
11. Lewin, B. (1985) Genes VII Wiley Eastern Ltd., New Delhi, Bombay, Calcutta, Madras, Hydrabad.
12. Allard R.W(1999): The Principles of Plant Breeding, John & Wiley and Sons.
13. Poelman J.M: Breeding Field Crops, Springer.
14. George Acquaah (2012): Principles of Plant Genetics & Breeding: Wiley-Blackwell.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Practicals List]

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: BOT-23110	**Course Title: Lab work based on theory [Practicals List]**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Distinguish prokaryotic and eukaryotic cells and design the model of a cell CO.2 Demonstrate techniques to observe the cell and its components under a microscope CO.3 Discuss the basics of Mendelian genetics, its variations and interpret inheritance of traits in living beings CO.4 Evaluate the structure, function and regulation of genetic material. CO.5 Understand the application of principles and modern techniques in plant breeding.		
Credit: 0+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 0+0+60		
Practicals List		**Practical (Hrs.)**
1. Study of ultra structureof plant cell and its organelles using Electron microscopic Photographs/models. 2. Demonstration of Mitosis in Allium cepa/Aloe vera roots using squash technique; observation of various stages of mitosis in permanent slides.		60

4. Demonstration of Meiosis in P.M.C.s of Allium cepaflower buds using squash technique; observation of various stages of meiosis in permanent slides. 5. Study of structure of DNA and RNA molecules using models. 6. Solving problems monohybrid, dihybrid, back and test crosses. 7.Solving problems on gene interactions (atleast one problem for each of the gene interactions in the syllabus). 8. Chromosome mapping using 3- point test cross data. 9. Demonstration of emasculation, bagging, artificial pollination techniques for hybridization.	

Suggested Readings:

Botany – III (Vrukshasastram-I): Telugu Akademi, Hyderabad

Pandey, B.P. (2013) College Botany, Volume-III, S. Chand Publishing, New Delhi

Ghosh, A.K., K.Bhattacharya&G. Hait (2011) A Text Book of Botany, Volume-III, New Central Book Agency Pvt. Ltd., Kolkata

Chaudhary, R. C. (1996) Introduction to Plant Breeding, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

Books for Reference:

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under

;Assignment/Practical/Projects – 05 Marks

Internal Class Test – 10 Marks

Attendance/Behavior – 05 Marks

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For Students Pursuing Hons. With Research

Programme: B.Sc. (Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: BOT-23111A	**Course Title: Research Methodology**	

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

CO.1 Understand and ensure uniformity, consistency, reliability and reproducibility of experience

CO2. To understand experimental data and interpretation.

CO3. To understand the principles and applications of basic laboratory methods and instruments

CO4. To know about imply appropriate tools and techniques to solve the problems

CO5.To know about ethic in research field

Credit: 4+0+0	**Paper: Core Compulsory**
Max. Marks: 40+60	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical): 60+0+0

Unit	Topics	No. of Lecture
Unit I	Foundations of Research: Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied	10
Unit II	Research Design: Need for research design— Features of good design, Important concepts related to good design; Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs	12
Unit III	Data Collection, Analysis and Report Writing, Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology	16
Unit IV	Biostatistics: Designing of experiments, Null hypothesis, probability, Correlation, regression, Distribution and measurement of central tendency, Chi Square test, Student t test F- test (one way ANOVA, two-way ANOVA)	12
Unit V	Ethical Issues, Intellectual Property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement	10

Suggested Readings:

1. Seiler, J.P. (2005). Good Laboratory Practice: the Why and the How. Springer
2. Webster, J. G. (2004). Bioinstrumentation. John Wiley & Sons Incorporated
3. Reilly, M.J. (2016) Bioinstrumentation. CBS Publishers & Distributor
4. Ross, M.H. and Reith, E.J. (1995). Histology A Text and Atlas. Harper International Edition
5. Kiernan j.A. (2015) Histological and Histochemical Methods: Theory and Practice. Pergamon Press
6. Sundar Rao P.S.S. and Richard J. (2012). Introduction to Biostatistics and Research Methods. PHI Private Ltd
7. Sokal R.R. and Rohlf F.J. (2009). Introduction to Biostatistics. Dover Publications.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under

;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

For Students Pursuing Honours Only

Programme: B.Sc. (Honours) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: BOT-23111B	**Course Title: Food Processing**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Concept of food and nutrients and energy valueof food. CO2. Understand the problems of Food adulteration CO3. Learn about Therapeutic diets & Diet planning CO4. Govern the methods in food processing – thermal processing, refrigeration, freezing etc CO5.Learn about food Quality & food standards		
Credit: 4+0+0	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 60+0+0		

Unit	**Topics**	**No. of Lecture**
Unit I	Food items; Fermented food, wine, bakery products, cereals, and milk products.	10
Unit II	Spoilage of food products including cereals, fruits, vegetables, meat, fish, and dairy products	12
Unit III	Milk and milk products, source of their contamination and control.	16
Unit IV	Starter cultures. Microbiological legal standards of selected food and milk products. Food poisoning and microbial toxins produced in food items and dairy products.	12
Unit V	Food preservatives and their uses. Mushroom cultivation technology and single cell protein	10

Suggested Readings:

1. Alfa-Laval. *Dairy Handbook*. Alfa-Laval, Food Engineering AB. P.O. Box 65, S-221 00 Lund, Sweden. [Well illustrated text. Excellent introduction to dairy technology]. American Public Health Association, *Standard Methods for the examination of dairy products*. 1015 Eighteenth St. NW, Washington, D.C.
2. Battistotti, B., Bottazzi, V., Piccinardi, A. and Volpato, G. 1983. *Cheese: A guide to the world of cheese and Cheese making*. Facts on File Publications, New York, NY.
3. Berger, W., Klostermeyer, H., Merkenich, K. and Uhlmann, G. 1989. *Processed Cheese Manufacture*, A JOHA guide. BK Ladenburg, Ladenburg.
4. Chandan, R. 1997. *Dairy Based Ingredients*. Amer. Assoc. Cereal Chemists, St. Paul, Minnesota.
5. Davis, J.G. 1965. *Cheese*. American Elsevier Publ. Co., New York.
6. Eck, A. and Gillis, J.-C., 2000. *Cheesemaking from Science to Quality Assurance*, Lavoisier Publishing, Paris..
7. Emmons, D.B., Ernstrom, C.A., Lacroix, C. and Verret, P. 1990. Predictive formulas for yield of cheese from composition of milk: a review. *J. Dairy Sci*. 73: 1365-1394.

8. Fox, P.F., Guinee, T.P., Cogan, T.M., McSweeney, P.L.H. 2000. *Fundamentals of Cheese Science.* Aspen Publishers, Inc. Gaithersburg, Maryland.
9. Hill, A.R. 1995. Chemical species in cheese and their origin in milk components. In *Chemistry of Structure Function Relationships in Cheese*, E.L. Malin and M.H. Tunick, Editors. Plenum Press, NY.
10. Masui, K..and Yamada, T. 1966. French Cheeses: *The Visual Guide to More than 350 Cheeses From Every Region of France*.
11. DK Publishing, New York.Official Methods of Analysis of the Association of Official Agricultural Chemists, P.O. Box 540, Benjamin Franklin Station, Washington, D.C

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Major (Elective): Choose Any Two Course

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23112A	**Course Title:** Medicinal Plants and Phytochemistry	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Student will understand the concept of herbal medicine and its type a CO.2 Student will know about various natural benefits of plants according to ayurveda CO.3 Student will know about the Phytochemical estimation and extraction CO4. To understand the conservations about endangered flora CO.5 To know about the nutraceutical scope of herbs		
Credit: 2+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 30+0+60		

Unit	**Topics**	**No. of Lecture**
Unit I	Importance of medicinal plants; use of medicinal plants in indigenous / traditional systems of medicine - Siddha, Unani, Ayurveda and Homeopathy. Herbal remedies for holistic health. Collection and processing i. e. harvesting, drying, garbling, packing, storage of crude drugs and their marketing.	6
Unit II	Plant morphology and organoleptic characters, biological source, chemical constituents and medicinal uses of the following herbs: Aloe (*Aloe vera*), Jungli pyaz (*Urginea indica*), *Kirayat (Andrographis paniculata)*, lemon grass *(Cymbopogon citratus*), mint *(Mentha piperita*), coriander (*Coriandrum sativum*), garlic (*Allium sativum*), tulsi (*Ocimum sanctum*), ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), sarpagandha (*Rauwolfia serpentina*) and periwinkle (*Catharanthus roseus*).	6
Unit III	General methods of preparation of crude herbal extracts – decoction, maceration, infusion, hot continuous extraction, distillation and supercritical fluid extraction. Histochemical tests for screening of phytoconstituents in natural drugs – alkaloids, flavonoids, steroids, terpenoids, tannins, glycosides and volatile oils. Drug adulteration – deliberate and indeliberate adulteration; types of adulterants. Need for quality control of herbal drugs; microscopic evaluation for quality control.	6
Unit IV	Herbal plants used in cosmetic formulations for skin care (cream, lotion and sunscreen), hair care (oil, shampoo, conditioner and dye) and oral care (toothpaste and mouthwash). Advantages of herbal formulations over synthetic cosmetics. Study of various oils used in aromatherapy with special reference to	6

	its applications in inhalation, local application and bath. Herbal nutraceuticals and their health benefits; culinary uses of herbs.	
Unit V	Conservation and sustainable use of medicinal plants; in-situ and ex-situ conservation methods. Centres for conservation of medicinal plants – CIMAP and FRLHT; TKDL. Plant tissue culture as a source of phytopharmaceuticals	6

Suggested Readings:

1. Kokate, C.K., Purohit, A.P. and Gokhale, S.B. 2010. Pharmacognosy. 45th edition. Nirali Prakashan, Pune.
2. Anonymous. 1999. The Ayurvedic Pharmacopoeia of India. Vol. I & II. Ministry of Health and Family Welfare, Govt. of India, New Delhi.
3. Jackson, B.P. and Snowdon, D.W. 1992. Atlas of Microscopy of Medicinal Plants, Culinary Herbs and Spices. CBS Publishers, New Delhi.
4. Sivarajan, V.V. and Balachandran, I. 1994. Ayurvedic Drugs and Their Plant Sources. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Rosaline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
6. Trease and Evans. 2009. Pharmacognosy. 16th edition. W.B. Saunders Co. Ltd., London.
7. Kar, A. 2003. Pharmacognosy & Pharmacobiotechnology. New Age International (P.) Ltd.
8. Fuller, K.W. and Gallon, J.A. 1998. Plant Products and New Technology. Clarendon Press, New York.
9. Sachs, M. 2014. Ayurvedic Beauty Care: Ageless Techniques to Invoke Natural Beauty. ISBN: 9788120818804.
10. Miller, L. and Miller, B. 1998. Ayurveda and Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing. Lotus Press, United States.
11. Akerele, O.O., Heywood, V. and Singe, H. 1991. Conservation of Medicinal Plants. Cambridge University Press, U.K.
12. Harborne, J.B. 1984. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 2nd edition. Chapman and Hall, New York.
13. Khandelwal, K.R. 2002. Practical Pharmacognosy: Techniques and Experiments. 9th edition. Nirali Prakashan, Pune.
14. Bakhru, H.K. 2010. Foods That Heal: The Natural Way to Good Health. Orient Paperbacks, New Delhi.
15. Mendonsa, G. 2010. The Best of Goan Cooking. UBS Publishers & Distributors Pvt. Ltd.
16. Kapoor, S. 2000. Khana Khazana. Popular Prakashan Pvt. Ltd., Mumbai

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Practicals List]

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23112A	**Course Title: Lab work based on theory [Practicals List]**	

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

CO.1 Practical knowledge on herbal plant extraction, isolation
CO.2 Chemical analysis of bioactive compounds
CO.3 Practical knowledge of optimization technique in herbal drugs
CO.4 To know about phytochemicals practical based on biochemistry
CO.5 Practical knowledge by filed visit.

Credit: 0+0+ 2	**Paper: Core Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**
Total Number of Lectures (Lecture +Tutorials + Practical): 0+0+60	

Practicals Activity	**Practical (Hrs.)**

1. Study of biological source, organoleptic characters, chemical constituents and medicinal uses of the following herbs*: Andrographis paniculata, Mentha piperita, Allium sativum, Ocimum sanctum, Rauwolfia serpentina and Catharanthus roseus*. (2P) 2. Study of organoleptic and microscopic characters, chemical constituents and medicinal uses of the following herbs: *Aloe vera* (leaf*), Zingiber officinale* (rhizome), *Curcuma longa* (rhizome), *Urginea indica* (bulb scale), *Cymbopogon citratus* (leaf) and *Coriandrum sativum* (fruit). (3P) 3. Detection of alkaloids (Datura / Sadafuli / Tirphal), flavonoids (Green Tea / Onion) and saponins (Karando / Godekashtha) or from other suitable plant materials. (1P) 4. Microscopic evaluation and chemical tests (Metanil yellow test and chalk powder test) to detect adulteration of turmeric powder. (1P) 5. Preparation of herbal mouthwash (demonstration). (1P) 6. Preparation of herbal soap (demonstration). (1P) 7. Preparation of herbal formulation for common cold (demonstration). (1P) 8. Preparation of lemon grass medicinal tea (demonstration). (1P) 9. Preparation of coriander chutney or any other herbal dish (demonstration). (1P) 10. Oral presentation and submission of one herbal plant grown by the student (to be evaluated during regular practical - 3 marks). (3P	60
Suggested Readings: Botany Practical book based on theory	
Course prerequisite: To study this course, the students must have had subject biology in class 12th	
Suggested continuous Evaluation methods-	
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks	

Or

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: BOT-23112B	**Course Title:** Environmental Biotechnology	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Student will understand the concept of waste treatment, control, therapy practices of the soil and water CO.2 Student will know about various natural benefits of microbes for the agriculture CO.3 Student will know about the management practices of global pollution CO4. To understand the conservations about environmentally sustainable approach CO.5 To know about the Environmental ecology		
Credit: 2+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 2+0+2		

Unit	Topics	No. of Lecture
Unit I	• Sewage Treatment • Decomposition of toxic waste • Degradation of Petroleum Material • Production of Biogas • Bioethanol • Biodiesel	6
Unit II	• Eutrophication • Green Fuel • Quality norms of water • Bioindicators • Bioremediation • Bioaugmentation	6

Unit III	• Agriculture in India in the rural development • Farmers Right • Biofertilizers • Biotransformation • Single Cell Protein • Biocontrol agent	6
Unit IV	• Mineral Extraction • Bioinsecticide • Disease Control • Organic Compound • Antibiotic • Enzymes	6
Unit V	• *Rhizobium* Spp. • *Azetobacter* and *Azospirillum* • *Cyanobacteria* and *Azolla* • Phosphate Solubilizing Microorganisms • Genetically Engineered Microbes • Industrially Important Microbes	6

Suggested Readings:

1. P F Stanbury, S. Hall, A. Whitaker. Principles of Fermentation Technology, Second Edition. Publisher Butterworth-Heinemann
2. Crueger, W. and Crueger, A. Biotechnology: A Textbook of Industrial Microbiology. PanimaPublsihers
3. AH Patel. A text book of Industrial Microbiology by, Macmillan Publishers India
4. Pleczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, 1993
5. Lansing Prescott, John Harley and Donald Klein, Microbiology R.Y.Stanier, General Microbiology
6. D. Peter Snustad, Michael J. Simmons, John B. Jenkins, PRINCIPLES OF GENETICS

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: BOT-23112C	**Course Title:** Plant Biotechnology	

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

CO.1 Student will understand the concept of Plant Tissue Culture
CO.2 Student will know about role of plant engineering in the agriculture
CO.3 Student will know about the services of Plant Yield
CO4. To understand the limitations of technology
CO.5 To know about the gene and genome technology for human welfare

Credit: 4	**Paper: Core Compulsory**
Max. Marks: 40+60	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical): 2+0+2

Unit	**Topics**	**No. of Lecture**
Unit I	• Plant Tissue Culture • Meristem Culture • Tissue or Cell Culture • Anther Culture • Cybrids • Cryopreservation	6

Unit II	• Plant Genetic Engineering • Gene Transfer • Insect Resistance • Virus Resistance • Improvement of Protein quality • Bio-chemical Production	6
Unit III	• Edible-Vaccines • Purified Recombinant Vaccines • Terminator Gene • Transgenic Agriculture • Plant Breeder's Rights • Biodiversity Convention	6
Unit IV	• DNA Bank • Genetic Advance • Genetic Erosion • Gene Pool • Molecular Mapping & Marker Assisted Selection (MAS) • Plant Domestication	6
Unit V	• BT Gene • Golden Rice • Plant as Biofactories • Hybrid Variety • Gene Designing • Gene Revolution	6
Suggested Readings: 1. H. S. Chawla. Plant Biotechnology A Practical Approach Science Publishers, USA 2. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer Book Description, Orient Longman Publishers 3. S.S. Bhojwani, M.K. Razdan - Plant Tissue Culture: Theory and Practice. Elsevier Science		
Course. prerequisite: To study this course, the students must have had subject biology in class 12th		
Suggested continuous Evaluation methods-		
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under ;Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks		

Minor Course : For Students of Other Discipline/Subject (Other than Major Subjects):

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VII**
Pedagogy:		
Course Code: BOT-23112A	**Course Title:** Plant Pathology (Minor)	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the basic concept of plant pathology and comprehend the disease cycle and various host and pathogen interactions. CO.2 Identify the common plant diseases and pathogens, isolate the pathogen and suggest control measures. CO.3 Demonstrate skills in laboratory and field related to plant pathology. CO4. Identify the common plant diseases according to geographical location. CO.5 Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.		
Credit: 3+0+0	**Paper: Core Compulsory**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+0		
Unit	**Topics**	**No. of Lecture**
Unit I	**Fundamentals of plant pathology**:	6

	Introduction, Concept of plant disease, history of plant pathology, common symptoms of plant diseases.	
Unit II	**Disease development:** Mechanism and mode of infection. Host parasite interaction, Dissemination., defence mechanisms, causes of Epidemics, Disease cycle.	6
Unit III	**Methods of Studying Plant Diseases:** Microscopic study, Macroscopic study, Koch's postulates. Plant Disease management: Physical, chemical and biological management of plant diseases, Plant Quarantine, IDM.	6
Unit IV	**Plant Diseases**: Study of Diseases- Club root of Crucifers, Late blight of potato, Rust of wheat, Leaf spot of cabbage, Blast of Paddy, Citrus Canker, Tobacco Mosaic Disease with reference to causal organism, symptoms and signs, disease cycle and control measures.	6
Unit V	**Resistance:** Systemic acquired and induced systemic, Disease resistance, R-genes, gene for gene concept, immunity (PTI & ETI), hypersensitive response and cell death.	6

Suggested Readings:

- Dickinson, M.2008, -Molecular Plant Pathology, Bios Scientific Publishers, London
- Gupta, G.P.,2004, Text book of plant diseases, Discovery Publ. House, New, Delhi
- Mehrotra, R.S. 1991, Plant Pathology, Tata McGraw Hill Co. Delhi
- Singh, R.S.2004, Plant Diseases, Oxford & IBH Publishing Co. Pvt. Ltd., Delhi.
- Trigiano, Windham and Windham, 2003, Plant pathology, Concepts and laboratory exercises CRC Press London.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under

;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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SEMESTER-VIII

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VIII**

Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc

Course Code: BOT-23113	**Course Title:** Molecular Biology

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

CO.1 Student will understand biotechnological knowledge and genetic engineering.
CO.2 Students will understand applications of biotechnology
CO.3 Students will understand environmental biotechnology
CO.4 Student will learn about the cloning and industrial use of biotechnology
CO.5 Understand the process of synthesis of proteins and role of genetic code in polypeptide formation, concept of gene and genome.

Credit: 03+0+02	**Paper (Code compulsory/Elective): Core**
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+60

Unit	**Topics**	**No. of Lecture**
Unit I	Historical perspective; DNA/RNA as genetic material (Griffith's; Hershey and Chase; Avery, McLeod & McCarty; Fraenkel-Conrat's experiment). Enzymes in translation; Basic features of translation - initiation, elongation and termination, Post-translational processing and modification.	5
Unit II	DNA Structure: Salient features of double helix (Watson and Crick), Types of DNA, Types of RNA, denaturation and renaturation, cot curves; Organization	10

	of DNA - prokaryotes, viruses, eukaryotes. Structure of nuclear DNA v/s organelle DNA.	
Unit III	Genetic code; Central and revised dogma of molecular biology; General principles - Modes of replication, bidirectional replication. Models of DNA replication (Rolling circle, Theta replication and semi-discontinuous replication). Replication of linear dsDNA, enzymes involved in DNA replication Enzymes in transcription; Basic features of transcription - initiation, elongation and termination, promoters and enhancers.	10
Unit IV	Gene organization in prokaryotes and eukaryotes; gene regulation in prokaryotes and eukaryotes. Split genes - concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, alternative splicing; Eukaryotic mRNA processing and stability (5' cap, 3' poly A tail); Ribozymes; RNA silencing.	10
Unit V	Definition of gene and recombinant DNA, steps in genetic engineering. Enzymes used in recombinant DNA technology (Restriction enzymes, DNA ligases, DNA modifying enzymes); Cloning Vectors: pBR322, Ti plasmid, YAC; λ phage, M13 phage, Cosmid; DNA isolation and sequencing (Sanger & Coulson, Maxam & Gilbert)	10

Suggested Readings:

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. 2007. Molecular Biology of the Gene. 6th edition. CSHL Press, New York, NY.
2. Snustad, D.P. and Simmons, M.J. 2010. Principles of Genetics. 5th edition. John Wiley and Sons Inc., U.S.A.
3. Klug, W.S., Cummings, M.R. and Spencer, C.A. 2009. Concepts of Genetics. 9th edition. Benjamin Cummings, U.S.A.
4. Russell, P.J. 2010. i-Genetics - A Molecular Approach. 3rd edition. Benjamin Cummings, U.S.A.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. and Doebley, J. 2010. Introduction to Genetic Analysis. 10th edition. W. H. Freeman and Co., U.S.A.
6. Glick, B.R. and Pasternak, J.J. 2003. Molecular Biotechnology - Principles and Applications of Recombinant DNA. ASM Press, Washington D.C.
7. Stewart, C.N. Jr. 2008. Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc., U.S.A.
8. Dubey, R.C. 1993. A Textbook of Biotechnology. S. Chand & Company Pvt. Ltd., New Delhi.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under

;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Practicals List]

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. IVth Year**	**Semester: VIII**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT-23113	**Course Title: Lab work based on theory [Practicals List]**	
Course Outcome: After completing this course, the students will be able to -		
CO 1. Student will gain the practical knowledge of biotechnology. CO.2 Students will learn separation techniques of the DNA CO.3 Student will learn separation technique of protein. CO.4 Student will learn separation technique of RNA CO.5 Student will learn immunological practical.		
Credit: 0+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 0+0+60		
Practical's List		**Practical (Hrs.)**

1. General laboratory methods and safety procedures. (2P) 2. Extraction of DNA from cauliflower. (2P) 3. Estimation of DNA by diphenylamine method. (1P) 4. Demonstration of separation of DNA by gel electrophoresis. (2P) 5. Extraction of RNA from plant material. (2P) 6. Estimation of RNA by Orcinol reagent. (1P) 7. Study of DNA replication mechanisms through models/photographs (Rolling circle, Theta replication and semi-discontinuous replication). (2P) 8. Study of structures of pBR322, Ti plasmid, YAC, λ phage through models/photographs. (2P)	60

Suggested Readings:

1. Das H.K.: Textbook of Biotechnology, Wiley India Pvt. Limited, ISBN 8126505567, 2004
2. Thieman, William, Michael A. Palladino: Introduction to Biotechnology, Pearson Education India; 3rd ed
3. B.D. Singh: Basic of Biotechnology
4. Kuby : Immunology
5. W.W. Daniel : Biostatistics, Wiley India, Publication
6. Prasad S.G. : Biostatistics

Virtual dissection:https://www.vlab.co.in,
www/onlinelab.in,
https:/vlab.amrita.edu

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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MAJOR (ELECTIVE): CHOOSE ANY ONE COURSE

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: Fourth Year**	**Semester: VIII**
Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc		
Course Code: BOT23114A	**Course Title: Seed Biology and Seed Technology**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understanding the seed structure and related functions, seed health and productivity. CO2. Technology for assessing the seed pathology, purity, and preservation. CO3. Learning the field and laboratory protocols of seed production, certification and quality. CO4. To describe the basic biology, life history, physiology of seed CO5.To know about ecology of seed plants.		
Credit: 3+0+0	**Paper (Code compulsory/Elective): Core**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+0		

Unit	Topics	No. of Lecture
Unit I	Introduction: Seed as basic input in agriculture; seed development in cultivated plants; seed quality concept and importance of genetic purity in seed production; types of cultivars, their maintenance and factors responsible for deterioration, seed production in self- and cross-pollinated crops.	9
Unit II	Mode of pollination and reproduction in crop plants and their modification in relation to hybrid seed production. Principles of hybrid seed production, isolation distance, synchronization of flowering, rouging etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management.	9
Unit III	Seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production – agro climatic requirements	9

	and their influence on quality seed production; seed – criteria involved; life span of a variety and causes for its deterioration; certification standards for self and cross pollinated and vegetatively propagated crops.	
Unit IV	Hybrid Seed – Methods of development of hybrids; use of male sterility and self-incompatibility and CHA in hybrid seed production; one-, two- and three-line system; maintenance of parental lines of hybrids; planning and management of hybrid seed production technology of major field crops and vegetables.	9
Unit V	Planning of seed production for different classes of seeds for self- and cross-pollinated crops, seed quality control system and organization, seed village concept; seed production agencies, seed industry and custom seed production in India, Seed banks.	9

Suggested Readings:

1. Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH.
2. Chhabra AK. 2006. Practical Manual of Floral Biology of Crop Plants. Dept. of Plant Breeding CCS HAU, Hisar.
3. Desai BB. 2004. Seeds Handbook. Marcel Dekker. Kelly AF. 1988. Seed Production of Agricultural Crops. Longman.
4. McDonald MB Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.
5. Musil AF. 1967. Identification of Crop and Weed Seeds. Handbook No. 219, USDA, Washington, DC, USA.
6. Poehlman JM & Sleper DA. 2006. Breeding Field Crops. Blackwell.
7. Singh BD. 2005. Plant Breeding: Principles and Methods. Kalyani.
8. Singhal NC. 2003. Hybrid Seed Production in Field Crops. Kalyani.
9. Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.
10. Tunwar NS & Singh SV. 1985. Handbook of Cultivars. CSCB, GOI

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested continuous Evaluation methods-

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: Fourth Year**	**Semester: VIII**

Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc

Course Code: BOT23114B	**Course Title: Organic Farming**

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

CO.1 Understanding the Soil analysis, soil enrichment methods.
CO2. Technology for assessing the composting procedure, recycling of wastes
CO3. Learning the field and laboratory protocols of use of waste materials in mushroom cultivation
CO4. To describe the nutrient requirement of various crops
CO5.To know about identifying various methods of keeping soil health

Credit: 3+0+0	**Paper (Code compulsory/Elective): Core Elective**
Max. Marks: 40+60	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical): 2+0+2

Unit	**Topics**	**No. of Lecture**
Unit I	Introduction: Farming, organic farming, concept and development of organic farming, Principles of organic farming, types of organic farming, biodynamic farming, Benefits of organic farming, need for organic farming, conventional farming v/organic farming, Scope of organic farming; Andhra Pradesh, National and International status, Agencies and institutions related to organic agriculture, Requirements for organic farming, farm components for an organic farm	14
Unit II	Organic farming systems, soil tillage, land preparation and mulching, Choice of varieties, Propagation-seed, planting materials and seed treatments, water management, Green manuring, composting- principles, stages, types and factors, composting methods, Vermi composting, Bulky organic manures, concentrated organic manures, organic preparations, organic amendments and sludges., Bio-	12

	fertilizers- types, methods of application, advantages and disadvantages, standards for organic inputs- fertilizers	
Unit III	Plant protection- cultural, mechanical, botanical pesticides, control agents, Weed management, Standards for organic inputs- plant protection	12
Unit IV	Organic crop production methods- rice, coconut, Organic crop production methods- vegetables- okra, amaranthus, cucurbits, Livestock component in organic farming., Sustainable Agriculture-Apiculture, Mushroom cultivation.	12
Unit V	Farm economy: Basic concept of economics- demand &supply, economic viability of a farm, Basic production principles, reducing expenses, ways to increase returns, cost of production system. Benefit/ cost ratio, marketing, imports and exports, Policies and incentives of organic production, Farm inspection and certification, Terrace farming.	10

Suggested Readings:

1. Palaniappan SP &Anandurai K. 1999. Organic Farming–Theory and Practice. Scientific Publishers, Jodhpur
2. Joshi, M. 2014. New Vistas of Organic Farming 2nd Ed. Scientific Publishers, Jodhpur.
3. Farming system: Theory and Practice - S.A.Solaimalai
4. Organic Farming: Theory and Practice- S.P.Palaniappan and K.A. Annadurai
5. A hand book of Organic Farming by A.K.Sharma

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested Activities: Preparation of Vermicompost in small scale, observing sewage sludge disposal mechanisms in urban/semi urban areas, studying the usage, of green manures, neem oil, neem cake, pongamia oil in organic farming, livestock component in various farming methods, visiting an Apiculture center, drawing various terrace farming models

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: Fourth Year**	**Semester: VIII**

Pedagogy: Lectures, Practical's, Field and laboratory visits, Participatory Learning, Seminars, Assignments, specimen submission etc

Course Code: BOT23114C	**Course Title: Natural Resource Management**

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

CO.1 Understanding the horticulture, silviculture and socio-culture
CO2. Management practices for recycling of wastes
CO3. Learning the field and laboratory protocols of use of waste materials in sustainable management
CO4. To describe the Ethical concept
CO5.To know about identifying agricultural waste

Credit: 3+0+0	**Paper (Code compulsory/Elective): Core Elective**
Max. Marks: 40+60	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical): 45+0+0

Unit	**Topics**	**No. of Lecture**
Unit I	Natural resources: Definition and types. Sustainable utilization: Concept, approaches (economic, ecological and socio-cultural). Land: Utilization (agricultural, horticultural, silvicultural); Soil degradation and management. Water: Fresh water (rivers, lakes, groundwater, water harvesting technology, rain water storage and utilization.	9
Unit II	Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan). Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.	9
Unit III	Energy: Renewable and non-renewable sources of energy-solar, wind, tidal, geothermal and bioenergy resources. Contemporary practices in resource management:	9

	EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon-footprint.	
Unit IV	Resource Accounting; Waste management. National and international efforts in resource management and conservation	9
Unit V	Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation. Measurement of dominance of woody species by DBH (diameter at breast height) method.	9

Suggested Readings:

1. B. W. Pandey. 2005. Natural Resource Management. Mittal Publication, New Delhi
2. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
3. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
4. 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. prerequisite: To study this course, the students must have had subject=t biology in class 12th

Suggested Activities: Calculation and analysis of ecological footprint, Ecological modelling, Collections of data on forest cover of specific area.

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under

;Assignment/Practical/Projects – 05 Marks

Internal Class Test – 10 Marks

Attendance/Behavior – 05 Marks

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Programme: B.Sc. (Honours/Honours with Research) in Botany	**Year: B.Sc. 4th Year**	**Semester: VIIIth**
Pedagogy: Lectures, Practicals, Field and laboratory visits, Participatory Learning, Seminars, Assignments,specimen submission etc		
Course Code: BOT23115A	Course/Paper Title:	Dissertation/Research Project & Viva voce [For Hons. with Research Students]
Course Outcomes: After completing this course, the students will be able to -		
CO 1: acquire Research Skills and awareness about Methodology CO 2: develop critical thinking skills for evaluating existing literature and research gaps. CO 3: develop Communication Skills, Analytical and Problem-Solving abilities. CO 4: develop Project Management and will be able to contribute to existing knowledge CO 5: Collaborate in Interdisciplinary Skills.		
Credit: 12		Paper (Core Compulsory / Elective): Elective
Max. Marks: **40+60**		
Total Number of Lectures (Lecture – Tutorials – Practical): 0+0+12		

Units:	Topics:	No. of Lectures
I	Dissertation/ Research Project & Viva Voce	360

Suggested Readings:

General Research Methodology

1. Kothari, C. R. & Garg, Gaurav
   Research Methodology: Methods and Techniques
   – New Age International Publishers
   - A foundational book on qualitative and quantitative research methods.
2. Creswell, John W.
   Research Design: Qualitative, Quantitative, and Mixed Methods Approaches

– SAGE Publications
- Comprehensive guidance for designing and conducting research.

3. Neuman, W. Lawrence
Social Research Methods: Qualitative and Quantitative Approaches
– Pearson Education
   - Ideal for social sciences and interdisciplinary studies.
4. Ranjit Kumar
Research Methodology: A Step-by-Step Guide for Beginners
– SAGE Publications
   - Practical guide with examples, useful for first-time researchers.

Academic Writing & Dissertation Structuring

5. Turabian, Kate L.
A Manual for Writers of Research Papers, Theses, and Dissertations
– University of Chicago Press
   - Covers formatting, citation styles, and academic tone.
6. Walliman, Nicholas
Your Research Project: A Step-by-Step Guide for the First-Time Researcher
– SAGE Publications
   - Student-friendly guide to planning and writing a dissertation.
7. Booth, Wayne C., Colomb, Gregory G., & Williams, Joseph M.
The Craft of Research
– University of Chicago Press
   - Insightful resource on forming arguments, framing research questions, and structuring.

Subject-Specific & Technical Writing

8. Day, Robert A. & Gastel, Barbara
How to Write and Publish a Scientific Paper
– Cambridge University Press
   - Ideal for students in science, engineering, and health disciplines.
9. Denscombe, Martyn
The Good Research Guide: For Small-Scale Social Research Projects
– Open University Press
   - Excellent for undergraduate dissertations and small research projects.

Plagiarism, Referencing & Ethics

10. American Psychological Association (APA)
Publication Manual of the APA (7th Edition)
– APA
   - For academic writing, referencing, and ethical research practices.
11. MLA Handbook (9th Edition)
– Modern Language Association
   - Referencing guide for literature, humanities, and liberal arts.

Office of Research Integrity (ORI), USA
Introduction to the Responsible Conduct of Research
- Free online guide on ethics, plagiarism, authorship, and data handling.

Suggested continuous Evaluation Methods –

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1(After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assesment will be distributed as under
;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Field Visit/ Educational Tour Visit & Report based Viva Voce [Course Code: BOT23115B] for (Hons. Students)

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Completion of the Programme: **Bachelor Degree with Honours/Honours with Research** in Major Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme. **[NHEQF Level 6.0]**

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